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new column —
Elmer's Notebook
by Tom McMullen, W1SL

ham radio magazine

compact cw transceiver for 20 meters

hr

focus on communications technology

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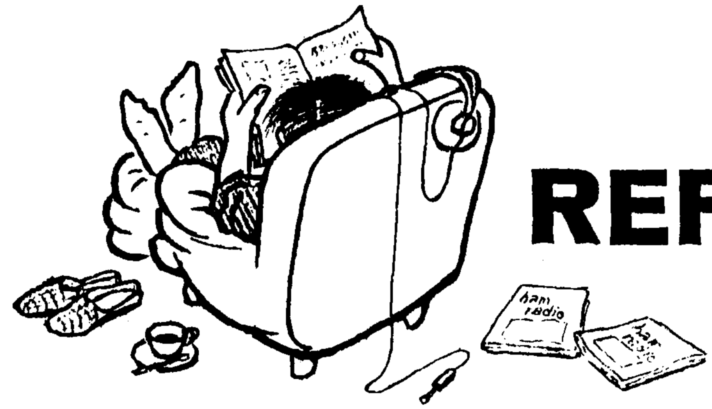

REFLECTIONS

a whole new generation of "designers"

I just read an honest, provocative article in the April, 1987 issue of *Folio*, a magazine for people who publish and produce magazines, about how some people expect to become editors and publishers simply by purchasing desktop publishing systems. In short, the author of that article said — and I fully agree — that a piece of equipment and some software do not an editor make.

I'm wondering if the same thing can be said about electrical circuit designers. Take a PC and any of your better interactive design software, be it for filters, amplifier stages, or receivers. Add some form of schematic capture capability — and voila! A full-fledged designer!

Well, maybe . . . .

Someone with reasonable intelligence (i.e., able to form cause-and-effect conclusions), when provided with a PC and some interactive software, will probably generate some pretty decent designs. You might even get those designs from him a lot faster than you'd get them from the generation of designers and engineers of which I consider myself a part.

For example, let's say you buy a relatively sophisticated piece of filter synthesis software with a well-thought-out, user-friendly, menu-driven program. A basic circuit is provided as part of a learning tutorial. Hit one of the function keys and the circuit response pops up on the screen, replete with MHz and dB. If the rejection or bandwidth or ripple isn't exactly what you want, back you go to the original menu; you simply turn the knob and *watch* the response take all different shapes.

Depending upon the sophistication of the software, you might have to do no more than enter your wish list; the computer will not only provide the circuit topology (after going through all the possible choices — Chebyshev, Butterworth, Elliptical, Gaussian, etc.) quietly and rapidly, but will determine the number of poles, matching sections, and component values as well. Of course, it's possible that your wish list will exceed even Fano's limitation (a fundamental mathematical relationship which says, in essence, that you can't get something for nothing). But then if the software is worth its salt, it will gently remind you that what you desire isn't exactly possible, and ask whether you might be willing to consider modifying the parameters to conform just a little bit more with reality.

Basically, then, what we have is a new generation of designers who don't necessarily need to rely on a storehouse of knowledge about resistors that *aren't*, coils that need to be "opened up" just a little more, box covers that *do* have an effect, and all other the peculiarities one can encounter in the analog world.

Though this makes me feel somewhat like a relic (I still enjoy "hands-on" designing), I suspect many of us older (read that "more mature") Radio Amateurs share the same feeling. However, in the case of circuit design software, I believe real progress has occurred: tools have been developed by the older generation that can be used by the younger generation to effect better and more efficient designs more quickly than ever before.

Rich Rosen, K2RR
Editor-in-Chief

comments

groundplane antenna

Dear HR:

The original "groundplane antenna" was not developed by Brown, Epstein, and Lewis in the late 1930s, as generally published and last mentioned in *ham radio* ["The Offset Drooper — An Improved Gound Plane," by Woodrow Smith, W6BCX, February, 1986, page 43].

This VHF/UHF antenna was invented several years before in France by Maurice Ponte (French patent No. 764.473, 1933) with all the main items such as elevated feedpoint, coaxial feeding, and radials.

The "groundplane" for preventing undesired radiation from feedline was described either as a disk 1/2-wave in diameter or as a number of horizontal 1/4-wave radials.

This invention was also known and patented in the United Kingdom and in the United States (United Kingdom patent No. 414,296, applied for in 1934; United States patent No. 2,026,652, applied for in 1933 and granted in 1936).

Two remarkable early contributions to the groundplane antenna development should be noted: a base reactance compensation for reduction of amplitude and phase distortion for television application (Germany, 1936) and tuned radials, either with coiled conductors and series capacitances or with bent or encircled arms tunable for series resonance (United Kingdom, 1937/38).

This present information about the early history of groundplane, however, does not diminish the importance of Dr. Brown's role as a great American inventor and antenna specialist. His remarkable works, known worldwide, include: *Earth Currents* (1933), *Turnstile* (1935), *Broadcast Antennas* (1935), *Multifrequency Antenna* (1936), *Ground Systems and Antenna Efficiency* (1937), *Directional Antennas* (1937, *Square Antenna* (1938), *Rotary Beam* (1940), *Collinear Antenna* (1941), *Duplex Balancer* (1942), and *RF Wattmeter* (1943).

Alois Krischke, DJ0TR/OE8AK
Munich, West Germany

kudos > kantronics

Dear HR:

With all of the less than desirable business practices going on in this world, it is with pleasure that I relate a good experience with you.

After purchasing a used Kantronics UTU Universal Terminal Unit, I discovered that there was a problem with "handshaking" between the UTU and the computer. After inserting a breakout box between the two, I found that the UTU was not sending a CTS (Clear To Send) signal to the computer. This prevented the computer from sending anything to the UTU, because as far as the computer was concerned, the UTU just wasn't ready.

I called Kantronics and spoke with their service technician, who informed me that I was using an older version of the firmware (version 1.0) and said that if I would give him my address, he would send me out the updated version (1.3). Although I informed him that I had purchased this unit used, he replied that it was company policy to correct any manufacturing errors. The replacement EPROM was received about four days later, and it works just fine.

Thus, in this day of the quick buck, it is a pleasure to announce to the world that there are still quality firms out there doing business. Please pass along the word, and send them more business!

Rick Mainhart, WB3EXR
Mystic, Connecticut 06355

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Unlike machine specific TNCs you never have to worry about your MFJ-1274 or MFJ-1270 becoming obsolete because you change computers or because packet radio standards change. You can use any computer with an RS-232 serial port with an apropriate terminal program. If packet radio standards change, software updates will be made available as TAPR releases them.

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a compact 20-meter CW transceiver

Pack a private DX-pedition in a *very* small bag

DX-ing from another part of the world is something most of us would like to try, but packing those extra suitcases full of equipment can take much of the joy out of traveling. My solution to this problem was to choose a favorable band and mode, and then design a super-compact station that would slip into my suitcase without displacing more essential items. I settled on the 20-meter band because it's open most of the time, and because portable antennas for that band are easy to pack and erect. I chose CW because it provides the best opportunity for reliable long-range communications on low power.

The *CW Travelradio*, described in this article, is what resulted. The entire package measures 1.5 x 4.5 x 6.0 inches and weighs just *1.5* pounds. The receiver is a conventional superhet with AGC and a switchable CW audio-bandpass filter; the choice of speaker or headphone operation is yours. The transmitter delivers 12 to 15 watts to the antenna, and features sidetone and semi-break-in. The VFO range covers the bottom 100 kHz of the band, where virtually all CW and most RTTY operation takes place.

circuit description

To expedite the design, I reworked board art from an existing 1-watt SSB exciter to make a basic transceiver circuit board. I then designed a control board to provide shaped keying, semi-break-in T/R switching, and sidetone generation. I completed the package by adding a simple two-stage audio-bandpass CW filter and a 15-watt class C PA.

The receiver is an updated version of previously published designs.[1,2] Double-balanced mixer U1 (see **fig. 1**) amplifies and converts 14-MHz signals to 9 MHz, which are filtered through FL-1 and fed to i-f amplifier U2. The gain of U2 is controlled by an audio-derived AGC. U3 is a DBM product detector. U4 amplifies received signals and sidetone to speaker level, and provides AGC drive to dc amplifier circuit Q1, Q2. U4 runs at full gain, with speaker and headphone volume controlled "downstream" via R1. This arrangement permits full AGC action at all gain control settings.

Transmit mixer U5 combines BFO and VFO drive to produce a 14-MHz output. This stage is keyed via Q8 (see **fig. 2**). Harmonics and other unwanted products are removed by the bandpass filter at L3, L4. Broadband amplifier Q6 then boosts the filtered signal to drive FET driver stage Q7. This stage operates in class AB, and delivers about 0.7 watts at the output of a 50-ohm Pi-network. If desired, a simple class-C configuration using a bipolar device could be substituted without major disruption to the circuit board.

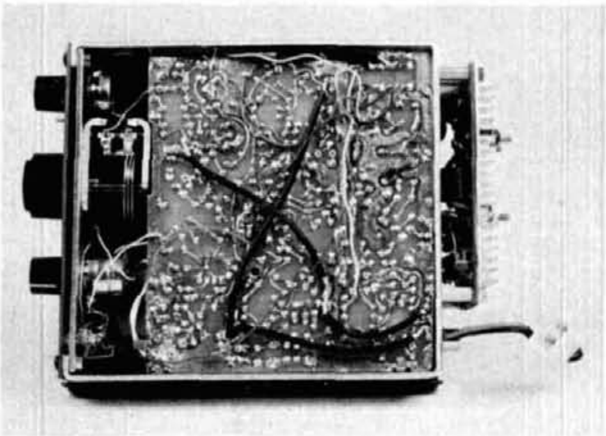
Q11 is a broadbanded class-C PA (see **fig. 3**) that delivers 12 to 15 watts output into 50 ohms. A five-section half-wave filter suppresses harmonics, and an adjustable diode detector provides a dc signal for metering rf output.

VFO Q4 tunes from 5.0 MHz to 5.1 MHz to cover the bottom 100 kHz of the band. Source-follower Q5 isolates the VFO and provides a low impedance drive to the mixers. BFO Q3 utilizes diode-switched capacitance in series with Y1 to provide a 700-Hz offset during transmit.

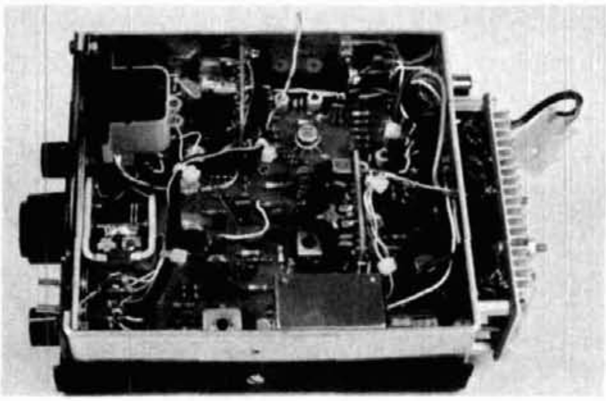
The CW control module provides three functions. Q8, the dc switch, simultaneously activates the transmit mixer, sidetone oscillator, and relay driver when the key is depressed. An RC input circuit shapes rise time, which in turn softens the CW wavefront and prevents key-clicks.[3] Twin-T oscillator Q9 generates a 700-Hz sidetone, which is fed to audio amplifier U4 during transmit.[4] Relays K1 and K2 are controlled by

Rick Littlefield, K1BQT, Box 114, Barrington, New Hampshire 03825

The 20-meter sub-compact QRP transceiver has most of the features of a full-sized radio, yet occupies very little space.



Main board is mounted about 1/4 inch above the bottom of the frame to allow space for wires and parts mounted on the bottom of the board.



The CW control module and CW filter are mounted onto the main board with stiff buss wire. FL1 is epoxied to side panel. The power amplifier is mounted externally on the back panel to reduce heating of internal circuitry during transmit.

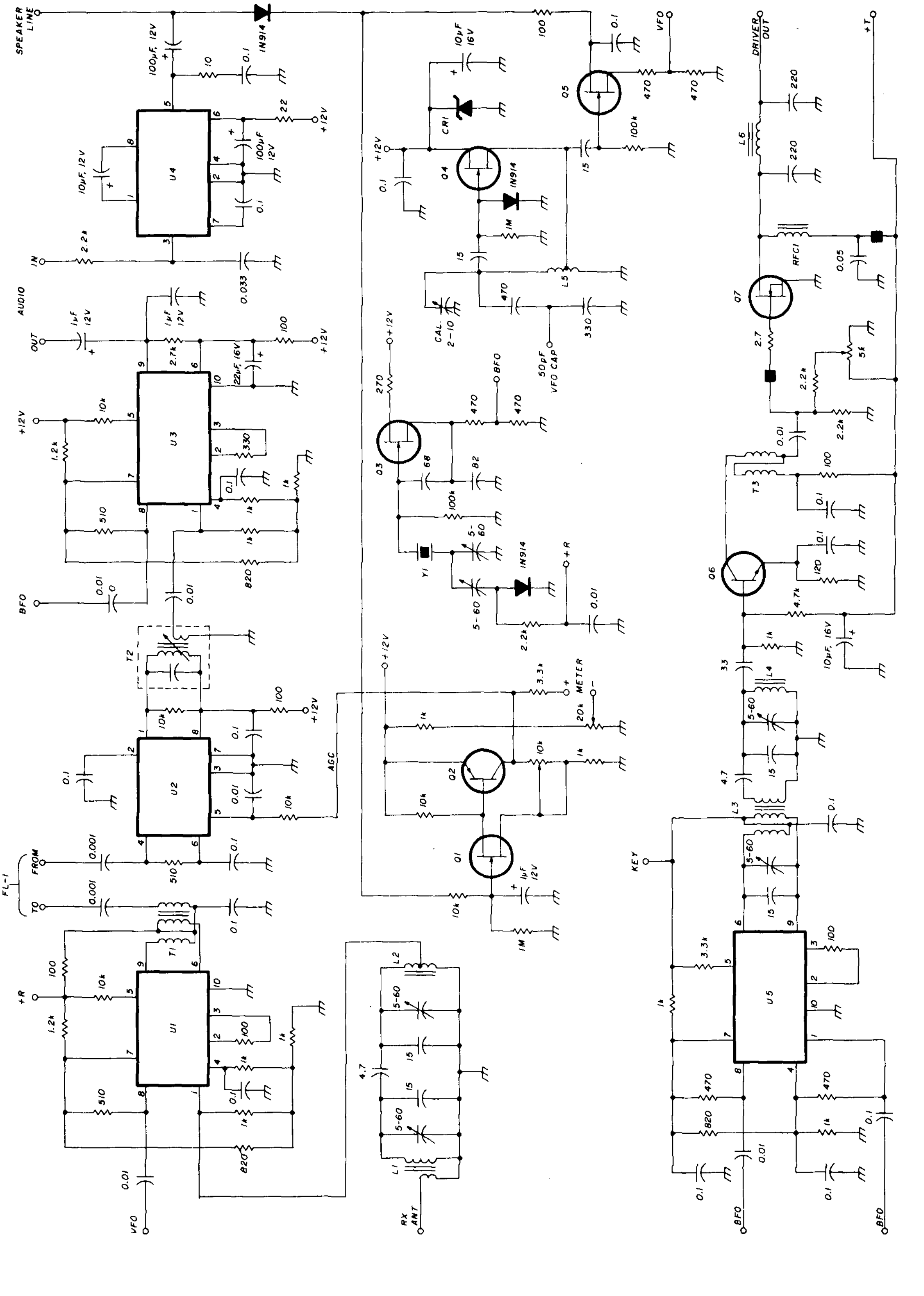


fig. 1. Main circuit diagram (see parts list, page 12).

Ferrite beads	*FB43-101*
FL1	*9-MHz crystal filter, Showa SF0922B or equivalent*
L1	*20 turns No. 26 on T37-2, 2-turn link*
L2	*20 turns No. 26 on T37-2; tap at 10 turns*
L3	*10 turns No. 28 trifilar wound on T37-2*
L4	*20 turns No. 26 on T37-2*
L5	*36 turns No. 32 on 1/4-inch form; tap at 9 turns, enclose in 1/2 x 1/2 x 3/4-inch shielded can*
L6	*12 turns No. 24 on T37-2, spread to occupy 80 percent of form length*
Q1, Q3, Q4, Q5	*MPF102*
Q2	*2N3906*
Q6	*2N2222A*
Q7	*DV-1201K (M/A-COM, 1742 Crenshaw Blvd., Torrance, CA 90501)*
T1	*10 turns No. 28 trifilar wound on FT37-43*
T2	*10.7 MHz output transformer, green core*
T3	*10 turns No. 26 bifilar wound on FT37-61*
U1, U3, U5	*MC1496G*
U2	*MC1350P*
U4	*LM386*
VFO capacitor	*50 pF, 6:1 reduction drive*
Y1	*8998.5-kHz crystal, series resonant*
Z1	*Zener, 9 volts @ 400 mA*

switching FET Q10. Delay time is set via an adjustable RC circuit on the gate of Q10.

CW filter U6 is a two-stage audio-bandpass CW filter (see **fig. 4**) built around a dual op-amp. This is a simplified version of a popular three-stage design.[5] With the values shown, center frequency was measured at 720 Hz. A response curve is shown in **fig. 5**.

Finally, U7 is a monolithic 12-volt regulator that protects and stabilizes voltage to all stages except the PA (see **fig. 6**). All T/R switching is handled by miniature DPDT relays K1 and K2. An extra set of contacts is available for switching an external amplifier.

construction

Space is limited, so choosing small components is important. All four boards were designed to accommodate 1/4-watt resistors, low-voltage ceramic or monolithic caps, tantalum dips, miniature vertical trimpots, and miniature trimmers. Attempting to substitute larger devices will quickly result in overcrowding.

Monolithic capacitors were used in most frequency-critical rf circuits. Silver mica or high quality NPO ceramic devices can be substituted in most cases, as

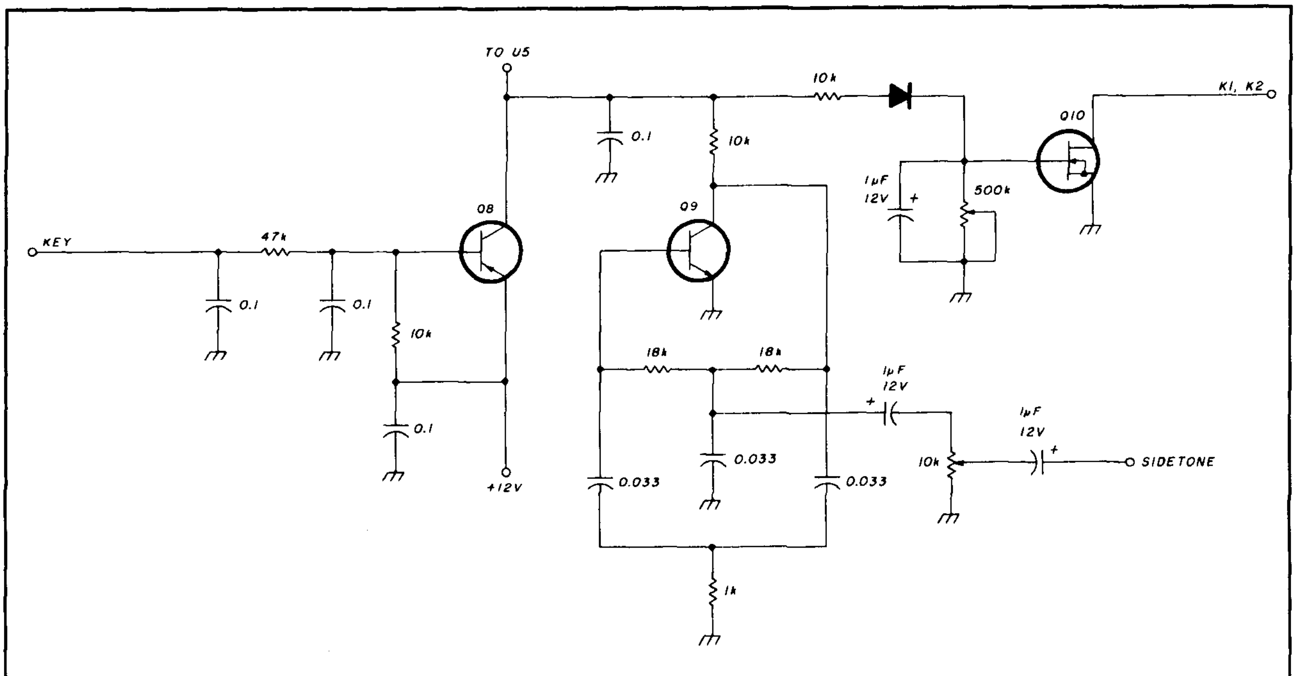


fig. 2. CW control module schematic.

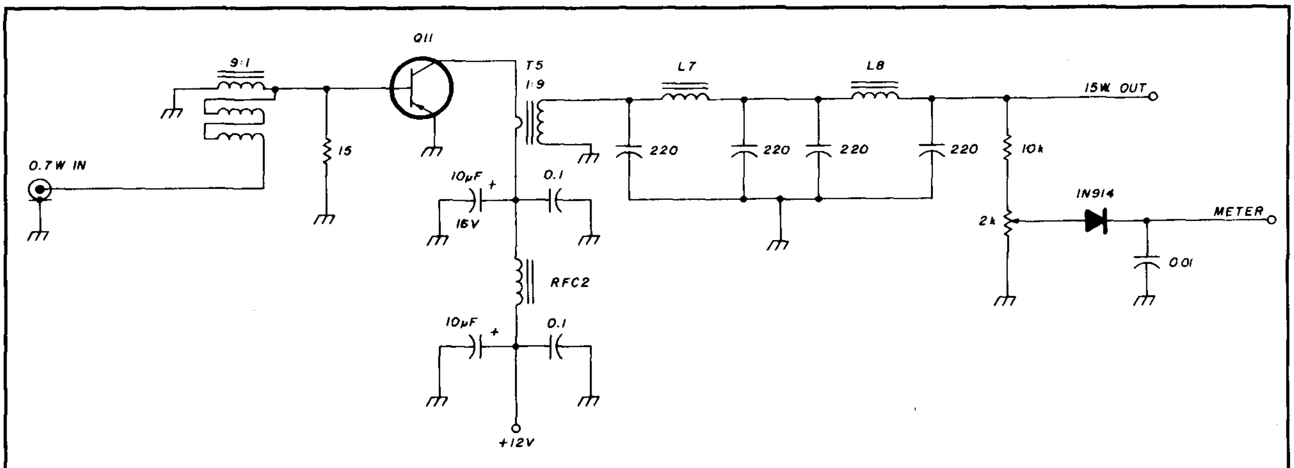


fig. 3. 15-watt class C power amplifier module schematic.

long as they're within 5 percent of specified values. While polystyrene capacitors are typically specified for frequency-critical elements in audio oscillators and active filters, monolithics are much smaller and seem to work just as well. To ensure accuracy, I matched active filter values carefully with a capacitance meter. Finally, I recommend using flexible small diameter wire and lavalier microphone cable for jumpers and interconnections. Harnessing leads together will reduce the chance of breakage. A complete kit and most of the individual parts are available from Radiokit.*

The parts layout for the main board is shown in **fig. 7**. It's generally easier to mount low-profile components (such as resistors, capacitors, and ICs) first, saving taller items (like trimpots and inductors) for last. FT-type toroid cores should be coated with clear nail polish before winding to prevent damage to enameled wire insulation. Toroids and chokes should be installed last and glued in place to prevent movement and lead breakage. When all parts and wires are installed on the top side, refer to **fig. 8** and complete the bottom side.

*For details, contact Radiokit, Box 973, Pelham, New Hampshire 03076.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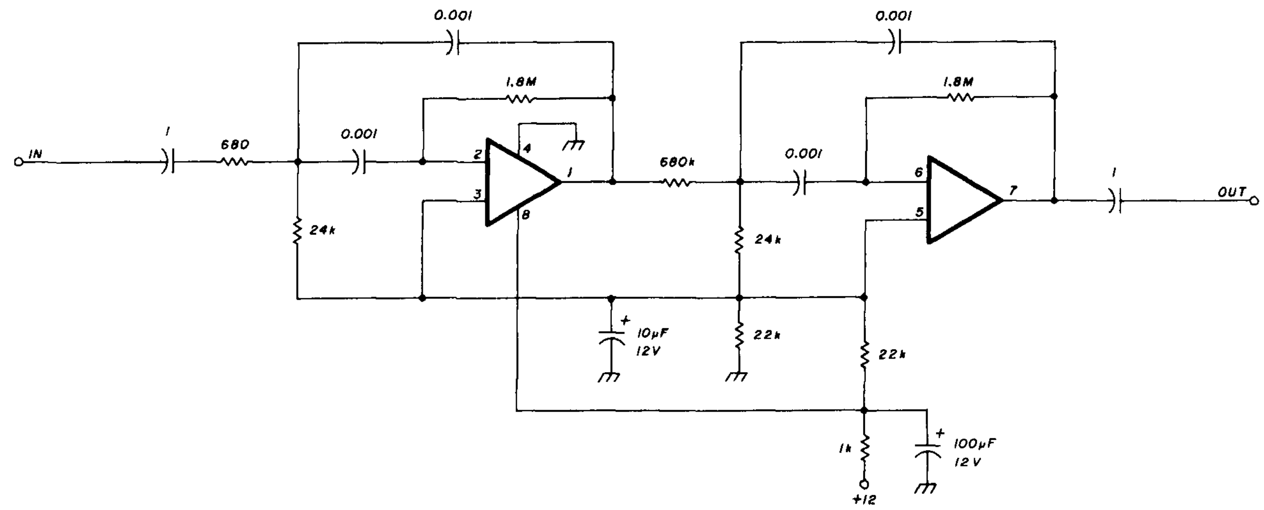

fig. 4. CW filter module schematic.

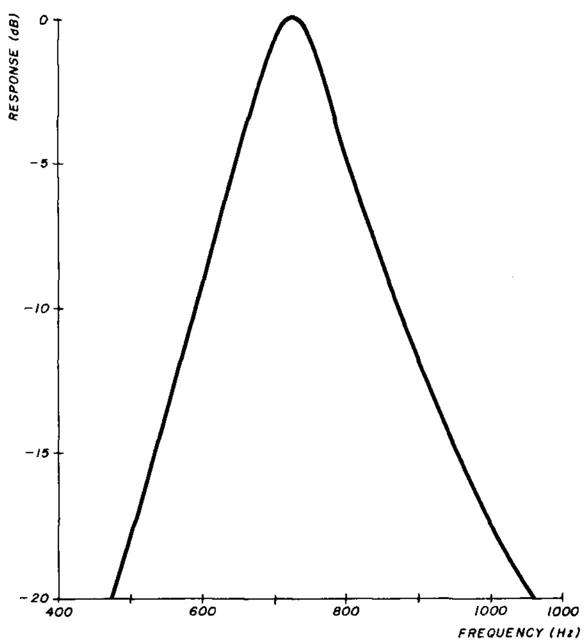

fig. 5. Measured frequency response of two-stage active audio CW filter. Filter significantly improves signal readability during crowded band conditions.

Construct the control module **fig. 9**, and the CW filter module **fig. 10** in similar fashion. Solder all power and signal leads to the foil side of these boards.

The PA circuit board is mounted onto the PA heatsink before construction (foil side up). All components are mounted stripline-style by soldering them directly to the tracks (**fig. 11**). Note that a rectangular hole is cut in the board to accommodate mounting the PA transistor directly to the heatsink. Since the MRF479 is an emitter-tab device, no insulating washer is used between the tab and ground.[6]

packaging

I packaged my transceiver in an open frame cabinet similar to what many commercial equipment manufacturers use. Mounting tabs for the main board were made by tacking solder lugs onto the foil, then fastening them onto the frame with No. 4-40 screws. The CW control board and CW filter modules were mounted into the main board with stiff bus wires. Crystal filter FL1, relay K2, and the meter are held in position with contact cement. Voltage regulator U7 is fastened to the frame with No. 4-40 hardware. The PA is mounted to the outside of the back panel with 3/4-inch spacers. This approach keeps circuit board and chassis wiring very accessible, and reduces the box size to a bare minimum. However, packaging is tight, and a cabinet of this type requires a metal shop and a fair amount of care to construct.

Since layout isn't very critical, the transceiver can be constructed in any convenient case — as long as a few basics are taken into account to ensure VFO stability. I recommend keeping the PA module on the outside of the case to reduce interior temperature fluctuations during transmit. Also, make sure all external VFO components are securely mounted and connected with short, rigid leads. Finally, route interstage wiring well away from VFO components. Mounted in a Hammond cast aluminum case, with a portable VCR battery, this rig would make an extremely tough and self-contained communications package for rough-and-tumble DX enthusiasts!

Once the packaging is done, and all interconnec-

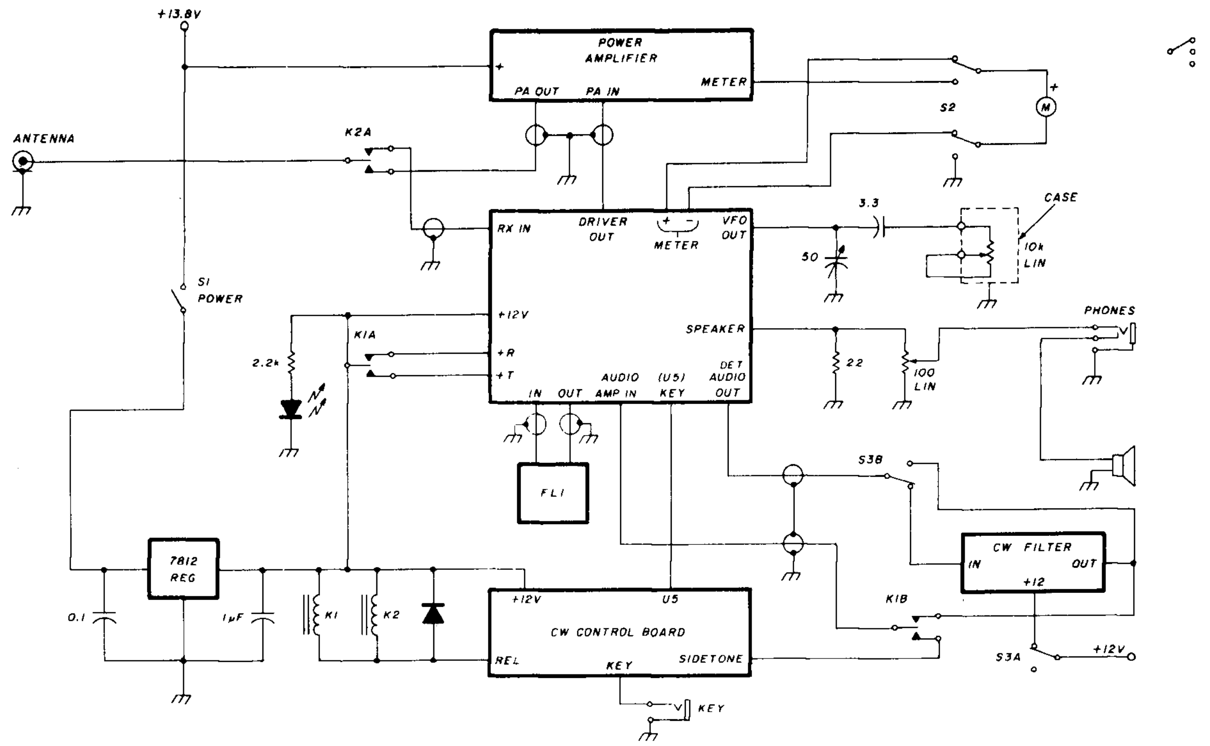

fig. 6. Module interconnections for completed transceiver. Note that K1 is actually located on the main board.

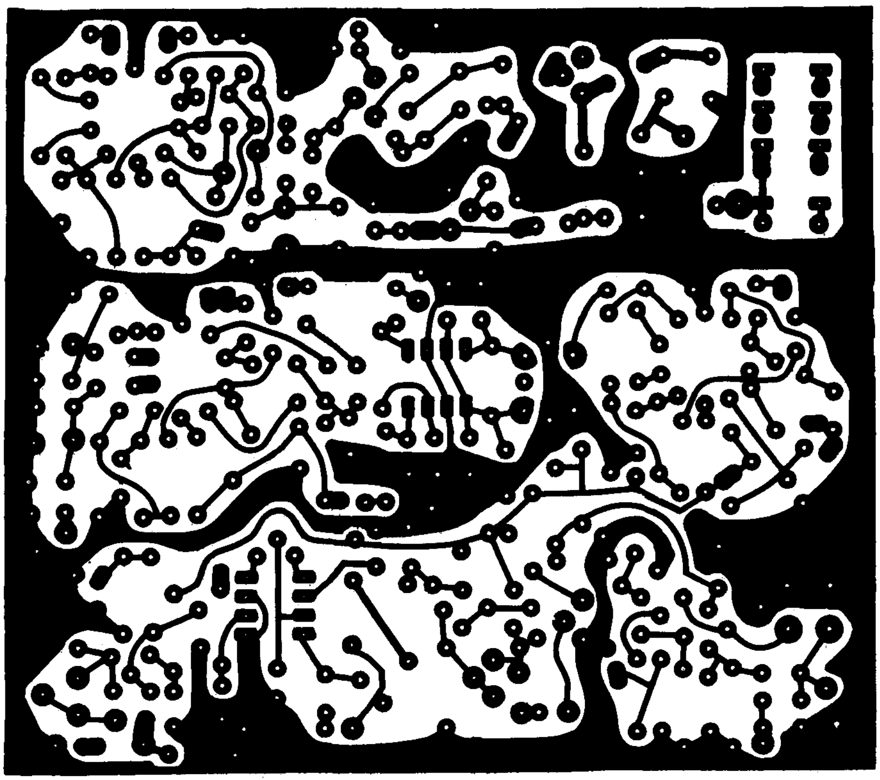

fig. 7A. Main transceiver board pc board art (foil side).

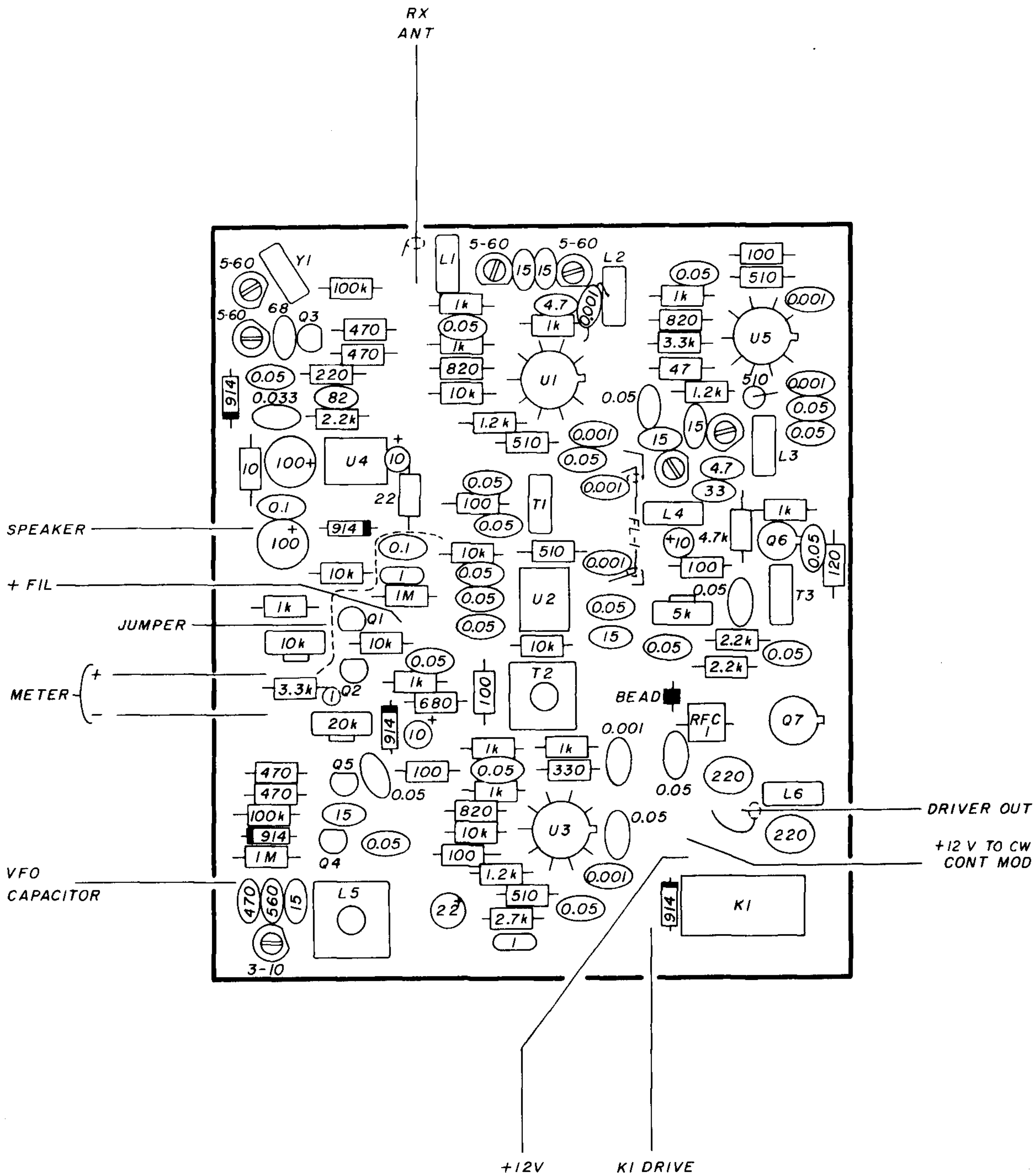

fig. 7B. Main transceiver board component layout.

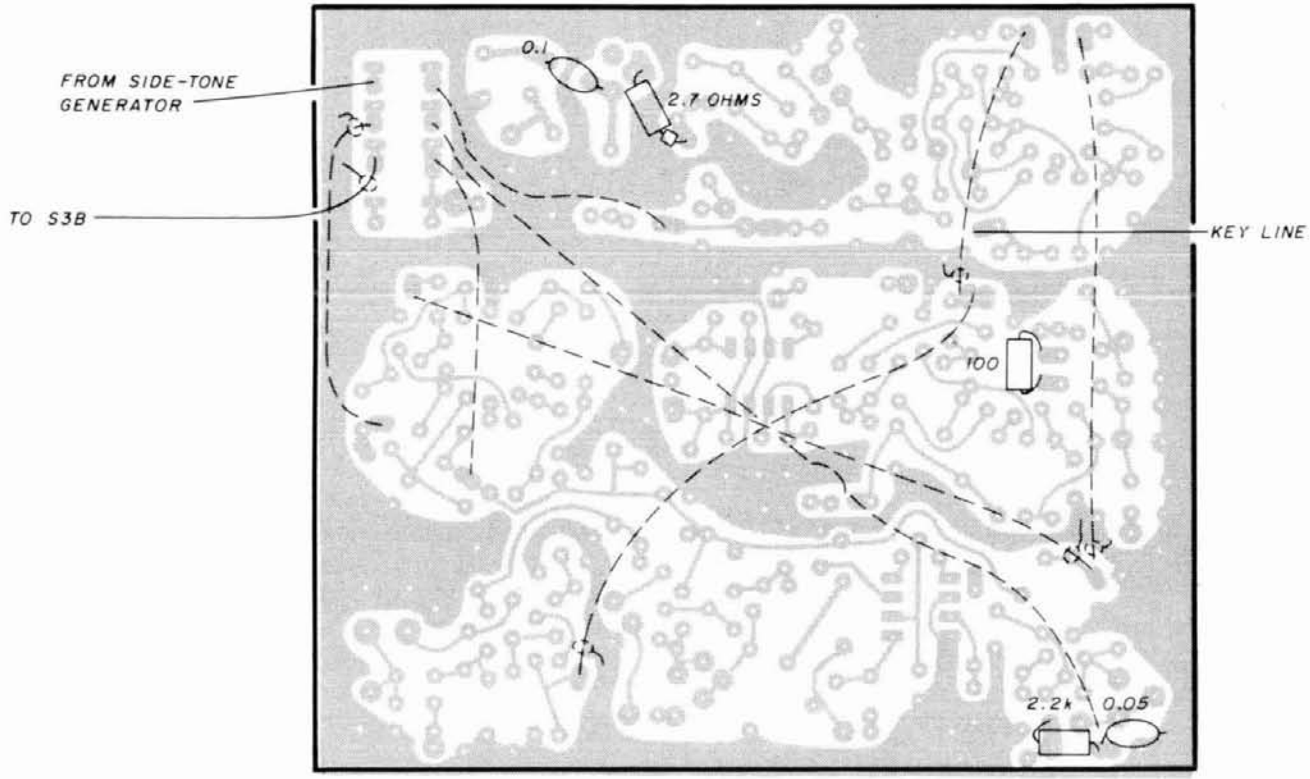

fig. 8. Wiring placement guide for main transceiver board.

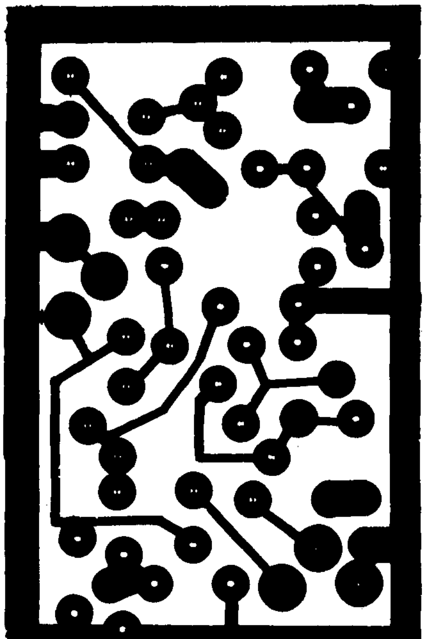

fig. 9A. CW control module pc board art (enlarged 2X).

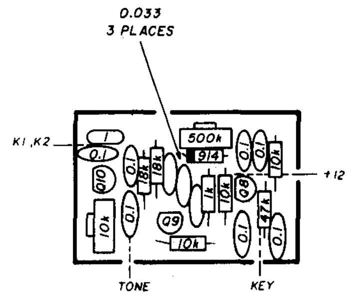

fig. 9B. CW control module component placement guide.

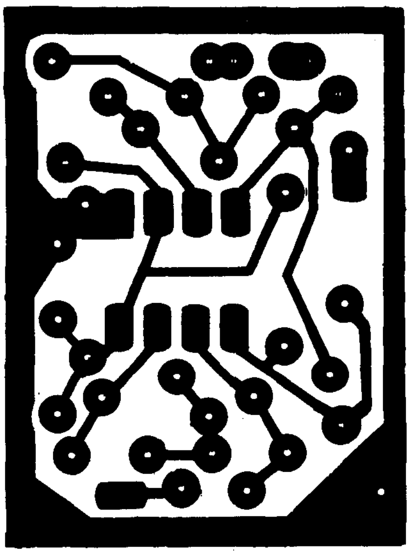

fig. 10A. CW audio filter pc board art (enlarged 2X).

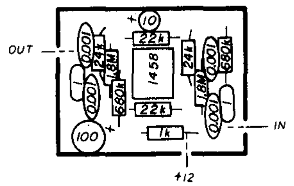

fig. 10B. CW audio filter component placement guide.

tions are made (**fig. 6**), it's time to double-check the wiring and connect a power supply. I use a compact 13.8-volt supply that's capable of supplying 2.5 amps for intermittent periods. Although this supply is regulated, I added 2000 μF to the output circuit to help the regulator track the current surge as the transmitter is keyed. Note that the transceiver's voltage regulator needs a supply voltage of at least 13 volts to function properly. Operation from a standard 12-volt battery may require regulating the main board at 10 volts with an adjustable device such as the LM317.

tune-up

The transceiver is easy to align (**fig. 12**). First, make sure both oscillators are functioning properly. Then monitor VFO output with a frequency counter or all-band receiver, and net VFO tuning into the 5.0 to 5.1 MHz range. Large adjustments may require substituting fixed-value capacitors (the VFO calibration trimmer has a range of about 50 kHz). Once the VFO tunes properly, the dial can be calibrated.

Next, monitor BFO output and set up BFO trimmers. When correctly adjusted, frequency on receive will be 8998.5 kHz (with +12 volts applied to the switching diode), and 8999.2 kHz on transmit (voltage removed from the switching diode). This provides a standard 700-Hz transmit offset. Since the two trimmers interact, some retuning will be necessary.

To set up the receiver section, first adjust AGC bias to 5 volts as measured at test point No. 1; then zero the S-meter. Tune T2 for maximum background noise in the speaker. Finally, peak both receiver bandpass filter trimmers for maximum sensitivity at 14.050 MHz (make sure there are two signal peaks per revolution).

Next, connect a power meter and dummy load to the transceiver output. To set a sidetone level, depress

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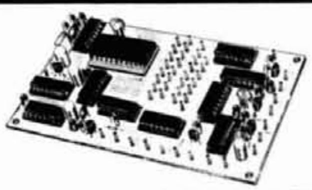

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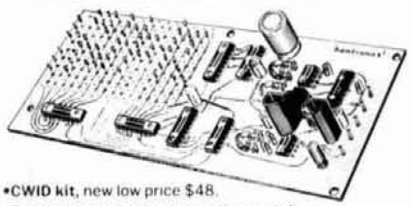

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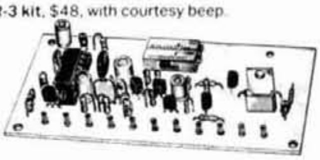

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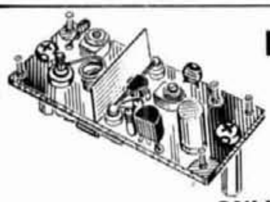

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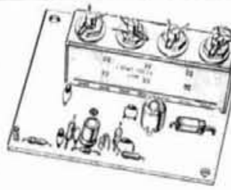

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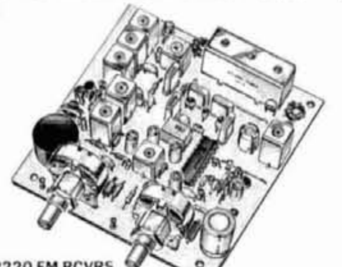

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Wired w/case	$69	50-54	144-148
		144-146	28-30
		145-147	28-30
		144-144.4	27-27.4
		146-148	28-30
		220-222	28-30
		220-224	50-54
		222-224	28-30

UHF MODELS

		Antenna Input Range	Receiver Output
Kit with Case	$59	432-434	28-30
Kit less Case	$49	435-437	28-30
Wired w/case	$75	432-436	144-148
		432-436	50-54
		439.25	61.25
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Wired $149	28-30	50-52
(specify band)	27-27.4	144-144.4
	28-30	220-222
	50-54	220-224
	144-146	50-52
	144-146	28-30
For UHF, Model XV4	28-30	432-434
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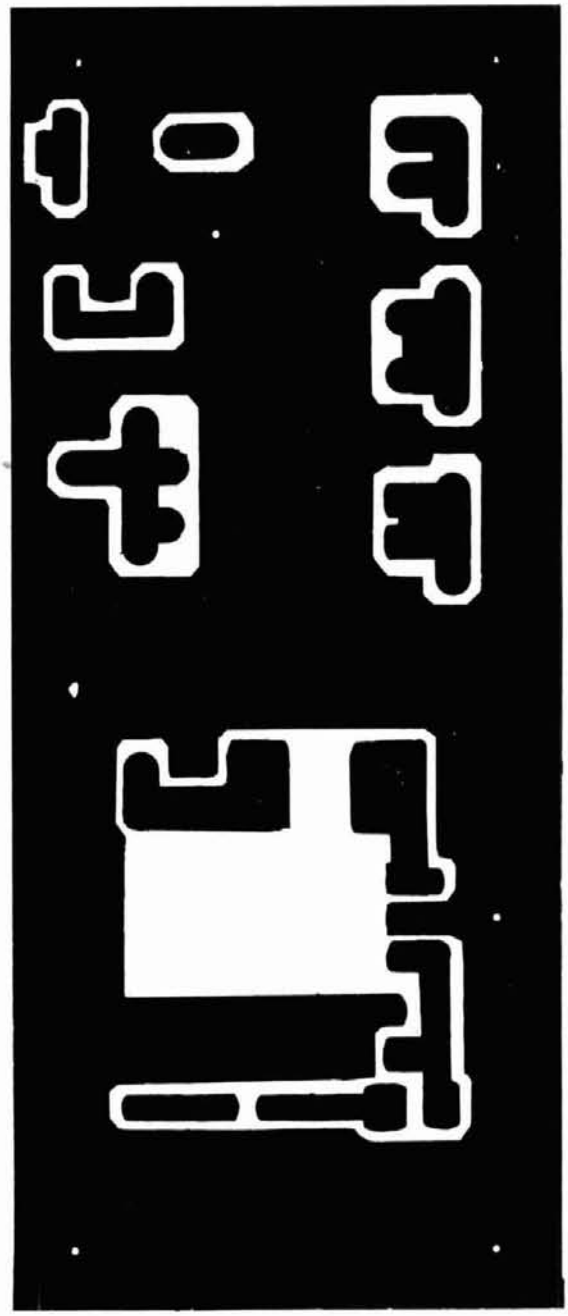

fig. 11A. 15-watt PA pc board art (enlarged 2x).

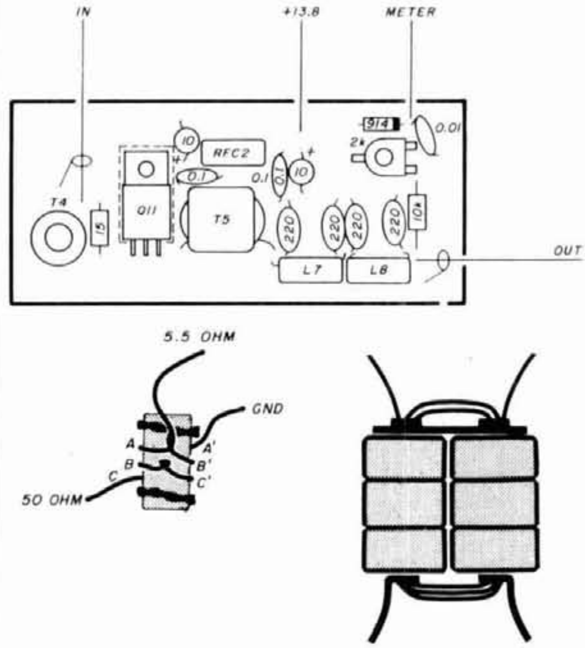

fig. 11B. 15-watt PA component placement guide.

the key and adjust the sidetone trimmer for a reading of S9 on the S-meter. Then key the transmitter and peak transmit bandpass filter trimmers for maximum output. Use a nonmetallic tuning tool; one trimmer is part of a balanced circuit, and will be detuned by a metallic blade. Finally, key the transmitter and set the bias of driver Q7 to 3 volts. Measure bias voltage at test point No. 2 with a high-impedance voltmeter.

The PA is broadbanded and requires no tuning. With a supply voltage of 13.8 volts, the indicated output should be between 12 and 15 watts into a 50-ohm load. Set the rf meter's sensitivity by adjusting the 2-k rf meter trimmer on the PA board for a 3/4-scale reading. The semi-break-in delay trimmer can now be adjusted to suit sending speed and operating style.

All that remains is to connect an antenna and try your luck. Antenna SWR should normally be held below 2:1 with solid-state rigs, and this one's no exception. However, momentary accidents do happen, and my MRF479 PA has survived several with no damage. The rf meter can help you avoid trouble; it will read excessively high or low when a serious mismatch is present.

conclusion

As I called my first CQ, I wondered if 15 watts into a dipole would cut the mustard. After all, 20 is a popular band, and finding a clear spot to operate can be difficult. My fears were quickly dispelled when a UQ2 came back and gave me a 579. Several more DX contacts followed — all with good reports. I quickly discovered that 15 watts was enough power to work almost anything I could hear, including ZLs and VKs. That reliability, along with "extras" like the CW filter, a smooth sidetone note, and semi-break-in, make this rig fun to operate. Now, all I *really* need is the proper test platform from which to field-test the transceiver's portable capability. A large schooner — something with two masts headed for a tropical island — would be just right!

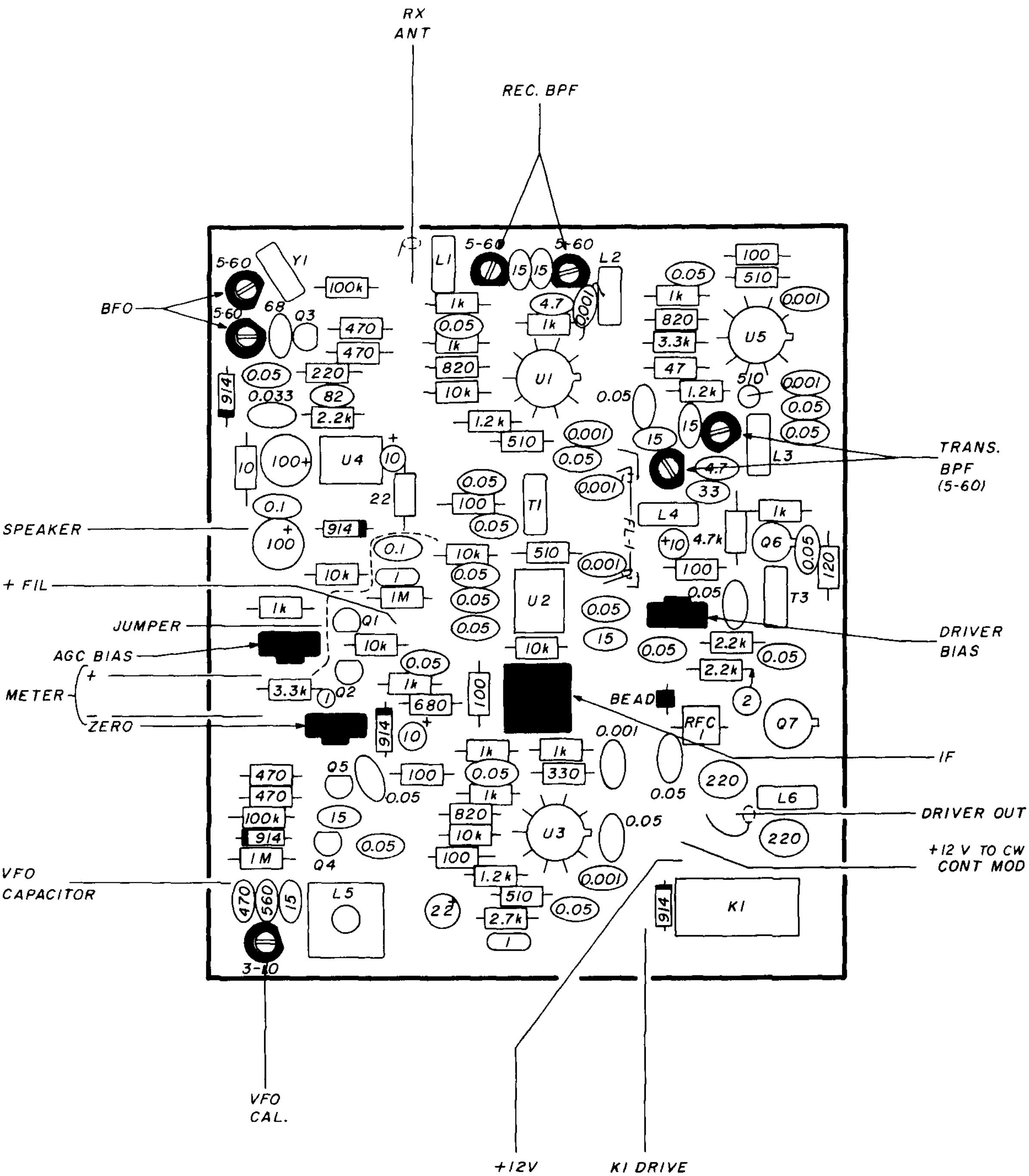

fig. 12A. Alignment control locations, main transceiver board.

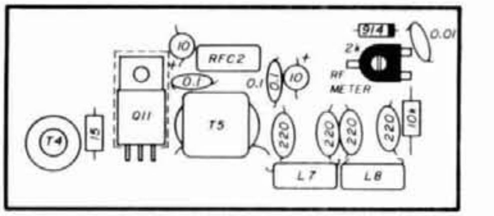

fig. 12B. Alignment control locations, power amplifier board.

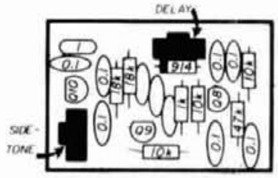

fig. 12C. Alignment control locations, CW control module.

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ham radio

short circuit

Figure 5(E), omitted from W1JR's "VHF/UHF World" in the May issue (page 92), appears below:

(E)

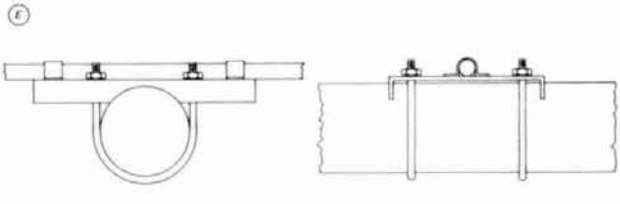

fig. 5(E). This non-piercing above-the-boom mounting method, devised with the help of Don Cook, K1DPP, is recommended for homebrewed antennas.

181

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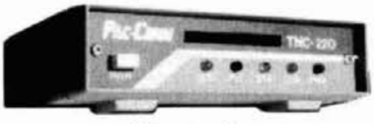

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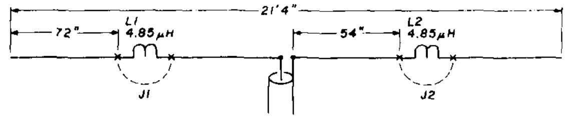
compact travel antenna

Complete the installation — add this antenna to your compact rig

Traveling with a portable rig* is fun, but raising a temporary antenna can be difficult. For one thing, few resort managers are willing to lend their flagpoles and trees to unsightly wires that could garrote paying customers. And, of course, there's always the possibility of a mishap — a poorly thrown beanbag dimpling the roof of a vintage Mercedes, for example. These liabilities are *real*, and all too often I've settled for makeshift alternatives to avoid an unpleasant confrontation.

Thinking there must be a better way, I set out to build an antenna that would provide solid on-the-road performance without scaring the spirit of cooperation out of resort owners. I started by writing down my needs: it must be self-supporting, easy to mount, and collapsible; it must cover 14-30 MHz, perform with high efficiency in either vertical or horizontal polarization, be made from available materials, and require no external matching devices.



Loading coils:
L1,L2 24 turns 3/4-inch x 16 TPI coil stock (B&W No. 3011 or Air Dux 616T) or 14 turns 1-1/2 inch x 8 TPI coil stock (B&W No. 3018 or Air Dux No. 1008).
J1,J2 8-inch clip leads.

fig. 1. Overall length of antenna is 21 feet, 4 inches, about 66 percent of a full-sized dipole. Two 4.85 μH inductors are required to resonate it at 14.05 MHz. Jumpers bypass inductors for 21-30 MHz operation.

Remembering my old Cushcraft "Trick-Stick" VHF dipole, and how easy it was to set up and use, I reasoned that a loaded hf dipole of similar size might be the answer.

design

Since I didn't want a high-budget project, my first step was to raid my junk pile, where I found several 4-1/2 foot lengths of 3/8-inch diameter thick-wall aluminum tubing. I decided that these would make sturdy center sections.

Six-foot collapsible replacement antennas from Radio Shack would be perfect for the ends. This would give me a 21-foot element in four pieces (**fig. 1**). Since 21 feet is a healthy 66 percent of full size, I concluded that my antenna would be efficient, and provide a good match without need for special matching devices.

loading coils

Power handling wasn't a concern, since my portable rig runs 15 watts. But efficiency was very important. With QRP and marginal locations, every watt counts! A friend who designs antennas for a living cautioned me against close-winding loading coils with enameled wire. His experience indicated that high-*Q* air-wound stock is less lossy, and well worth the extra investment. He said I might get away with using 3/4-inch 16 TPI (turns per inch) miniductor for low power, but strongly recommended larger diameter stock with 8 or 10 TPI spacing.

construction (see table 1)

Since this antenna is intended for temporary use,

*See K1BQT's "A Compact 20-meter CW Transceiver" on page 8 of this issue.

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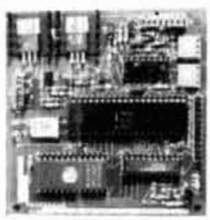

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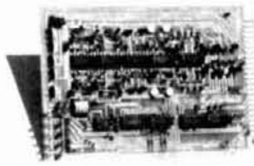

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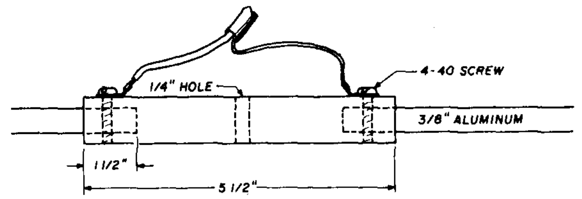

fig. 2. The 3/8-inch elements slip into the center block, and lock in place with No. 4-40 screws. Only one element need be removed to break down and transport the antenna.

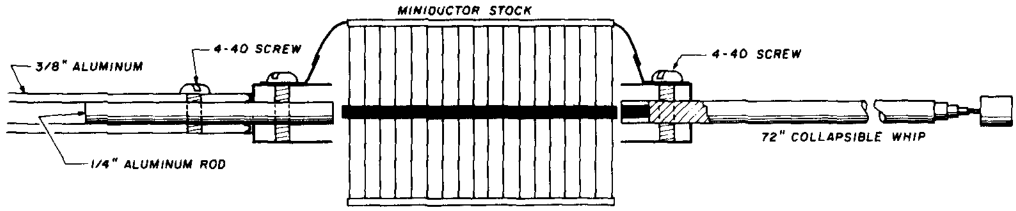

fig. 3. End sections slip into 3/8-inch elements and are locked in place with a No. 4-40 screw. Solder lugs provide electrical connections for loading coils.

I concentrated on making it lightweight and easy to assemble in the field. The center block was made from a piece of 5-1/2 inch x 3/4-inch plastic rod stock (see **fig. 2**). This material is fairly inexpensive, easy to machine, and available from most plastic supply houses. Each end was drilled to a depth of about 1-1/2 inches to accept the 3/8-inch tubing. The block and tubing sections were drilled and tapped to accept a No. 4-40 screw, which locks each element in place. This screw also provides electrical connection for the feedline. The center of the block can then be drilled to accept any kind of mounting scheme, including the one shown here or a standard TV mast U-bolt.

The loading coil and collapsible whip are constructed as a single assembly (see **fig. 3**). The coil support is a 3-inch length of 1/2-inch diameter plastic rod. A 1/4-inch solid aluminum stub is installed in one end to mate with the 3/8-inch element tubing. The whip is inserted in the other end. Note the location of the solid insert at the base of the whip. The locking hole must be drilled through this insert to ensure a secure mount and good electrical contact. Install solder lugs on mounting hardware; these will be needed for connecting the loading coils. If you plan to operate in foul weather, protect the coils with a plastic sleeve. Without them, rain and snow may detune the antenna and make it temporarily unusable.

To simplify feedline attachment, I hard-wired an electrical half wavelength (22 feet) of RG-58U directly to the center block. This accommodates most out-the-window and off-the-balcony setups. Since this antenna is certain to be *installed in imperfect locations*, it may be especially beneficial to decouple the feedline from the antenna. While a balun can be installed for this purpose, looping five or six tight turns in the feedline or slipping a few large ferrite beads over the cable jacket will prove just as effective.

Feel free to modify the design to suit your own particular needs. I've constructed a second version of the antenna that breaks down into 2-1/2 foot sections — just for air travel. A friend of mine built a ruggedized model for permanent installation on his TV mast. In reality, moving loading coils closer to the ends, adjusting element lengths, and using different tubing schemes will probably do little to change performance. The most critical factors are keeping the length greater than 20 feet and using high-*Q* loading coils to achieve resonance. A grid dip meter works fine for making initial adjustments.

Table 1. List of materials for compact antenna.

2	3/8-inch OD x 53-inch aluminum tubing
2	1/4 x 3-inch aluminum rod
1	3/4 x 3-1/2 inch aluminum channel stock
1	3/4 x 5-1/2 inch plastic rod
2	1/2 x 3-inch plastic rod
2	Radio Shack 72-inch collapsible antenna (No. 270-1408).

supports

To support my antenna, I cut a 6-foot strip of 3/4 x 1-inch poplar. Wood is preferable to metal in this application because it's strong, light, and less likely to damage or discolor woodwork. A short piece of 3/4-inch aluminum channel stock was used to square the center block so it would lock securely into a square notch cut into the mast. A single 1/4-inch bolt holds the antenna in place (see **fig. 4**).

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RM-50A	37	50	5¼ × 19 × 12½	50
• Separate Volt and Amp Meters				
RM-35M	25	35	5¼ × 19 × 12½	38
RM-50M	37	50	5¼ × 19 × 12½	50

RS-A SERIES

MODEL RS-7A

MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H x W x D	Shipping Wt (lbs)
RS-4A	3	4	3¾ x 6½ x 9	5
RS-7A	5	7	3¾ x 6½ x 9	9
RS-7B	5	7	4 x 7½ x 10¾	10
RS-10A	7.5	10	4 x 7½ x 10¾	11
RS-12A	9	12	4½ x 8 x 9	13
RS-20A	16	20	5 x 9 x 10½	18
RS-35A	25	35	5 x 11 x 11	27
RS-50A	37	50	6 x 13¾ x 11	46

RS-M SERIES

MODEL RS-35M

MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H x W x D	Shipping Wt (lbs)
• Switchable volt and Amp meter				
RS-12M	9	12	4½ x 8 x 9	13
• Separate Volt and Amp Meters				
RS-20M	16	20	5 x 9 x 10½	18
RS-35M	25	35	5 x 11 x 11	27
RS-50M	37	50	6 x 13¾ x 11	46

VS-M SERIES

MODEL VS-20M

- Separate Volt and Amp Meters
- Output Voltage adjustable from 2-15 volts
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MODEL	Continuous Duty (Amps) @13.8VDC	@10VDC	@5VDC	ICS* (Amps) @13.8V	Size (IN) H x W x D	Shipping Wt (lbs)
VS-20M	16	9	4	20	5 x 9 x 10½	20
VS-35M	25	15	7	35	5 x 11 x 11	29
VS-50M	37	22	10	50	6 x 13¾ x 11	46

RS-S SERIES

MODEL RS-12S

- Built in speaker

MODEL	Continous Duty (Amps)	ICS* Amps	Size (IN) H x W x D	Shipping Wt (lbs)
RS-7S	5	7	4 x 7½ x 10¾	10
RS-10S	7.5	10	4 x 7½ x 10¾	12
RS-10L(For LTR)	7.5	10	4 x 9 x 13	13
RS-12S	9	12	4½ x 8 x 9	13
RS-20S	16	20	5 x 9 x 10½	18

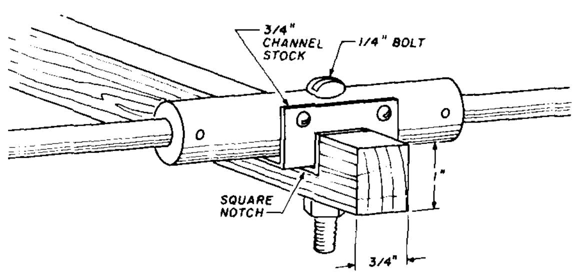

fig. 4. A short piece of square channel stock locks center block firmly in place on support mast. A 1/4-inch bolt holds the antenna in place.

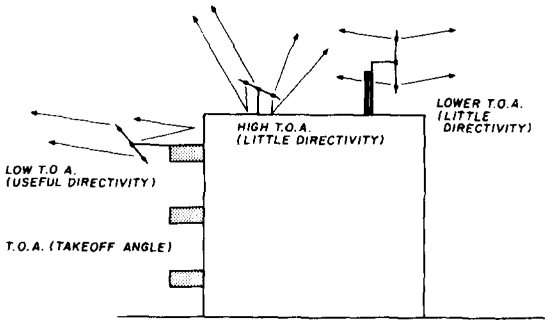

fig. 5. Conductive surfaces on buildings may be an advantage or *disadvantage, depending on how you use* them. On 20 meters, placing a horizontal dipole near the surface of a conductive roof may produce poorer results than mounting vertically, or mounting off to one side of the building!

When setting up the antenna, almost anything can be a potential supporting structure (window sills, balcony rails, fire escapes, standpipes, and existing TV masts are all favorites). Attaching antenna and mast to one of these supports can be a real exercise in "jerry-rig" engineering. Having the right tools helps! Gaffer's tape, lightweight ratcheting C-clamps (Stanley 83-157 or equivalent) and motorcycle bungie cords are essential tools of the trade for the imaginative field-installer!

performance

For initial testing, I mounted the antenna out a second story window, about 5-1/2 feet from the side of the building. Sections went together without difficulty, and the completed assembly seemed well balanced and easy to handle. The support mast was clamped to the window casement with a C-clamp.

After pruning the loading coils for resonance at

14.05 MHz, I measured a minimum SWR of 1.4:1. My noise bridge read the impedence as 38 ohms — an acceptable load for broadbanded solid-state rigs. Listening across the band, I was encouraged to hear several 599 + signals. Running 15 watts, I called two lengthy CQs, both yielding no reply. Beginning to think the worst, I tried again. This time, a much-welcomed CT3 came back with a 569 report. Several more DX and stateside contacts followed, with signal ranging from 559 to 589. Flipping the antenna to vertical polarization brought similar results.

other bands

Although untested on the other bands, this antenna should do very well on 18, 21, 24, and 30 MHz. For 18-MHz operation, simply readjust the collapsible end sections for minimum SWR. For 21 MHz and up, place 8-inch jumper wires across each loading coil (the extra jumper length is needed to make the antenna resonate at 21.0 MHz). Collapsing the length of the end sections (with jumpers in place) will provide continuous coverage through 10 meters.

site suggestions

Here are some tips to help you achieve maximum performance:

- **Look for a high, open location**. Get above the roofline if you can, but keep directivity and takeoff angle in mind (**fig. 5**).
- **Keep the antenna at least 5 or 6 feet from the building surface**. Proximity to electrical wiring, foil insulation, and structural metal can detune it. Bending elements outward may help to decouple the ends from a metal structure.
- **When you side-mount to a building, try to locate the antenna on the side facing the desired direction of transmission**. Better to use the structure as a reflector than as a shield!
- **If there are horizontal wires close by, vertical polarization may work better**. When using vertical polarization, make sure the bottom leg is at least 6 feet above ground. Also, make sure the antenna is clear of people and pets. Even QRP rigs can develop enough rf potential at element tips to cause painful burns and injury.

conclusion

Whether you're jet-setting to VP2-land, driving cross-country, or working tabletop DX from the local flea market, a good portable antenna will help you get on the air with a minimum of hassle and frustration. I am continually pleased with how well this one has worked for me. On occasion, it has even been spotted emerging from my office window . . . at lunchtime, of course!

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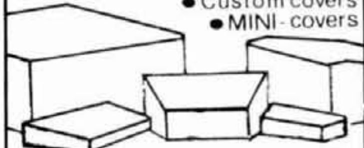

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I couldn't resist the temptation. Driving along the south coast of Kauai Island, Hawaii, I saw a sign reading *U.S. Department of Commerce, National Bureau of Standards Radio Station WWVH.* In a microsecond, I turned off the highway and headed toward a brace of interesting looking antennas. After passing through a checkpoint, I quickly arrived at WWVH and was greeted by Ernie Farrow, the Engineer-in-Charge.

What an interesting visit! A low-frequency DXer would have been visibly shaken by the sight of the extensive vertical antenna and ground screen for the 2.5-MHz transmissions of WWVH. The antenna would be a "bomb" on 160 meters!

Ernie surprised me when he mentioned the time and frequency transmissions from WWVS, a station I never knew existed. WWVS, it seems, refers to the satellite-disseminated time code using the GOES (Geostationary Operational Environmental Satellite) satellites of NOAA (National Oceanic and Atmospheric Administration). The time code can be used for general-purpose reference time in the Western Hemisphere from two satellites on a nearly full-time basis.

The two active GOES satellites are in orbit over the Pacific. The satellite that serves the western United States, Canada, and western South America operates at 468.825 MHz and is located at 135 degrees West Longitude. The eastern satellite can be received on 468.8375 MHz and is positioned at 75 degrees West Longitude to serve the eastern seaboard of the United States, as well as Brazil and western Africa.

The time code to the satellites is sent from Wallops Island, Virginia. Because the path delay to and from the satellite is about 260,000 microseconds, the signals are advanced in time by this amount. The arrival time of the signal back on earth is corrected to within 16 microseconds. Other path delays are known, and the exact satellite position is included in the downlink signal for correction by the observer.

Additional information on the transmissions via WWVS and general data on time signals can be obtained in *NBS Special Publication 432*, available from Time and Frequency Division, National Bureau of Standards, Boulder, Colorado 80303.

Many thanks to Ernie Farrow at WWVH for an interesting tour, which is recommended to all visitors to the south coast of Kauai Island. Aloha, Ernie, and Mahalo!

(Note: Want to participate in the NBS 1987 survey? A brief explanation and a tear-out, postage-paid survey form follow this article. — Ed.)

nothing new under the sun!

Sam Pavone, W2DDN, sent me a copy of the original patent on the top-loaded vertical antenna, in common use today as a broadcast antenna and also as a DX antenna on the low frequency ham bands (see **fig. 1**). Looks familiar, doesn't it? Even the current distribution curve (marked "3") is what one would expect from an antenna of this type.

The U.S. Patent No. 930,746, however, was granted to Simon Eisenstein of Kiev, Russia on August 10, 1909! The preamble of the patent refers to Simon as "a subject of the Czar of Russia, residing in Kiew [sic], in said Empire of Russia." The patent then goes on to define the current in the antenna in terms of degrees and discusses the problem of corona discharge. In spite of the fact that the patent was witnessed by a lady with the unlikely name of Fannie Fisk, it is apparent that Simon knew his onions. I wonder what happened to him? Did he disappear from the pages of history after filing this contribution to radio communication?

the W0SVM minibeam design

Jack Sobel, W0SVM, has been working for some months on a miniature beam antenna for hams who have restricted air space. His basic design consists of out-of-phase, loaded dipoles in the familiar W8JK configuration (**fig. 2**). Jack's first design is for a 40-meter beam with 7.5-foot spacing. Element lengths are about 37 feet. This is about half the size of a conventional 40-meter, 2-element beam. The experimental antenna uses No. 12 AWG copper wire for the elements and is hung between two supports. Eight-foot spreaders made of wood or PVC pipe are used for the test antenna.

The radiation resistance of the antenna seems to be about 5 ohms, so its operational bandwidth is small. Jack feeds the antenna with a 50-ohm coax line and uses a Transmatch at the station to permit operation over a

reasonable portion of the 40-meter band. The phasing line between the elements is coiled up on the boom, or spreader. Jack hopes to get his antenna up high in the air so he can run some real operational tests. Perhaps with the coming of spring, he'll get some on-the-air tests with this interesting, compact antenna.

Jack has also built a compact beam of this design for 21-MHz operation. Spacing is less than 6 feet and overall element length is about 12 feet. For the elements, he uses 3/4-inch diameter copper pipe, available from plumbing supply stores in 10-foot lengths.

By changing the length of the phasing line, the beam pattern can be made unidirectional. As shown in the illustrations, both beams have a figure-8, bidirectional pattern, as is common with the W8JK antenna design.

Jack is experiencing lobe-splitting with the antenna and it remains to be seen if the simple feed system is distorting the antenna pattern. This problem won't be solved until milder weather comes to Missouri. Stay tuned for the latest developments.

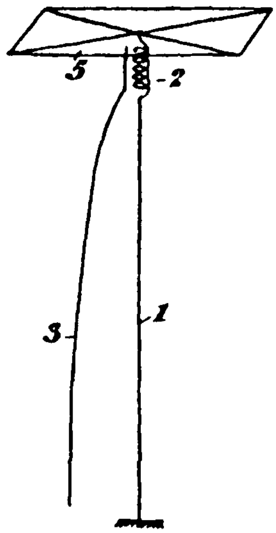


fig. 1. Patent application of August 10, 1909 shows original drawing of top-loaded vertical antenna.

more on "white noise"

My January column discussing the problem of "white noise" in the modern frequency-synthesized ham gear drew a lot of interesting mail. Obviously, I'm not the only one who has noticed this problem. Synthesizer noise is well known in the industry. Standards of measurement have been developed and most modern military and commercial communication equipment has limitations on this type of annoying radiation.

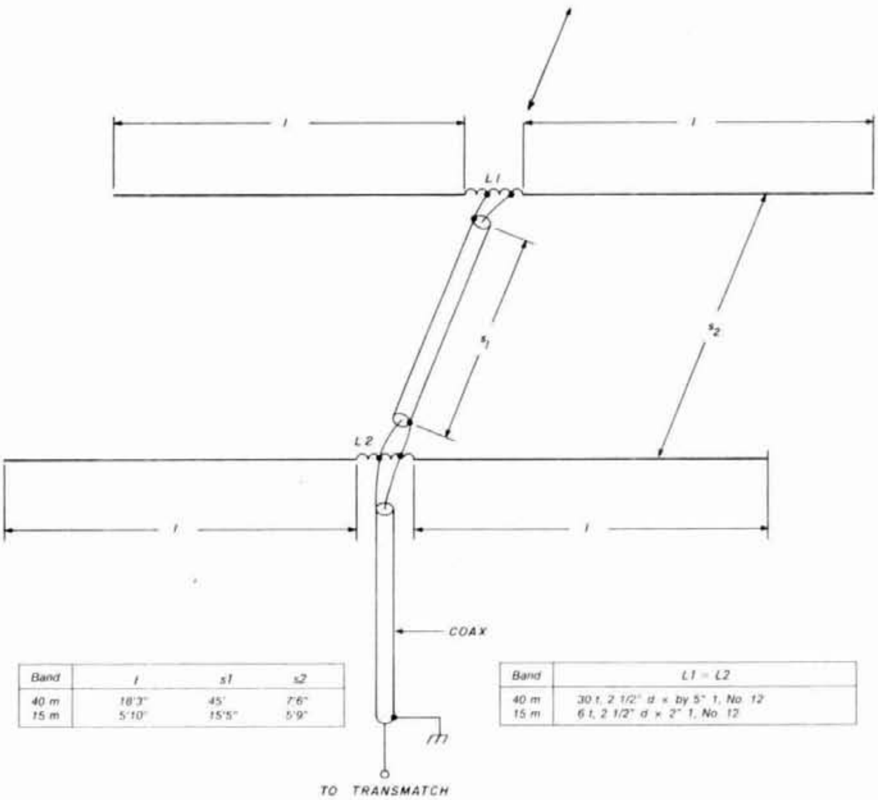
An interesting letter from Tom Bay, OZ5KG, outlines the ongoing problem he and other European Amateurs have had with a BBC (British Broadcasting Corporation) transmitter operating in the early morning hours on 7120 kHz. Tom provided the BBC with spectrum photographs showing the sideband noise, as monitored in Denmark.

While the problem has not been solved, the transmitter is now shifted to another frequency outside the 40-meter Amateur band, so the generated noise doesn't affect the Danish Amateurs. This spring the BBC will *again resume* transmissions on 7120 kHz; it will be interesting to see if the wideband noise is still present on the signal.

phase noise standard?

Another letter came from John Grebenkemper, KA3LBO, of Saratoga, California. John said, in part, that the problem of excessive phase noise in phase-locked oscillators (PLO) isn't inherently due to the phase-locking of the oscillator. According to John, it's attributable, rather, to the necessity of keeping manufacturing costs under control.

John wrote, *In pre-PLL days, the oscillator would be designed with good coils and good capacitors in order to achieve temperature stability. This also resulted in a design which had a very high-Q oscillator resonant circuit. The high Q means that the oscillator is very good at filtering out the phase noise far away from the carrier. However, the newer designs that have PLOs can use much cheaper components because the phase-lock circuitry can now*



Band	l	s1	s2
40 m	18'3"	45'	7'6"
15 m	5'10"	15'5"	5'9"

Band	L1 = L2
40 m	30 t, 2 1/2" d × by 5" 1, No. 12
15 m	6 t, 2 1/2" d × 2" 1, No. 12

fig. 2. The experimental mini-W8JK beam of W0SVM. Elements lie in the horizontal plane. The center of the middle section of coax attaches to the center of coil L2, while this cable's shield is tapped nine turns from center. Connections are reversed at L1. The middle section of coax is wrapped into a coil and taped to the boom.

remove the local oscillator drift. Therefore, the manufacturer uses less expensive coils and capacitors and gets an oscillator which has a much lower Q and higher phase noise. The fact that the oscillator is phase-locked does not prevent the generation of noise that is far removed from the carrier.

I would suggest that Amateurs generate a set of standards for local oscillator phase noise. These standards would be much less stringent than some of the numbers that you mention. They only need to be adequate to guarantee non-interference based upon a reasonable set of assumptions. I would suggest something on the order of −140 dBc/Hz at whatever offset frequency one desires to achieve no interference. This would guarantee no interference for a 1-kW effective isotropic radiated power transmitter at a distance of 1 mile. A number of Amateur transceivers could then be tested as to how well they meet these standards.

I have made phase noise measurements on an ICOM 745. It has a phase noise of better than −120 dBc/Hz at a 10-kHz offset, and better than −125/Hz at a 100-kHz offset. I think that is a pretty clean transceiver.

John closes his letter by saying: *Phase noise is really in the same state as receiver dynamic range was 10 to 15 years ago. It yet has to be addressed by specific articles which deal with its causes, effects, and how to measure it.*

I wish to thank the following individuals who sent me comments on white noise and also provided some interesting material on this subject:

- **Dr. William J. Robertson, W8KHO**, who sent a reprint of his article, "The Effects of Transmitter

*A more realistic value might be −125 dBc/Hz at 10 kHz offset. —W6SAI

Noise and Receiver Local Oscillator Noise in a Co-site Environment";

- **Douglas R. Schmieskors, Jr., WA6DYW**, who sent a reprint of "Phase Noise Intermodulation and Dynamic Range," written by Peter Chadwick of Plessey Semiconductors, Swindon, England;
- **Chod Harris, VP2ML**, who sent copies of the "DX Bulletin," which summarized problems various Amateurs have had with white noise;
- **Art Block, W3YK**, who reported severe white noise on his synthesized transceiver when subjected to heavy off-channel interference;
- **Hal Jones, W6ZVV**, who sent a reprint of "Oscillator with Odd-symmetrical Characteristics Eliminates Low Frequency Noise Sidebands," from the *IEEE Transactions on Circuits and Systems*, September, 1984.

More information on the subject is coming in. Stay tuned.

ham radio

More Details? CHECK—OFF Page 98

✓ 149

NBS time and frequency survey

Uncle Sam wants *your* input

The National Bureau of Standards has invited readers tc participate in its 1987 survey of users of NBS time and frequency services. More than 10,000 responses to the last survey (1975) were received; according to the NBS, these were "invaluable" in planning and carrying out the mission of the NBS over the past decade.

WWV and WWVB signals are broadcast from these antennas located about 7 miles north of Fort Collins, Colorado. The tall WWVB (60-kHz) array is fed from the building at left center, and the WWV antennas are powered from the building at right center. (Most of the WWV vertical dipoles are to the right, and scarcely visible.) Traces of the buried ground plane wires radiate from under the WWVB array.

This year the NBS is expanding the scope of its survey to include not only WWV, WWVH, and their associated telephone-accessible time-of-day services, but also the WWVB 60-kHz service and the newer GOES satellite time code broadcasts. Your responses will help NBS provide the best mix and levels of time and frequency services in the future, consistent with your needs and NBS resources.

Please answer each question that is appropriate to your use of the NBS services. Even if you answer only some of the questions, your responses will be of great help to NBS. If your responses represent the views of an entire organizational unit, please indicate that fact, clearly identifying the name of the organization you represent.

For those who may be relatively unfamiliar with the present NBS services, the term *GOES,* as used in the questionnaire, refers to the Geostationary Operational Environmental Satellites that broadcast the NBS time code. *DUT1* refers to information included in NBS broadcast formats that provides the approximate difference between the UT1 astronomical time scale and the UTC atomic time scale. *Marine Weather* refers to the marine storm warning announcements provided on WWV and WWVH, and *Geoalerts* refers to the WWV announcements relating to solar activity and solar-terrestrial conditions. *Omega* refers to the WWV and WWVH announcements that relate to the current status of the U.S. Coast Guard's Omega Navigation System. *BCD Time Code* refers to the time-of-day information in binary-coded-decimal form provided on 100-Hz subcarriers on WWV and WWVH.

Please cut out and mail your completed questionnaire to the Time and Frequency Division, 524.00, National Bureau of Standards, 325 Broadway, Boulder, Colorado 80303. (No postage is necessary if mailed within the United States.)

United States Department of Commerce, National Bureau of Standards, 325 Broadway, Boulder, Colorado 80303

NBS-1220
(2-87)

1987 SURVEY OF NBS TIME AND FREQUENCY SERVICE USERS

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
OMB NUMBER 0652-0024
APPROVAL EXPIRES JUNE 30, 1987

My responses primarily reflect the view of: ☐ an individual ☐ an organization

Organization name ______________________ Approximate number of time and frequency users in this organization ______

USE OF CURRENT SERVICES	WWV (MHZ) 2.5	5	10	15	20	WWVH (MHZ) 2.5	5	10	15	WWVB 60 KHZ	GOES SATELLITE 469 MHZ	TELEPHONE WWV	WWVH
How often do you use each of these NBS services? (0=Never; 1=Rarely; 2=Sometimes; 3=Frequently)													
How often do you observe harmful interference when using these services? (0=Never; 1=Rarely; 2=Sometimes; 3=Frequently)													
How would you characterize your usual reception reliability? (0=Extremely poor; 1=Poor; 2=Generally adequate; 3=Excellent)													
Do you usually use these services during daytime or nightime hours? (D=Day; N=Night; B=Both)													

ADEQUACY OF CURRENT SERVICES —	WWV	WWVH	WWVB	GOES SATELLITE	TELEPHONE TIME-OF-DAY
Do the current NBS services satisfy your needs for accuracy? (0=No; 1=Marginally; 2=Generally yes; 3=Yes)					
Do the current NBS services satisfy your needs for reliability of reception and ease of use? (0=No; 1=Marginally; 2=Generally yes; 3=Yes)					

FOR USERS OF WWV AND WWVH	VOICE TIME OF DAY	BCD TIME CODE	1-SECOND TICKS	STANDARD FREQUENCY	DUT1 VALUES	MARINE WEATHER	GEOALERTS	OMEGA STATUS
Which types of information on these broadcasts do you use at least occasionally? (Indicate by checking each appropriate box)								
How important is each type of information? (0=Not at all; 1=Marginal importance; 2=Important; 3=Very important)								

Is the present quality of the voice announcements of weather, geoalerts, and Omega System status adequate for your needs? (Yes or No) ☐ Yes ☐ No If no, why? ______________________

FOR USERS OF WWVB	STANDARD FREQUENCY	TIME CODE
How important to you or your organization is each of these aspects of WWVB? (0=Not at all; 1=Marginal importance; 2=Important; 3=Very important)		

FOR USERS OF THE GOES SATELLITE TIME CODE

Does interference in your area significantly hinder the usefulness of the satellite time code? (Yes or No) ☐ Yes ☐ No

Do you use the GOES time code status reports by accessing the "NBSGO" file in the U.S. Naval Observatory's Automated Data Service System? (Yes or No) ☐ Yes ☐ No

Do you use the full accuracy of the time code (100 microseconds) via a receiver that automatically corrects for path delay variations? (Yes or No) ☐ Yes ☐ No

Do the occasional time code shifts of more than 100 microseconds at times of satellite maneuvers cause serious problems for your application? (Yes or No) ☐ Yes ☐ No

FOR USERS OF THE WWV OR WWVH TELEPHONE TIME-OF-DAY SERVICES

How often do you encounter busy signals when calling (303) 499-7111 or (808) 335-4363? (0=Never; 1=Rarely; 2=Sometimes; 3=Frequently) ☐

Would the value of these services be decreased if only a high-quality voice time announcement were available without the weather, geoalert, or Omega status information? (Yes or No) ☐ Yes ☐ No

If yes, why? ______________________

(OVER)

PLEASE FOLD AND TAPE BEFORE MAILING. DO NOT STAPLE!

POSSIBLE FUTURE CHANGES IN NBS SERVICES	ACCURACY	RECEPTION RELIABILITY	COVERAGE AREA	EASE-OF-USE	USER COST
In the development of future time and frequency services which of the following aspects need the most improvement? (Check appropriate boxes)					

If the availability of new services in the future with improved capabilities in terms of accuracy, reliability, coverage, etc. required the payment of an annual user fee of less than $250/year, would you or your organization likely subscribe to such a service? (Yes or No) ☐ Yes ☐ No

Do you need NBS timing signals designed for direct interfacing to computers? If "Yes", what accuracy level is needed? ☐ Yes ☐ No

Accuracy Level ____________

What new or improved time and frequency services would you find useful? (Please describe briefly)

____

USER DATA

Please indicate which of the items below apply to you as a user of NBS services: (✓)

- ☐ Private Citizen
- ☐ Government/civilian
- ☐ Government/military
- ☐ Radio/TV Operations
- ☐ Standards Lab
- ☐ Electric Power Industry
- ☐ Telephone Industry
- ☐ Aviation/aerospace Industry
- ☐ Transportation Systems
- ☐ Communications Systems
- ☐ University
- ☐ Geophysics/seismology
- ☐ Health Care Industry
- ☐ Pleasure Boating
- ☐ Equipment Manufacturing
- ☐ Jeweler/watchmaker
- ☐ Amateur Radio

Other (Specify) ____

Please indicate which of the items below describe the purposes for which you use the NBS time and frequency services: (✓)

- ☐ Frequency Calibrations
- ☐ Watch/clock Setting
- ☐ Master Clock
- ☐ Navigation/Position Location
- ☐ Time Base for Computers
- ☐ Time Base for Synchronizing or Controlling Operations
- ☐ Time Base for Data Monitoring
- ☐ Surveying
- ☐ Space/missile tracking
- ☐ Marine Weather
- ☐ Propagation Information
- ☐ Astronomy
- ☐ Hobby
- ☐ Geolart Information
- ☐ Omega System Information

Other (Specify) ____

In what state of the United States or foreign country do you use the NBS time and frequency services? (Two-letter state abbreviation or country) ____________

Please estimate the annual economic value of the NBS time and frequency services to you or your organization, if possible. $ ________

Additional Comments:

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Understanding Automatic Antenna Tuners

One of the most popular yet often misunderstood accessories in modern amateur radio setups is the fully automatic antenna tuner. While this item plays a significant role in any station's overall performance and enjoyment, inquiries regarding its specific use and operation continue surfacing during conventions and ICOM Day discussions. Answering those questions in a "shared knowledge" manner thus inspired this Tech Talk's topic.

The basic purpose of an automatic antenna tuner is matching an antenna's transmission line-presented impedance to that of a transceiver's output. This technique is usually referred to as **obtaining a low SWR for full band coverage.** Many of today's multiband dipoles, beams, and verticals exhibit narrowband characteristics, for example, and must be pretuned for SSB or CW band segments before outdoor installation. Attempting subsequent operations in their less favored or "high SWR" range creates an impedance mismatch that restricts RF power output from their connected transceiver.

An antenna tuner utilizes a large multitapped coil and two variable capacitors to counteract undesired capacitive or inductive reactances and re-establish a matched condition between the transmission line and the transceiver. While this impedance matching doesn't eliminate coax cable losses, it does allow a station's transceiver to efficiently deliver its full output to the antenna system. This impedance matching arrangement has **also been proven beneficial in reducing harmonic radiations and TVI.**

The basic inner operation of all automatic antenna tuners is similar in nature. Initial band selection determines the proper coil tap to be utilized while reversable motors position the variable capacitors at their point of lowest SWR. "Correction voltage" applied to the motors is derived from the tuner's SWR sensing circuits which, in turn, are activated by RF energy from the transceiver.

Manual antenna tuners perform similar impedance matching functions; however, the station operator must personally monitor SWR readings while trial-and-error selecting coil taps and rotating capacitors to find a proper impedance matching point. The convenience and enjoyment of an automatic tuner "following your lead and readying everything for action" creates a **deluxe setup that's a pleasure to operate.**

There are presently two design variations in automatic antenna tuners: the totally "hands off" unit, and the operator-adjustable unit. "Hands off" units typically exhibit a limited impedance matching range and can't be operator fine-tuned. Operator-adjustable units usually exhibit a comparatively wider tuning range and offer greater overall station flexibility, but improper settings must be minimized.

ICOM's fully automatic AT-500, AT-100, and AT-150 antenna tuners incorporate the best features of previously discussed concepts in their designs. They can be used as a strictly automatic/hands-free unit or operator-adjusted when desired. Additionally, each tuner includes an automatic **four-selection antenna switch** and a transceiver interfacing cable for fully automated station operating convenience. The AT-500 and AT-100 handle 500 and 100 watts, respectively, and operate automatically with all ICOM HF transceivers (LDA option required for IC-730). The AT-150 handles 100 watts and mates with the compact IC-735 for true "dream station" performance.

Operating an AT-500/AT-100/AT-150 equipped ICOM station is an amateur's delight. When a particular band is selected on the station's transceiver, the "slaved" tuner connects the required antenna and internal coil tap. Transmitting a brief low power signal then allows the tuner to adjust its capacitors for an optimum impedance match, and the station is ready for action. If additional "tweaking" is desired, a top access hatch permits indirectly fine tuning capacitor settings. Four LEDs (two for each capacitor) provide direct assistance by indicating the resonant point of each control. Merely ensure the tuner's AUTOmatic/Preset (Manual operation) switch is in its **AUTO** position, then rotate the controls until all LEDs extinguish. If a particular antenna exhibits exceptionally high SWR, the tuner may be switched into preset/**manual** operation. The previously mentioned internal controls may then be (**slowly**) adjusted while monitoring SWR on the transceiver's meter. Two capacitor-adjusting controls are provided for each band; thus, one band's antenna settings will not disturb another's. Two helpful hints: when **manually** presetting, always start with adjustments in **midrange**. When auto tuning reluctant antennas, try "**Walking**" the tuner by allowing it to fully retune in 25kHz steps rather than 300kHz jumps. Remember, also, all tuners have their limits.

Inclusion of an automatic antenna tuner in any HF setup truly opens an exciting new world of enjoyment. A smooth operating station also inspires investigation of new pursuits and modes. Naturally, ICOM wants you to enjoy amateur radio's many rewards in TOP style!

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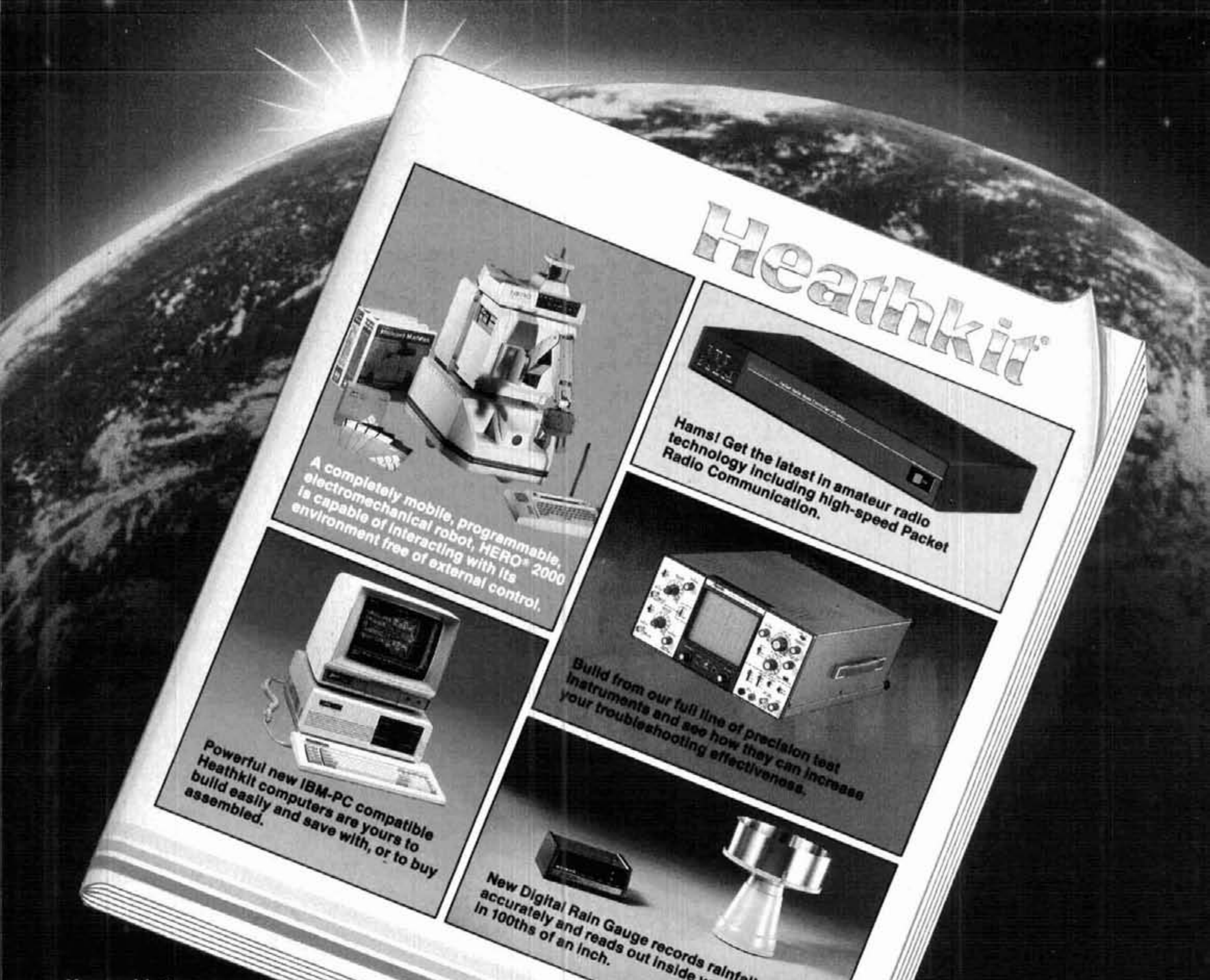

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the TEXNET packet-switching network

part 3: software overview

Z-80 assembly language software offers multi-node, multi-user versatility in real time

In previous installments of this three-part series,[1,2] we described network algorithms and the design and testing of network hardware. This month, we'll discuss node control software.

Contained in a single 27C256 ROM, the software determines the functions and user features offered by the network nodes. Highly modular in design, the software was written in Z-80 assembly language for two reasons: one, because the wide array of services offered by a single node put memory space at a premium; and two, because one or more of each node's ports would be operating at 9600 bps, therefore stressing real-time capacity.

Because space is limited, we'll discuss the functions of specific software areas rather than describe the software itself in detail. **Figure 1** illustrates a typical node, with each major software area indicated by a circled reference letter.

common logic

The common logic portion of the software package, identified as *A* in **fig. 1**, is responsible for memory allocation and management, real-time scheduling, and interfacing to the various hardware I/O devices, such as SIO's and the CTC. As an example of these housekeeping tasks, let's look at memory management. Because there are many more users for memory than there is memory capacity, memory management — specifically in regard to time-sharing — is critical to efficient system operation. The generic problem with most memory management schemes, however, is *deadlock*, which occurs, for example, when a memory user has some memory allocated and needs more to complete the job, but can't get more because of what's already been assigned. The node software package follows a procedure known as *load shedding* to prevent deadlock; it does this by finding the "oldest" and largest consumer of memory and aborting his resource allocation.

The largest section of the common logic is the multi virtual connection PAD (Packet Assembly/Disassembly) logic. This general-purpose software has a standard interface to the higher layers of software wishing to use its services. The PAD is completely state table driven and currently implements the ARRL AX.25 V1.0 and V2.0 protocol specification. The PAD supports a variable number of simultaneous virtual connections

Thomas H. Aschenbrenner, WB5PUC, and Thomas C. McDermott, N5EG, Texas Packet Radio Society, P.O. Box 831566, Richardson, Texas 75083-1566

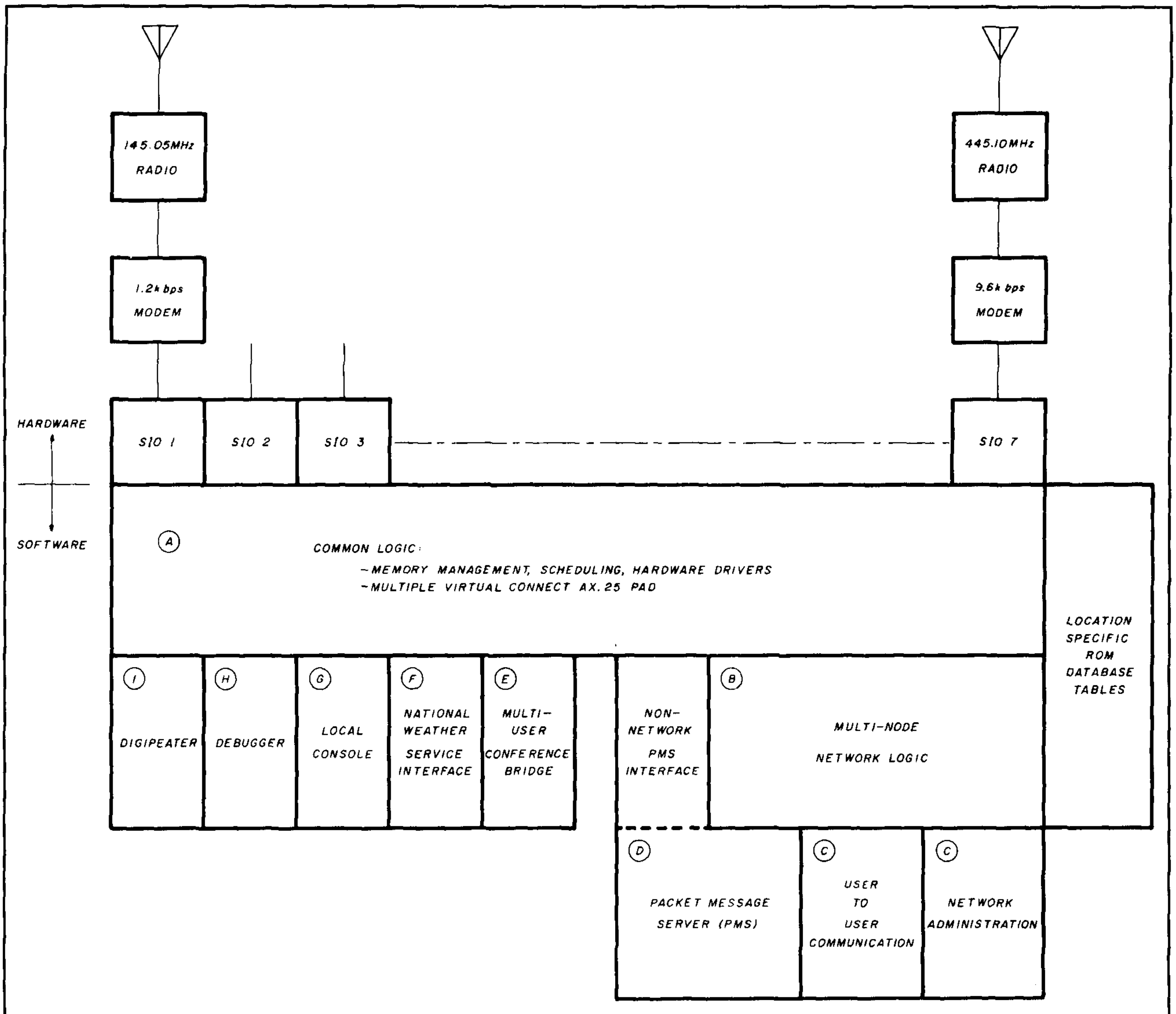

fig. 1. Node software block diagram shows hardware/software boundary and layering of various software functions.

(currently set to 20), with any of the virtual connections conforming to either V1.0 or V2.0 of AX.25. Selection of V1 or V2 operation is determined by the users' setting of their TNCs — for example, if they're running V1, then the node will act like a V1 TNC when they connect. Users running V2 will see the node as a V2 device.

The PAD, which supports up to eight physical communications channels (four SIO's), has been tested in a multiport configuration with both 9600 bps and 1200 bps, operating simultaneously without loss of data. In order to achieve this performance level for 9600-bps operation, a nested interrupt structure (the interrupt service routines are themselves interruptible) which would allow timely response to interrupts from the 9600-bps port(s) had to be designed.

The common logic provides a number of features of the node. All users of the node see the node as a series of AX.25 addresses. For example, this is how users see the Garland, Texas node:

W9DDD-2 1st conference bridge
W9DDD-3 2nd conference bridge
W9DDD-4 TEXNET Access
W9DDD-5 Node's local console
W9DDD-6 Test access

These applications will be explained shortly; what's important to note here is that all of the addresses have the same Amateur call, W9DDD, and that the application is selected according to the SSID. (This method of operation is only one configuration of the address database. Instead of using the same call (W9DDD) five times, different calls could have been configured, with the SSID held constant. The node will support any combination of the above examples.)

The common logic also supports various restriction and parameter tables. New connections to any AX.25 address of the node can be inhibited as a function of the number of digipeaters used to get to the node. This has been found to be useful in reducing channel congestion attributable to excessive retries on long digipeater paths to a specific node. The preferred method is to put a network node near enough to the user group and carry the traffic on the network backbone trunks.

Parameters managed by the common logic, on a per-physical port basis, include all of those specified in the AX.25 protocol (i.e., T1, T2, T3, K, N2, etc.) and some unique to this application. It was found desirable to define the AX.25 T3 timer as either an all-seems-well timer (its original function) or an auto-disconnect timer. In the auto-disconnect mode, if a user's virtual connection is idle for greater than the T3 time value (nominally 3 minutes) he or she is automatically disconnected from the node, thereby making room for other users. This mode can be overridden by the ALERT network mode, which will be discussed below.

Finally, the common logic is responsible for gathering statistics for the node. Two main groups of statistics are collected. The first are those that aid in "traffic engineering" the node. Quantities such as the amount of memory in use, the maximum amount ever used, and the total available allow visibility into the level of service being provided and indicate whether or not more RAM should be allocated to the free memory pool, thus decreasing memory space available for applications. Experience indicates that a free memory pool of approximately 30K, allocatable in about 200-byte chunks, provides good service with enough reserve capacity to handle rather large impulse loads, such as congestion on 9600-bps trunk circuits.

The second group of statistics collected are those having to do with node use. Quantities such as the number of frames transmitted, received, and retransmitted for each physical channel yield data on overall network use, thereby suggesting possible additions to the node or changes in network configuration. These numbers can also be used to determine the performance level of network trunks.

multi-node network logic

As illustrated, the multi-node network logic (see *B* in **fig. 1**) is supported by the common logic. In turn, it supports higher-level applications such as Network Administration, User Intercommunication, and the Packet Message Server.

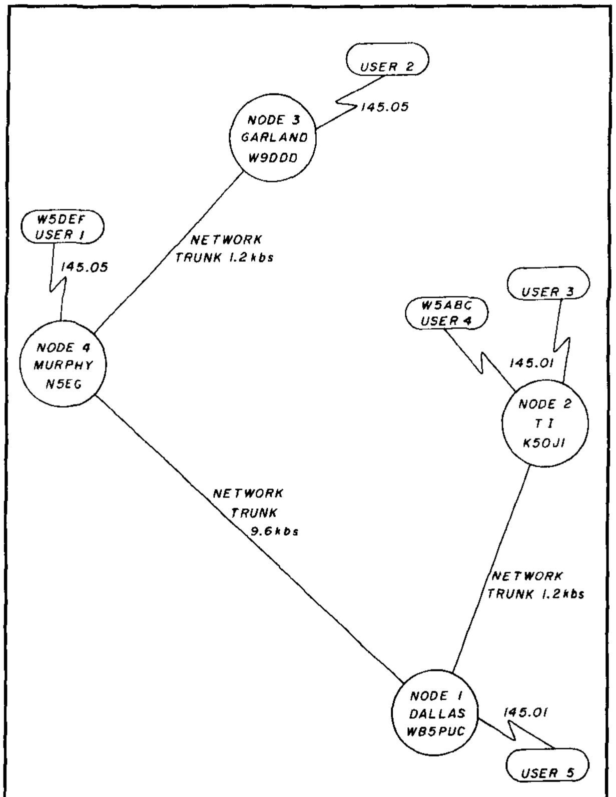

fig. 2. Dallas network test configuration.

The multi-node network logic is a datagram-based system that can support up to 256 node locations with as many as 20 simultaneous users at each node. All network nodes interconnect via permanent virtual connections between them.

The network is a database-driven system that features an extremely user-friendly termination-based routing structure. The network provides end-to-end flow control to eliminate internal congestion. A user's TNC "going busy" causes a network message to be sent to the far node, which in turn will "busy" the subject port at the far node, thus causing the remote user's TNC to stop sending.

In order to allow for an increased level of reliability, the network allows for alternate routing of data via multiple routes to a single node. Controlled by the node's database, alternate routing is automatically performed upon detection by a node that its first-choice route has failed.

The network provides substantial feedback to the user community via a mechanism called *Network Information Codes* (NIC). These NICs are printed at a user's terminal when something unusual happens that will affect the performance of the network from the user's viewpoint.

For an example of NIC operation, and for further illustration and explanation, see **fig. 2**, which illustrates the network test configuration as it was in Dallas when this article was being prepared. This test configuration was used for software testing during the development phase and for a series of operational tests during the beta-test phase.

The system shown in **fig. 2** is located in the north Dallas area. No particular attention was paid to the geographical locations except for convenience of access for testing. The illustrated network architecture was chosen because it provides for testing of all possible configurations of actual network operation.

Each of the four nodes has an Amateur call sign assigned as its user-access AX.25 address. Each node also has a mnemonic name to which all users refer when asking the network for services. For example, Node 4 has a user-access address of N5EG-4, and is referred to by users in all network commands as MURPHY. (Note: MURPHY is named for its location in Murphy, Texas — not in honor of the universal law of the same name.)

In an actual geographically dispersed network, the user community around each node has to know only their own node's user access address (N5EG-4 in the example above). They refer to all other nodes in the network by the network node names (GARLAND, *MURPHY, DALLAS, TI [Texas Instruments Radio* Club] — see **fig. 2**).

Also shown in **fig. 2** are typical user stations, labeled User I through User 5. These stations are standard Amateur packet stations equipped with commercially available TNCs and VHF transceivers.

the network users' interface

The Network Users' Interface (see *C* in **fig. 1**) provides the user's view of the network. Referring to **fig. 2**, if User 5 were to connect to WB5PUC-4, he would see the following displayed on his screen:

C WB5PUC-4
*****Connected to WB5PUC-4**
WB5PUC-4 Virtual Connection 06 at 18:32:20 on 11/20/86
*****Welcome to TEXNET*****
Network Cmd?

At this point he can issue any of the network commands or just disconnect if he's finished.

network command structure

The network command structure is as follows:

• **@NODENAME**. The NODENAME field may consist of any valid network node name. Valid node names may be two to seven characters long and can consist of any ASCII character except carriage return. As indicated in **fig. 2**, these names are MURPHY, GARLAND, TI, and DALLAS in our test configuration. User entry of a name not recognized by the node as valid will result in a message to the user indicating that an invalid node name has been entered. A list of valid names will be printed to allow correction of the error.

Because any command may be destined for any node, most commands are terminated by the @ NODENAME field. Some commands have an implied node name. Commands that are currently implemented are listed in **table 1**. For purposes of this description, the network commands are divided into two categories: User and Administration. Note that this division is for explanation only; any user may execute any command. Those who simply want to communicate via the network need learn only the commands listed in the User category. A much smaller group of people — those who are responsible for network engineering and administration — need to learn the Administration commands.

While the command words are spelled out fully in **table 1**, only the first character must be entered for most commands — for example, ***H*** for *HELP*. **Table 1** includes examples of network commands and their abbreviated formats.

• **HELP**. The user entering this command is given a partial list of commands (those marked "user") and referred to the network operation manual for further enlightenment. This strategy, rather than the on-line tutorial method, was chosen in order to reduce channel congestion. All new users are sent a copy of the TEXNET manual; this eliminates trial-and-error learn-

Table 1. Active network commands can be typed by user in response to the network command prompt, which is received after the user does a standard connect to the node.

Type	Command	Parameters () = optional input	Example using abbreviated command
User	Help	None	H
User	Circuit	Call sign (via Digi)	C W5ABC @ Dallas C W5ABC V WA5LXS @ Dallas
User	Locations	None	L
User	Message	None	M
User	Alert-on	None	A -on
User	Alert-off	None	A -off
Admin	Statistics	None	S @ Dallas
Admin	Initialize	None	I @ Dallas
Admin	Time	(DDMMYYHHMM)	T @ Dallas T 0108871420 @ Dallas
Admin	Route add	26 bytes of information	R A 01 . . . . 7F @ Dallas
Admin	Route delete	Number	R D 2 @ Dallas
Admin	Point	Function number	P E 2 @ Dallas P D 2 @ Dallas P S @ Dallas

ing on the air, which results in more efficient use of channel space.

• **The CIRCUIT** command tells the network the desired destination of the user's connection. See **fig. 2**; if User I wanted to communicate with User 4, he would enter the following at the command prompt:

C W5ABC @ TI

Obviously, this example assumes that User 4's call sign is W5ABC. Note that User 1 doesn't need to know how the network will connect to User 4; he just enters the terminating node name TI, and it's the network's responsibility to figure out how to route the message to TI.

The routing strategy is accomplished by the database in a node's knowing which of its adjacent nodes should be used to get to a remote node. It's a tradeoff, in that it makes the node database somewhat more complex — but it does allow the users an extremely easy interface.

Because the users don't need to know the physical configuration of the network in order to communicate, the network administration group can change it at will without having to inform (and thus re-educate) the entire user community. This routing strategy takes advantage of the disparity between the number of times users access the network to communicate (very large) versus the number of times the administration group adds or makes changes to a node (very small). The increased burden on the administration group is more than offset by the benefit to users.

In order to compensate for incomplete geographic network coverage, the CIRCUIT command allows an optional string of digipeaters to try to connect to the desired station. Thus,

C W5ABC V WA5LXS @ TI

would cause the remote node TI to attempt to connect to W5ABC, using WA5LXS as a digipeater. Up to two digipeaters can be specified in the CIRCUIT command.

Operations note: whenever a remote node attempts to connect to a station (as when TI attempts to connect to W5ABC in our example), the node will use Version 2 of the AX.25 protocol unless a digipeater is specified. If a digipeater is specified, the remote node will attempt the connect using Version 1 AX.25. This is because there are still some digipeaters around that won't accommodate Version 2.

After User I enters the CIRCUIT network command, one of three things will happen. First, his CRT may display the message,

Your connection is established

in which case he's being advised that the desired remote user (User 4) is on line. At the far side, our remote user (User 4) would receive the following on his screen:

*****Connected to K5OJI-4**
*****Linked to W5DEF at Murphy via Texnet**

Therefore, User 4 knows exactly to whom he is connected via the network, and where the originating station is located. The above example, of course, assumes User 1's call is W5DEF.

The "**** Linked to" string received from the network allows a WØRLI-compatible BBS system to know who the real user is (W5DEF) rather than thinking it is connected to the node (K5OJI-4).

The second possible message is:

Remote user not responding

In this case, User 1 is informed that connection is impossible. This could occur for a number of reasons: the remote station may not have its equipment turned on, or it may be turned on but involved in another QSO.

The third possibility is receipt of an NIC message. Using our example, if user 1 received:

Network information code 017 from Dallas

he could look in the TEXNET manual and find that code 017 means his attempt was routed as far as Dallas, but couldn't be routed further because of a network trunk outage. This can then be reported to network administration for remedial action.

• The **LOCATIONS** command allows users to ask the node for a list of remote locations which can be reached through the network.

• **The MESSAGE** command gives any network user, regardless of node location, access to the network Packet Message Server (PMS) logic. Details of the PMS subsystem will be covered below; for the moment, let's just say that it's a network-wide message file system similar to the W0RLI bulletin board system.

It's important to note that users at any node in the network don't need to know where in the network the PMS system is physically located. All a user needs to do is type MESSAGE or M, and the network takes care of routing to PMS. In the test configuration shown in **fig. 2**, PMS is actually located at Node 1 or Dallas, but very few users are aware of this, since they can connect to any node to access PMS. Once the network has established a connection for the user to PMS, the user can enter PMS commands to store, list, or read messages.

• **ALERT-ON** AND **ALERT-OFF** enable or disable a special mode of operation called ALERT, which is especially designed for accommodating emergency traffic handling via packet radio. The ALERT mode can be enabled from any node in the network. When a user connects to any node and issues the ALERT-ON network command, his or her node will send a "broadcast" command to all other nodes in the network informing them that ALERT mode is being enabled and telling each the name of the originating node. At this point, several things happen in every node.

Users connecting to the network are informed that an ALERT is in progress. Let's assume that a user at Dallas has enabled the ALERT mode. As in our previous example, User 1 wants to communicate with User 4; when he tries to connect, however, he receives the following message on his CRT:

*****Connected to N5EG-4**
N5EG-4 Virtual Connection 03 at 08:30:20 on 12/15/86
Pls disconnect unless your traffic is related to the network alert in progress from Dallas.
****Welcome to TEXNET****
Network cmd?

When ALERT is enabled, all user automatic disconnect timing is disabled. Thus, instead of the standard 3-minute idle time disconnect, to which all users are subject, all nodes will allow connections of unlimited duration to their ports. This disconnect timing suspension affects all connects to the node. Thus, if groups of users want to use their node's conference bridges to handle emergency traffic, they can remain connected indefinitely. User connects to PMS may also be of indefinite duration.

With the enabling of ALERT, a special mode of PMS that provides a real-time message exchange between the multiple users connected to PMS is also enabled. Thus, when one user SENDS (see PMS description below) to another, all of the standard PMS functions are invoked. In addition, after automatically saving the message on disk, PMS will check to see if the addressee is currently connected to PMS on another of its logical ports. If he is, PMS will automatically display the message at the addressee's terminal.

With this mode of operation enabled, PMS becomes a real-time message forwarding system among its connected users, with the added feature that all messages are archived to the disk. This feature can be extremely useful in emergency government communications back-up, since the stations connected to PMS could be physically located anywhere along the network.

For a Department of Public Safety (DPS) exercise, for example, Amateurs equipped with standard packet equipment could be located in each community's DPS office. Each station would be connected, via the network, to one of the logical ports of PMS. Because the ALERT mode would be enabled, they would be able to stay connected indefinitely — remember, DISC (disconnect) timing is inhibited with the enabling of ALERT — and each time one station uses the standard **S** feature of PMS, the message would be displayed in real time at the receive station. Of course, the message would be automatically saved to disk so the receive station can review it at will. Other advantages of this technique include a complete on-disk record of all messages (useful for exercise postmortems) and the fact that other connected stations may review all communications except those sent as private messages.

• **The STATISTICS** command, when issued with the NODENAME parameter, causes the local node to acquire the operational statistics of the remote nodes. The statistics counters in a node aren't cleared by this command; this allows timed interval measurements to be taken. Every midnight, all statistics counters are cleared to zero.

The following are the statistics kept at each node and therefore available via the STATISTICS command:

Frame buffers available
Frame buffers in use
Maximum frame buffers ever used
Total connects
Connects to weather
Connects to conference bridge
Connects to network
Network circuits active
Maximum network circuits ever active
Packets sent on each physical channel
Packets received on each physical channel
Packets re-sent on each physical channel

In addition, the real time at the subject node is sent back with the statistics. By looking at some of the statistics returned, the network administrators can make various engineering judgments about the level of service being provided by a node to its user community. Quantitative measurements of the activity of a node's local user community, and of which node services are being used, can also be made.

• **The INITIALIZE** command is the means of remotely restarting any node. When a node receives an INITIALIZE command directed to it from someplace on the network, two functions are executed. First, upon receipt and decoding of the command, the software kills all activity in the node for 30 seconds. This delay allows time for adjacent nodes to have their network trunks to the subject node time out because of the subject nodes' lack of activity. This action gracefully removes the subject node from the network fabric. At the end of the delay period, the subject node does a cold restart, thus appearing to the rest of the network as if it had just been turned on. In response to this action, the subject node — after consulting its database — establishes network trunks to the appropriate adjacent nodes. Network operation is now re-established.

The second thing that happens upon receipt of an INITIALIZE command is the activation of an external hardware fail-safe circuit. Buried in the INITIALIZE command as it traverses the network is a unique bit sequence generated by the originating node and specific to the subject node. Upon detection of the bit sequence by the subject node's external hardware fail-safe circuit, the master reset line of the Z-80 is asserted. This technique obviates the above discussion on the software execution of the INITIALIZE command unless, of course, there's a failure in the fail-safe hardware itself. The combination of the two techniques would require a double failure in a node before the ability to remotely reset it would be lost.

• **The TIME** command, when issued by a user at any node and directed to a specific remote node, will cause the real-time clock at the remote node to be updated to the time contained in the message. If no time parameter is input by the originating user, then the current time at the user's node is sent to the remote. If the time parameter is entered by the user, his or her node's real-time clock is updated with the input time before its value is sent to the remote node.

• **ROUTE ADD/DELETE**. Since in every node the ROM routing table is copied to RAM for operation, it may be changed by being added to or deleted from. The ROUTE commands are the means by which new nodes can temporarily be added to an existing network or by which the network configuration can be changed to accommodate a failure or some other special event.

• **POINT** COMMAND. This command is used to control external equipment at any node site. Within each node control point (NCP), there are 5 bits of input and 5 bits of output available for external use. These bits, called control points, could be used to control and monitor anything that interfaces via contact closures. Co-located equipment at the node site, such as other repeaters, could take full advantage of digital control via this feature of the NCP.

The POINT command allows full on/off control of the output points. For example, suppose a co-located voice repeater at the GARLAND node needed to be controlled. NCP output Point 1 could then be wired to the voice repeater's control relay, and perhaps NCP input Point 1 would be wired to one of the control relay contacts to allow monitoring of relay closure.

Any authorized packet station, anywhere on the network, can issue the following command to enable the co-located voice repeater:

POINT ENABLE 1 @ GARLAND

or for short,

P E 1 @ GARLAND

Displayed on the CRT — after the network has passed the POINT command to the GARLAND node and the command was executed — would be:

Control Points at Garland Are

Point:	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Input:	**E**	**D**	**D**	**D**	**D**	**D**	**D**	**D**
Output:	**E**		**D**	**D**	**D**	**D**	**D**	**D**

Since the control operator knows that Control Point 1 is wired to the voice repeater, he can see that it's enabled, and by looking at Input Point 1, confirm that the control relay is closed.

Any time the control operator wishes to check if the voice repeater is on, he needs only to type **P S @ GARLAND** to get the status display of the control functions. When he chooses to shut the voice repeater down, he enters **P D 1 @ GARLAND** at the network command prompt. Again the status will be displayed on his screen in response to the command, allowing confirmation that shutdown has occurred.

One important use of the POINT command is the control of a pair of control points wired over to the node's Uninterruptible Power Supply (UPS). By design, the UPS has a control lead which, when enabled, forces the UPS to switch from ac to battery. Another UPS lead provides an indication that the UPS has switched to battery operation.

In a normal node configuration, Control Point 5 input and output are wired to the UPS control leads. This allows any node in the network to be instructed to operate off battery power by the simple issuance of the **P E 5 @ Node** command. Issuing the **P D 5 @ Node** command restores the node to ac operation. This feature allows weekly testing of the UPS to ensure that it would be effective during an emergency.

network internals

It may be interesting at this point to describe some of the internal workings of the network software, which has the ability to establish, kill, and communicate over any number of virtual connections. Thus, at system startup, the network application executes logic to find out who its neighboring nodes are. It then establishes a virtual connection to each, over whatever physical channel is specified to be used as the network trunk. This virtual connection is left up forever. All subsequent communications from this node to its neighbor, whether user data or network management data, travel over this permanent virtual connection. Additional logic determines the network configuration for the node's routing table.

A special byte string is added to the beginning of all packets going over a network trunk. This string, known as a *Network Header Block* (NHB), consists of a minimum of 5 bytes:

NHB.RNN	**Destination Node Number**
NHB.RLC	**Destination Virtual Connection Number**
NHB.LNN	**Originating Node Number**
NHB.LLC	**Originating Virtual Connection Number**
NHB.NCF	**Network Control Field**
~ ~	**Any Network or User Data**

When a node receives information from a virtual connection marked as a network trunk, it examines the NHB. Looking at NHB element **NHB.RNN**, it checks to see if the received string is for this node. If it isn't, the node consults its routing table to see on which of its trunk circuits (virtual connections) it is to retransmit the string. This is known as *transit routing*, and it's extremely fast, thereby yielding a large node bandwidth in this mode. If the examination of **NHB.RNN** confirms that the string is for this node, the **NHB.NCF** byte is decoded to tell the node the proper action to take on the received string. There are over 15 valid network control fields in the current design, so it wouldn't be practical to cover them all here; therefore, we'll choose just one as a simple example.

The example will be of a remote node (perhaps many hops, or nodes, away — we don't know, and we don't care if the information came to us via transit routing through multiple nodes) asking us to send our operational statistics. When we finally receive the string, we find it's directed to our node; moreover, after examining the network control field, we see it is set at 01 HEX, which tells us that the remote wants us to send our collected statistics. Our response to this is to reverse the NHB items so we can send information back to the requester and reset the network control field to 02 HEX, which will inform the requester, when he receives the string, that we responded. We append approximately 40 bytes to the string. These appended bytes are the operational statistics we've been collecting, which is what the remote requested.

the packet message server

The PMS logic (see *D* in **fig. 1**), resident within a node, allows a simple three-chip interface to a Western Digital WD 1002-05G disk controller and a standard ST506 5-Megabyte hard disk to become a network wide integrated message storage/retrieval system. Normally, only one disk is required per network. It's possible, however, in a very large network, to assign specific groups of nodes to a given PMS, in which case there could be more than one PMS disk. The PMS logic is resident in each node, but only the node(s) equipped with a physical disk allow it to execute.

From an individual user's viewpoint, the PMS looks and acts like a W0RLI bulletin board system. This choice of operational methods was made to reduce the amount of end-user training required. It also aids in the transition that must occur when all users in a given area are switching from being served by an in-place W0RLI system to the PMS system running on the network. Because of the similarities between the familiar W0RLI system and the PMS, this discussion will not cover details such as how the SEND, READ, KILL, and other commands work, but will instead concentrate on the PMS's enhancements.

Because the PMS system is designed to provide message service for all the users of a network subregion, the bandwidth requirements are greater than those found in other message systems. Unlike existing message systems, which have the ability to service only one user at a time, the PMS system allows up to ten users to log on simultaneously, providing the same grade of service, relative to response time, to each.

The storage element in a PMS is a 5-Megabyte hard disk. These disks are equipped with four head assemblies and a platter assembly capable of accommodating 154 cylinders. To make use of these characteristics and to provide the response time needed, the software was expressly designed to have a message file structure that takes advantage of the physical characteristics of the disk. The first time a new node is energized, the disk is automatically formatted and then configured to the necessary file structure. Every restart thereafter preserves all saved messages.

The combination of the hard drive and special file structure results in an incredibly small response time; even with multiple users, each user has a real-time response from the PMS, with a delay of less than 1 second. In tests run on the Dallas network test configuration, remote network users accessing the PMS via a 9600-bps network trunk observed no difference in response time from that observed by users directly connected to a PMS system. Both experienced a response time of less than 1 second. Most operational response time delay was attributable to congestion on the 1200-bps final link to the user.

The PMS system supports up to 500 active messages from a message number range of 1 to 99,999. There's no difference in response time if a user is accessing Message No. 1, 500, or 50,000.

All active messages are subject to the auto-delete function of the PMS. An undeleted message will remain in PMS for no fewer than 14 days and no more than 28 days before being automatically deleted by the system. While these times are variable, users seem to find them satisfactory.

Important note: the PMS message system is

designed to run *completely* unattended. No SYSOP is required. All duties previously performed by people running mailboxes are done automatically by the PMS logic.

The PMS system can run "stand-alone" — for example, with its user community geographically near the PMS equipment, thus replacing an existing mailbox system. In testing this configuration, a version of the software was put into an MFJ 1270 TNC-2 with a hard disk interfaced to it. This system is currently used as a demo system for other groups of Amateurs wishing to participate in TEXNET.

PMS is used primarily as a network-wide message system. In its network configuration, any user located anywhere on the network may, after receiving the network command prompt, issue only the MESSAGE command to be automatically routed over the network to his servicing PMS. Referring again to **fig. 2**, the PMS equipment (all that's required in addition to an existing NCP is the disk controller and hard drive) is physically located at Node 1 in our Dallas test system. Any user can connect to any other node by issuing a connect request to the desired nodes call and using the -4 SSID. After this, all that must be done is to issue the MESSAGE command. The next thing that appears on the CRT is the text from PMS.

Since the PMS is network-compatible, it knows who the originator is as well as where (i.e., at what node name — DALLAS, GARLAND, TI, etc.) he's located. All of this is used automatically whenever a user does an **S** command to send a message to another user. If, after doing the message send, the user does a simple **R** (in PMS, the **R** with no qualifier or number will read back the last message number), he'll see that his call and the name of his node have been automatically entered in the message header.

In order to provide a message interface between an entire network and the existing Amateur message forwarding system, the PMS supports a subset of message forwarding. All messages that network users enter into PMS and which require forwarding will be passed by PMS to a single W0RLI system for eventual forwarding by the existing systems. The identification of this W0RLI system is contained in the node's database. This same W0RLI system can also forward messages into the PMS system for reading by all network users. PMS is designed to follow the standard forwarding protocol and uses a direct access port to connect with the W0RLI system. For example, in **fig. 2**, Node 1, containing the PMS system, will access the WA5MWD BBS system in Dallas by using its WB5PUC-7 direct access port. The WA5MWD BBS system can pass messages into the network by connecting to WB5PUC-7. The WA5MWD box doesn't know it's talking to the network system; it thinks it's talking to just another standard W0RLI system.

non-network local services

The following are services provided by each network node on a standard basis. These services are independent of the network, but still extremely useful:

Multi-user Conference Bridge
National Weather Service interface
Local Node Console
Debug Aid
Digipeating

multi-user conference bridge[3]

The multi-user conference bridge (see *E* in **fig. 1**) logic allows up to six remote users to hold a roundtable conversation with each remote, with the ability to see all text generated by all other remotes. Each remote user has a direct AX.25 connect to a logical port on the conference bridge. Upon reception of a packet of information from one user, the bridge will make multiple copies and send one to each of the other connected users. Since each user has an AX.25 connect to the bridge, he's assured of not losing packets, since the bridge will retry upon lack of an acknowledgment from the affected remote.

As the text is being transmitted to a remote user, it's modified to show which of the other remotes originated it. Therefore, all users not only see all text from each other, but know who originated it.

In a standard software package, the conference bridge logic simultaneously supports two completely independent six-party conferences. Each of these independent conference bridges is accessed by remotes using unique SSIDs, (usually -2 and -3).

Since the bridge logic is supported by the common logic, any of the remote users may be operating in either AX.25 version 1 or 2. Text is transferred among users without regard to versions used by individual remotes.

At any time during a conference, any of the users may type **CONTROL-U**. Upon receipt of this character, the conference bridge logic will respond by sending the requester a list of call signs of all other remote users currently connected to the conference bridge. Any of the remotes may exit an established conference, and other remotes may join (on a noninterference basis) the conference in progress.

Tests conducted in the Dallas area show the conference bridge to be a cleaner and more reliable way for groups to hold multi-user roundtable connects than the UNPROTO mode available on standard TNCs. This is because of the built-in advantage of error-free AX.25 connects combined with the fact that each remote has to have a good path only to the conference bridge, not to all other users.

NWS interface

The National Weather Service (NWS) application (see *F* in **fig. 1**) runs concurrently with others at a node. Typically, one node in each region could have this application enabled and interfaced via a standard 75-wpm, Baudot-encoded, 20-mA landline to the National Weather Service.

The NWS wire feed provides raw weather data for a large geographic region. The NWS logic monitors all received data, but selects and stores only those NWS products (for example, region forecasts, severe storm alerts, thunderstorm warnings, etc.) which have their unique codes programmed into the node's database. The NWS logic currently supports 30 code sequences, with each having the ability to be from 2 to 11 characters in length. This code format is consistent with the nine-character sequence utilized as a standard by the NWS.

Remote users connect to the node's NWS logic by means of a unique SSID (usually -1). Up to ten remote users may be connected to a node's NWS logic simultaneously. Upon connection to the logic, the system will wait for the remote user to enter a single product designator — for example, a user in Dallas who enters "D" causes the node to send the current Dallas area weather forecast. Entering a question mark prints the entire list of stored product designators.

All remote users are assured of receiving the latest data because the node updates its buffers in real time, as new information is received from the weather bureau. At 2 A.M. each day, the node clears all buffers to eliminate products sent infrequently by the weather service.

local CRT console

Figure 1 (see *G*) shows the local console CRT logic "sitting on top of" the common logic. The CRT logic at each node allows a locally connected standard ASCII CRT to originate and terminate connects with any standard TNC. In operation, it uses a unique SSID (usually -5) to distinguish itself from other node services. The local console logic isn't meant to be a full TNC-human user interface, as commercial TNCs are. Instead, this logic provides a minimum subset of human user commands that are necessary for testing and administration of the node. **Table 2** contains examples of command types supported; some specific commands follow.

• **The ORIGINATE ON PHYSICAL CHANNEL command** allows the user to select which physical channel is to be used for originating connects. The console will accept connects from any physical channel, but will do so only if it's not currently busy. This command allows the console to originate on the physical channel connected to the 1200-bps radios and, therefore, look like a standard user. Also allowed are connections to be established to any other node site via the 9600-bps trunk circuits. The latter is particularly useful for troubleshooting remote nodes from our network control site.

Table 2. Command types supported by TEXNET's CRT logic.

Command Type	Format
ORIGINATE ON PHYSICAL CHANNEL	ON where N = 0, 1, etc. = physical channel
CONNECT	C W5ABC V WA5MWD, N5EG
DISCONNECT	D
BUSY	B
FRAME TRACE	FT
LOCAL TIME SET	LT DDMMYYHHMM
STANDARD MODE	SM
VERSION SELECT	V1

• **CONNECT AND DISCONNECT** are identical to the commands on any standard TNC.

• **BUSY** sets the console into a busy state to facilitate troubleshooting the network's end-to-end flow control logic.

• **FRAME TRACE** is similar to that command on any standard TNC in that it provides a real-time look at all frames as they're received by any physical channel on the node. Displayed are both hex and ASCII equivalents of the received frame.

• **LOCAL TIME SET** allows maintenance personnel to reset the real-time wall clock at a node. This command usually isn't used because it's possible to set the time at any node in the network from any other node using the network TIME command.

• **STANDARD MODE** permits an unused bit in the standard AX.25 protocol to be toggled. This bit is utilized by the PAD logic, network logic, and debug logic to signify that the remote is a special user capable of accessing advanced functions.

• **VERSION SELECT** allows the local console to originate connects in either AX.25 V1 or V2. This command controls only the originating version, since the common logic automatically accommodates either version on terminating connects.

The local console CRT interfaces to the NCP via one half of an SIO, which can be strapped for multiple baud rates. The console employs a 1000-character buffer to accommodate the speed differences between incoming text and the rate of display. Because the local console need not be equipped on a node, the console logic handles cases where no hardware is present.

Table 3. Some commands and functions supported by the debug logic.

Command	Format	Description
MEMORY	M Adr1,Adr2	Do a hex dump from memory location Adr1 to Adr2.
	M Adr1	Display the contents of memory location Adr1 and then wait for new contents to be entered. Entering a period escapes this mode.
COPY	C Adr1, Adr2, Adr3	Copy the contents of memory locations Adr1 to Adr2 to the new location, beginning with Adr3.
*(OFFSET)	* Adr1	The offset (*) register is useful for input arithmetic. For example, setting the * register to 1000H (*1000) allows subsequent entering of M* +2 to display location 1002H.
HEX ARITH	H Num1 + Num2 - Num3	Perform hex arithmetic on any entered numbers. Addition and subtraction are supported with support of the offset (*) register.
PORT	P75	Display the contents of the Z-80 I/O address 75H, then wait for a new number to be input. Entering a period escapes this mode.
INITIALIZE	I Adr1, Adr2, Num	Initialize the memory block from Adr1 to Adr2 with the number (Num) entered.
EXECUTE	E Adr1	Transfer execution control to Adr1 with the Z-80 registers initialized per the "R" command.
REGISTER	R	Display and allow change of the Z-80 register file
X DIAGNOSTIC	X Adr1, Adr2	Run read/write/verify memory diagnostics on the memory block Adr1 to Adr2.

debugger

The debug logic (see *H* in **fig. 1**) has proved to be an invaluable aid in initial software debug as well as in system integration. The debugger at any node is accessed by specially authorized remote users via requesting a connect to the node utilizing a given SSID (usually -6). This logic supports a single user and inhibits others from connecting if someone is currently active.

The debugger executes concurrently with the network logic and the PMS, as well as at the same application level (see **fig. 1**). Accessed from the common logic, it is used as an aid in debugging these and other applications in an on-line manner.

Table 3 describes some of the commands and functions which are currently supported by the debug logic.

digipeating

Unless inhibited from doing so by the database, every network node can also function as a local digipeater (see *I* in **fig. 1**) for whatever frequency is being used as an input. In Dallas, it's 145.05. Multiple digipeater addresses are supported, thus allowing for any number of ALIASES or standard AX.25 addresses. It should be noted here that the PAD addresses mentioned above and the digipeater addresses are completely separate.

Enhanced digipeating is supported by the node because the output physical channel for retransmission of a packet is a function of both the digipeater address and the physical channel on which the packet was received. Thus, it's possible to have a cross-frequency digipeater using no special tricks or logic. For example, N5EG-8 (Node 4, MURPHY) is configured to be a bidirectional cross-frequency digipeater between 2 meters and 450 MHz. This has proven to be extraordinarily useful in network software construction because it allows access to a remote node (one which is potentially many hops away) via digipeating over the 9600-bps trunk circuits. This method of access completely bypasses all other software and is, therefore, useful (in conjunction with the debugger) in troubleshooting.

conclusion

Thanks to the members of the Texas Packet Radio Society for helping to make this series of articles possible.

We'd like to hear from developers and users of other packet systems to learn what you're doing. Please address correspondence (enclose SASE) to Tom McDermott, N5EG, The Texas Packet Radio Society, P.O. Box 831566, Richardson, Texas 75083-1566.

references

1. Thomas H. Aschenbrenner, WB5PUC, and Thomas C. McDermott, N5EG, "The TEXNET Packet Switching Network: Part 1 — System Definition and Design," *ham radio*, March, 1987, page 29.
2. Thomas H. Aschenbrenner, WB5PUC, and Thomas C. McDermott, N5EG, "The TEXNET Packet Switching Network: Part 2 — Hardware Design," *ham radio*, April, 1987, page 29.
3. Bill Wade, WD5HJP, "Packet Radio Conference Bridge," *ham radio*, April, 1987, page 24.

ham radio

DX FORECASTER

Garth Stonehocker, KØRYW

sporadic-E season

During the summer months the sun — directly overhead at 23 degrees north — produces more ions in the lower ionosphere than it does in winter. These abundant ions are formed into cloud-like patches known as sporadic-E. The patches, which form in a thin but dense layer about 60 miles above the earth, give rise to strong mirror-like signal reflections over short-skip distances of 600 to 1200 miles.

Because E_S is related to the summer sun, the best locations for working these E_S openings are in the Northern Hemisphere from June through September and in the Southern Hemisphere during their summer, December through March. In each hemisphere, the best E_S is found on either side of the geomagnetic equator; it's especially good where the geomagnetic equator is furthest from the geographic equator. These special areas are Southeast Asia and the Mediterranean in the Northern Hemisphere and South America in the Southern Hemisiphere, with the former the better, as shown in **fig. 1**. The contours in the figure represent the percentage of the time sporadic-E is available along that line. A "10-line" indicates that sporadic-E is available 10 percent of the month, or three days out of 30 — or, equivalently, 6 minutes out of each hour. This is a purely statistical measure of the chance of an E_S patch being available at the location of the midpoint of a 2000-km path. E_S openings can be utilized as high as the 6-meter band this year.

last-minute forecast

During the first two weeks of the month, daily MUFs should be lower. As a result, fewer openings on 10 to 30 meters can be expected, except for a few sporadic-E short-skip paths. There's a slim possibility of one occurring on 6 meters. Long-skip conditions on these bands will improve somewhat in the third week. The lower bands will be best for daytime short-skip paths during the second week, corresponding to a minimum solar flux in June. Nighttime DX conditions should be best then as well, and should be fairly good during the whole month except when atmospheric noise levels are high.

The moon will be full and at perigee (its closest approach) on June 11. Summer solstice is on the 21st at 2211 UTC. The Aquarid meteor shower starts about the 18th, peaks about the 28th, and lasts until about August 7. The maximum radio-echo rate will be 34 per hour.

band-by-band summary

Six meters will provide occasional openings to South Africa and South America around noontime via short-skip E_S propagation.

Ten meters will provide long-skip conditions in the afternoon during the peak times of the 27-day solar cycle. Otherwise, look to sporadic-E short-skip and multihop openings around local noon for DX on this band. (Trans-equatorial evening openings usually don't occur in the summertime.)

Twelve and fifteen meters, almost always open to some southern part of the world, will be the main daytime DX bands. Operate on 12 first, then move down to 15 later. DX is considered 5000 to 7000 miles on these bands. There may be some long one-hop transequatorial propagation early in the month.

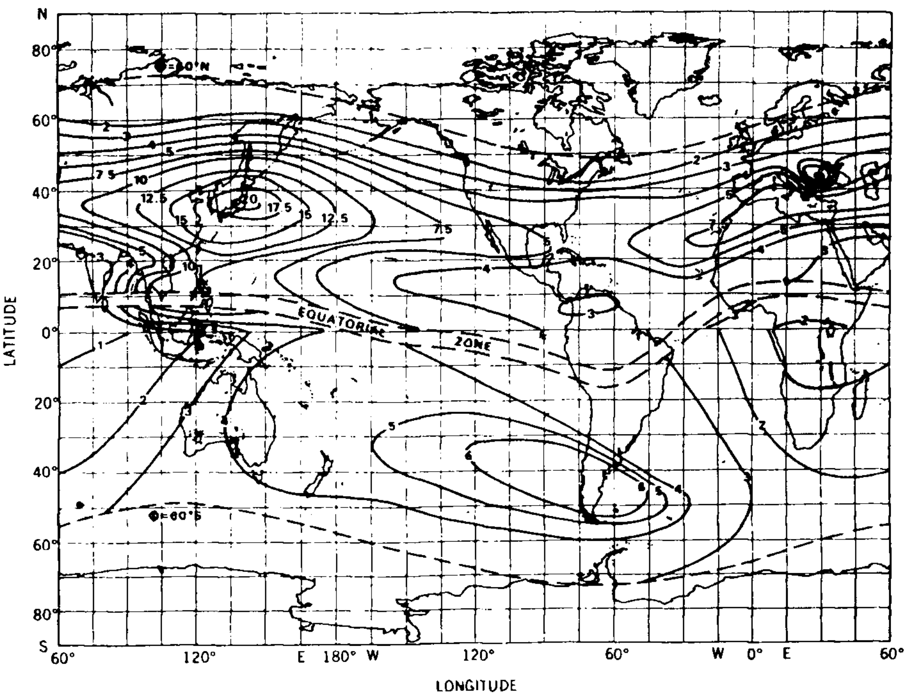

fig. 1. World map includes sporadic-E contours. The numbers on each line represent statistically the percentage of time during the month that a sporadic-E patch exists at that location.

GMT	2300	2200	2100	2000	1900	1800	1700	1600	1500	1400	1300	1200	1100	1000	0900	0800	0700	0600	0500	0400	0300	0200	0100	0000		
JUNE	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	5:00	PDT	
ASIA FAR EAST	20	20	30	30	30	30	20	20	20	20	20	30	30	30	30	20	20	20	20	20	15	20	20	20	N	WESTERN USA
EUROPE	20	20	20	20	15	15	15	20	20	20	20	20	20	30	30	30	20	20	20	30	30	30	30	30	NE	
S. AFRICA	20	20	20	15	15	12	10	10	10	12	12	15	20	20	30*	20	15	15	20	30	30	30	20	20	E	
S. AMERICA	12	10	10	10	12	12	12	12	12	15	20	20	30	30	30	20	20	20	20	20	20	15	15	12	SE	
ANTARCTICA	20	20	20	20	20	20	30	40	40	40	40	40	40	40	40	30	30	30	30	30	20	20	20	20	S	
NEW ZEALAND	12	12	15	12	15	20	20	30	30	20	30	20	20	20	15	15	15	12	12	10	10	10	12	15	SW	
OCEANIA AUSTRALIA	10	10	12	12	20	30	30	30	30	30	30	20	20	20	20	20	15	15	12	10	10	10	10	10	W	
JAPAN	20	20	20	20	20	20	30	40	30	20	30	30	30	20	20	20	20	15	15	15	15	15	15	15	NW	

	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	MDT	
ASIA FAR EAST	20	30	40	30	30	20	20	20	20	20	20	20	20	30	30	30	30	20	20	20	20	20	20	20	N	MID USA
EUROPE	20	20	20	20	20	20	20	20	20	20	20	20	30	30	20	20	20	30	30	30	40	30	30	20	NE	
S. AFRICA	20	20	20	15	15	12	10	10	12	12	15	15	20	20	30*	20	20	20	20	30	30	30	20	20	E	
S. AMERICA	12	10	10	10	10	10	12	12	15	15	20	20	30	30	30	20	20	20	20	20	20	15	15	12	SE	
ANTARCTICA	20	20	20	20	20	20	30	40	40	40	40	40	40	40	40	40	30	30	30	30	30	20	20	20	S	
NEW ZEALAND	12	12	15	15	15	20	20	20	30	30	30	30	20	20	15	15	15	12	12	12	10	10	12	15	SW	
OCEANIA AUSTRALIA	10	10	12	12	15	20	30	30	30	30	30	20	20	20	20	20	15	15	15	12	12	10	10	10	W	
JAPAN	20	20	20	20	20	20	20	30	30	20	20	20	30	30	30	20	20	20	20	20	15	15	15	15	NW	
	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	CDT	

	7:00	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	EDT	
ASIA FAR EAST	20	30	40	30	30	20	20	20	20	20	15	20	20	20	20	20	30	30	30	20	20	20	20	20	N	EASTERN USA
EUROPE	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	30	30	40	30	40	30	20	20	NE	
S. AFRICA	20	20	20	15	15	12	10	10	10	10	12	12	15	15	20	20	30*	20	20	30	30	30	20	20	E	
CARIBBEAN S. AMERICA	12	12	10	10	12	12	12	12	12	12	12	15	20	20	30	20	20	20	20	20	20	15	15	12	SE	
ANTARCTICA	20	20	20	20	20	20	30	30	40	40	40	40	40	40	40	40	40	40	30	30	30	30	20	20	S	
NEW ZEALAND	12	12	15	15	15	15	20	20	30	20	20	20	20	30	20	20	15	15	15	12	12	12	10	10	SW	
OCEANIA AUSTRALIA	10	10	10	12	15	30	30	30	30	30	20	20	20	30*	20	20	20	15	15	12	12	12	10	10	W	
JAPAN	20	20	20	20	20	20	20	30	30	20	20	20	20	20	30	30	30	20	20	20	20	20	20*	20	NW	

Shaded numbers signify the bands to try during the transition and early morning hours, while the standard type provides MUF during "normal" hours.

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

Twenty, thirty, and forty meters will support DX propagation from most areas of the world during the daytime and into the evening hours almost every day. Forty meters has joined this daytime DX group because of lower signal absorption, and therefore lower LUF (lowest usable frequency) during these sunspot minimum years. DX on these bands may be either long-skip to 2500 miles or short-skip E_s to 1250 miles per hop. The length of daylight is approaching maximum, providing many hours of good DXing.

Thirty, forty, eighty, and one-sixty are all good for nighttime DX. Although the background thunderstorm noise is beginning to be noticeable, these bands are still quiet enough to provide good DX working conditions. Sporadic-E propagation may be a contributing factor toward enhanced conditions at local sunset and will occur more often during the next three months.

ham radio

PRACTICALLY SPEAKING ... Joe Carr K4IPV

build your own time-domain reflectometer

Solving transmission line difficulties can be a tedious and difficult chore, especially when the load end isn't easily accessible. Although a number of different methods of dealing with these problems are available, I want to discuss time-domain reflectometry this month; we'll cover some of the others in subsequent columns. Although commercial time domain reflectometers (TDRs) are expensive, some of the methods of time-domain reflectometry can be used by any Amateur who has access to an oscilloscope. The results won't be as good as those obtained with professional TDR equipment, but the methods will work.

TDR fundamentals

Time-domain reflectometry works on the principle that waves on a nonmatched transmission line *reflect*. [Any variation from the characteristic impedance of the transmission line will cause a reflected component to be sent back to the source. — Ed.] The waveform seen at any given point along the line is the algebraic sum of the forward and reflected waveforms. In TDR measurements, we look at the waveform at the input end of the transmission line system.

Figure 1 shows the basic setup for a TDR. A pulse generator, or other source of 1-MHz square waves, is applied simultaneously to the vertical input of an oscilloscope and the input end of the transmission line. The simplest way of splitting the signal is to use an ordinary coaxial "tee" connector, either a BNC or UHF.

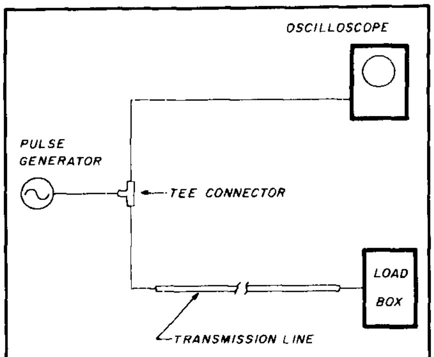

fig. 1. Time domain reflectometry (TDR) test setup shows effects of various load resistances on transmission line display.

pulse source

Almost any source of 1-MHz square waves can be used for the pulse generator. If you have a function generator with a 1 MHz or higher output pulse rate, you can use it; be careful, however, if the output impedance is 600 ohms. In such a case, you might want to wind a 600-to-50 ohm transformer or add a simple resistor pad. Alternatively, you can build your own pulse source.

building an oscillator

Many different forms of TTL oscillator can serve as a pulse source. **Figure 2A** is a circuit for a pulse generator that uses the Motorola MC-4024P device. This dual, TTL-compatible, voltage controlled oscillator is enclosed in a shielded box. The operating frequency is determined from $f = 300/C$, where f is the frequency in MHz and C is capacitance in pF. The actual operating frequency isn't terribly critical, as long as it's somewhere near 1 MHz. For very short transmission lines, the operating frequency may have to be increased. Experiment with it.

The output waveform is a square wave with a period of about 1.1 μS, with C1 = 330 pF. The half-cycle used in the experiment (see **fig. 2B**) has a duration of 550 nanoseconds (0.55 μS). If you want to clean up the rise

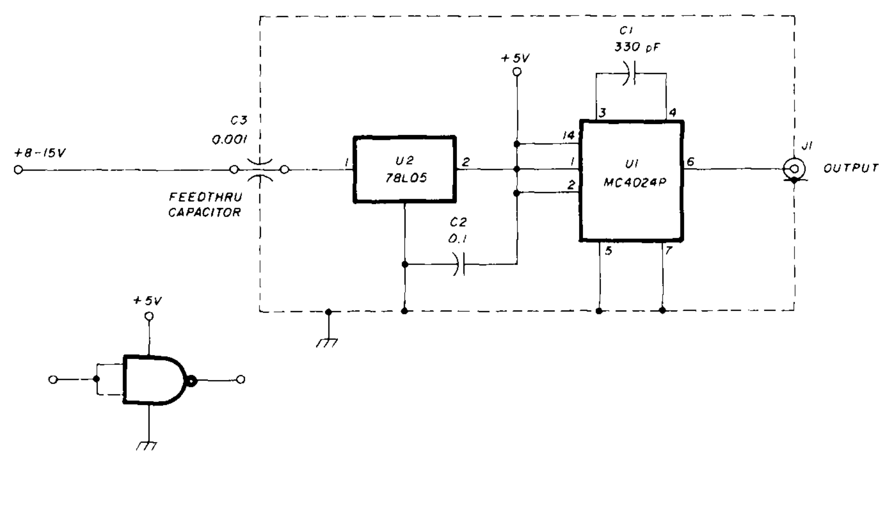

fig. 2A. TTL oscillator used as pulse generator source: circuit diagram.

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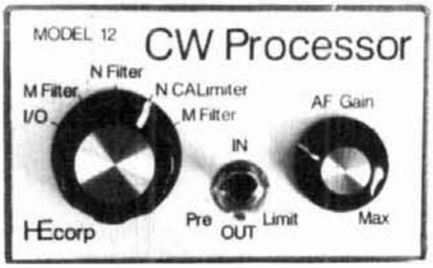

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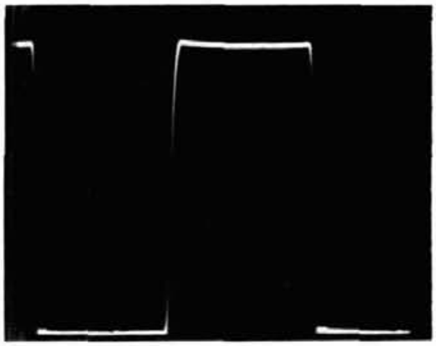

fig. 2B. TTL oscillator used as pulse generator source: output waveform.

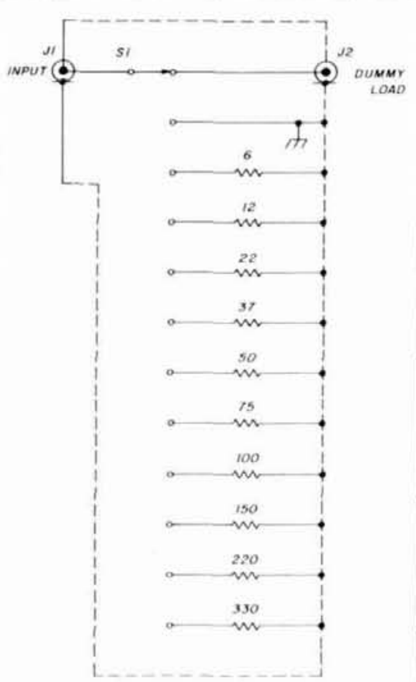

fig. 3. Test box provides various load resistances below and above characteristic impedance of transmission line.

and fall times of the output waveform, *pass the output through either an inverter* made from an "H" series TTL or a Schmitt trigger (7414). The inset to **fig. 2A** shows an inverter made by strapping the inputs of a 74H00 NAND gate.

Figure 2B was photographed from my oscilloscope with the coaxial cable *disconnected*. In the following photos, we'll see what this pulse looks like when a reflected pulse hits it after returning from its round trip on the transmission line.

Another alternate pulse generator is a 1- or 2-MHz crystal oscillator. These oscillators can also serve as marker generators for other purposes.[1] Another possibility would be a 20-MHz TTL crystal oscillator with cascaded TTL frequency dividers providing 10-MHz, 5-MHz, 2-MHz, 1-MHz, 500-kHz, 100-kHz, 50-kHz, and 10-kHz outputs. There's no reason the marker generator can't be used as the pulse source in TDR measurements.

test setup

The test setup shown in **fig. 1** was built to accomplish these measurements. The load box (see **fig. 3**) at the "antenna" end of the transmission line is a multi-impedance dummy load. The choices are ten discrete impedances, a short circuit, or an external load. When the external dummy load is disconnected, the load box sees an open transmission line in that switch position. (Why have a load box? It isn't part of the TDR, but it helped in *calibrating the system and in generat*ing the pictures that follow.) The impedance values shown were selected to represent a wide range of actual impedances typically encountered in Amateur antennas.

measurements

Figure 4 shows two conditions that often occur on transmission lines: open circuits and short circuits. It rarely matters which one happens; both need to be corrected at the antenna end. The VSWR reading won't tell you which one has occurred, because in either case the entire incident wave is reflected. The only difference is the location of the nodes and anti-nodes, which are out of phase with each other. If the exact electrical length of the line is known, we can determine whether the line is open or shorted. Otherwise, we'll need to make a TDR measurement.

Figure 4A shows the waveform when the load end of the line is short circuited (in other words, when Z_L is zero). In the opposite case, an open-circuited line (with infinite impedance) appears as shown in **fig. 4B**.

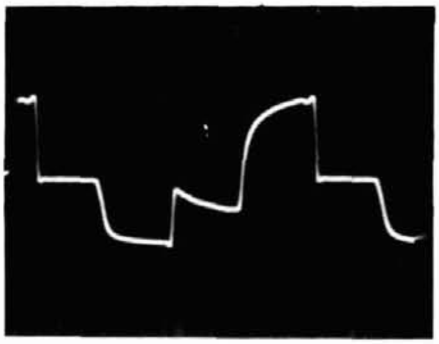

fig. 4A. Waveform seen on the oscilloscope under extreme load conditions: short circuit.

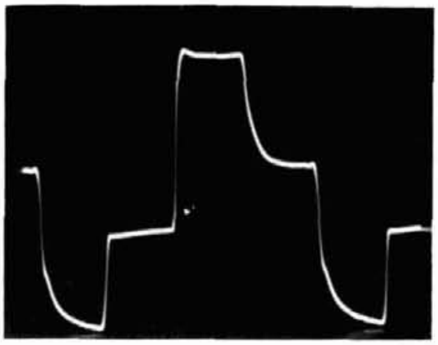

fig. 4B. Waveform seen on the oscilloscope under extreme load conditions: open circuit.

As you might suspect, impedances between zero and infinity are represented by various combinations (see **fig. 5** of the two waveforms shown in **fig. 4**. **Figure 5A** shows the supposedly matched 50-ohm case. If the system were perfect, the top edge of the pulse would be totally flat. But the *actual resistor used in the load box was* 51 ohms (with 5 percent tolerance). In addition, there's bound to be some reactance in the load, and perhaps some anomalies in the coax itself. When I performed this little experiment before, using a non-inductive 200-ohm potentiometer as the load, I was able to all but totally adjust out the lack of flatness. As you'll see in a moment, the waveform in **fig. 5A** represents a real load impedance greater than 50 ohms.

The waveform shown in **fig. 5B** is for a 22-ohm load. This impedance is common on vertical antennas. (The nominal impedance for quarter-wave-

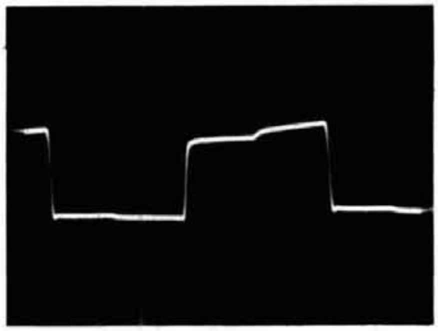

fig. 5A. Waveform seen on oscilloscope under typical load conditions: 50 ohms.

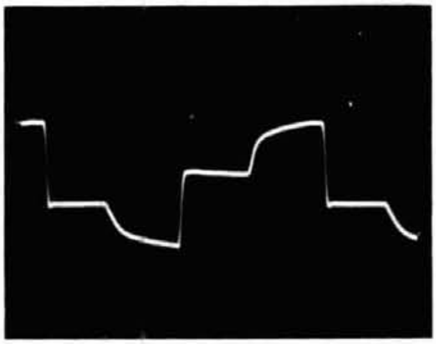

fig. 5B. Waveform seen on oscilloscope under typical load conditions: 22 ohms.

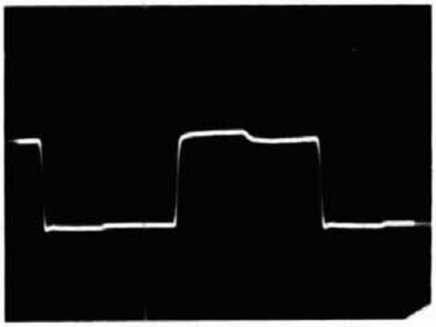

fig. 5C. Waveform seen on oscilloscope under typical load conditions: 75 ohms.

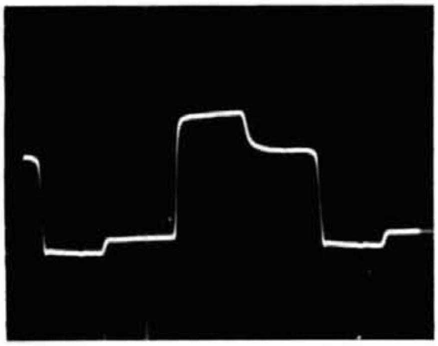

fig. 5D. Waveform seen on oscilloscope under typical load conditions: 150 ohms.

length vertical is 37 ohms, but impedances will lower for shorter verticals.)

With load impedances greater than 50 ohms, the waveform takes on a different shape. Instead of the reflected impedance causing a little rise in the flat-top edge, it causes a droop. By comparing **figs. 5C** and **5D** you can see that the amount of droop is related to how far above the surge impedance the load is.

The ideas presented here work, but I'm sure they can be improved upon. If you have any ideas, let me know. (Please note new address: P.O. Box 1099, Falls Church, Virginia 22041; current *Callbook* address is incorrect).

repairs in a jungle QTH

A missionary friend of mine, home on leave from some jungle QTH, asked about tools, parts, and test equipment to take with him when he returns. His purpose: to keep his two SSB rigs operating. (One is a Kenwood TS-130 for Amateur operation, and the other's a six-channel, crystal-controlled portable HF SSB rig from Stoner Communications. The Stoner has been the mainstay of backpacking missionaries, but the new Yaesu portable is making inroads in that market). Although I have plenty of experience, including years of communications repair shop time and more than a few Beer Days . . . errr, I mean *Field* Days . . . I'm soliciting your help in this matter.

Why? Well, once upon a time a couple planning to spend a year on a desert island asked a physician — who had never been in such a situation — what medicines they should take with them. While they used few of the recommended medicines (except for aspirin), they regretted not having taken along a topical antibiotic for skin infections. If you've had any experience with repairing radio communications gear in remote areas, I would especially appreciate hearing from you.

references

1. R. Richardson, W4UCH, "Low-cost Spectrum Analyzer with Kilobuck Features," *ham radio*, September, 1986, page 82.

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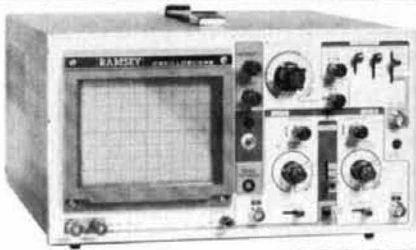

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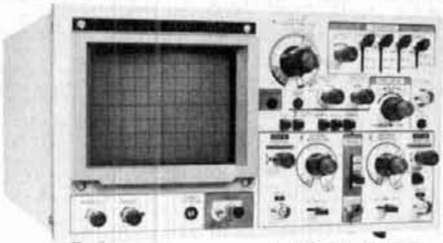

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CT-90	10 Hz-600 MHz	< 10mv To 150 MHz < 150mv To 600 MHz	1 PPM	9	0.1Hz, 1Hz, 10Hz	169.95
CT-50	5 Hz-600 MHz	LESS THAN 25 mv	1 PPM	8	1Hz, 10Hz	189.95
CT-125	10 Hz-1.25 GHz	< 25mv @ 50 MHz < 15mv @ 500 MHz < 100 mv @ 800 MHz	1 PPM	9	0.1Hz, 1Hz, 10Hz	189.95
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VHF/UHF WORLD

Joe Reisert W1JR

microwave portable operation

Spring and summer are the seasons of the year for VHF/UHF microwavers to dust off their rigs, fix all the gear that's been waiting for their attention, and get set to do some serious operating.

Portable operation offers some unique opportunities, especially if the home QTH isn't an ideal VHF location. Other reasons are often centered on the thrill of putting out rare VUCC grid squares, setting new DX records, or just the desire to commune with nature while enjoying our favorite activity. It presents some special problems however, not only for newcomers, but for old-timers as well. Often special equipment and antennas are required and things *can* go wrong — even things that might have been easily anticipated.

selecting your location

One of the first considerations in going portable is the choice of location. For starters, it probably would be advisable to select a location that's reasonably close to home. This will incur minimum expense, and if something goes wrong, you can either go home and bring back reinforcements or just QRT. After a few local operations, go for the long haul!

Successful portable or contest operation demands careful preparation. First, you'll have to determine whether the chosen location is accessible by conventional vehicles. Can you get there by four-wheel drive, or will you have to hike the last part of the trip? If you have to hike, what about lugging all the gear to the site? Is power available, or do you have to bring your own? (More on this shortly.)

Is the chosen location sufficiently clear so that you won't have problems erecting an antenna high enough to get above local obstructions — such as tall trees? It's always best to secure a topographic or geological survey map in advance. Usually available in local book stores, libraries, or sporting goods shops that carry camping or backpacking gear, such maps typically cover only a 7-1/2 minute section, 1/8 of a degree, or about a 6- by 9-mile area at midlatitudes. Therefore, more than one map may be necessary.

Accurate, detailed maps are invaluable, especially if you intend to operate near a state, county, or grid square border. You must always know, with a reasonable degree of certainty, *that you really are where you think you are!* Bring a camera; photos are good evidence, and you and your friends can enjoy the pictures for years to come (see **fig. 1**). They can also help when briefing others who may be interested in operating from the same location later on.

If possible, contact a local resident (preferably an Amateur) who's familiar with the area in question, or visit the proposed location before your operating excursion. Bring a small rig to try out the location. Check out possible operating positions, available facilities, and power sources. Don't underestimate travel and setup time! A preparatory visit will also give you a feel for the travel time from your home QTH so you can be on site and ready to operate at the scheduled time.

Even if you've visited the proposed location beforehand, bring a magnetic compass. Find the local magnetic offset for the proposed location before you leave home. In the New England area, the magnetic offset is over 15 degrees! If you have a distance and bearing program, this can be determined before you go.[1] Enter the approximate location for the magnetic north pole at 76 degrees north latitude and 101 degrees west longitude into your program.

An elementary knowledge of astronomy is also helpful for locating the North Star, but obviously this will be impossible in the daytime or if the

fig. 1. Antenna installation used by W1JR/CY1 operating from FN76 in the June, 1983 QSO party. The brick building was our shelter. Andy McLellan, VE1ASJ/VE1SPI is at left; Joe Reisert, W1JR is at the right.

Table 1. This table shows some of the more well-known mountain-top locations popularized by VHF/UHF/microwave and millimeter-wavers to set DX and contest records.

Name	Location (approx.)	Elevation (feet)	Grid Square
Eastern USA			
Cadillac Mountain	Bar Harbor, Maine	1,530	FN54
Mount Washington	Glen, New Hampshire	6,288	FN44
Pack Monadnock	Peterborough, New Hampshire	2,280	FN42
Mount Equinox	Manchester, Vermont	3,816	FN33
Mount Mansfield	Burlington, Vermont	4,393	FN34
Mount Greylock	North Adams, Massachusetts	3,491	FN32
High Point	Port Jervis, New York	1,803	FN21
Watchusett Mountain	Princeton, Massachusetts	2,006	FN42
Mount Mitchell	Asheville, North Carolina	6,684	EM85
Mount Toxaway	Oakland, North Carolina	4,777	EM85
Spruce Knob	Simoda, West Virginia	4,860	FM08
Western USA			
Pikes Peak	Colorado Springs, Colorado	14,110	DM78
Mount Rose	Reno, Nevada	10,778	DM09
Mount Diablo	Walnut Creek, California	3,849	CM97
Mount Hamilton	San Jose, California	4,209	CM97
Mount Pinos	Frazier Park, California	8,831	DM04
Mount Palomar	Julian, California	6,126	DM13
Mount Ashland	Ashland, Oregon	7,530	CN70

weather is inclement, so back to the compass! The local transit time of the sun can also be determined for a true south marker. Check maps ahead of time to see what azimuth directions will be used most. At the same time, check the approximate bearings of other local landmarks which can be used for additional sightings.

Probably the most famous VHF/-UHF and microwave locations are the high hills and mountains where prior contesting has taken place or from which DX records have been set. Some of these are shown in **table 1.** Reference 2 discusses some of these locations and includes pointers on how to get to them and what to expect, as well as any particular local considerations. Regardless of the above, do your homework in advance, since it's often difficult to secure on-the-spot operating permission.

On-site rf emitters can be a problem. But they, too, can be checked on a preparatory visit. Elevated locations frequently have broadcast, VHF/UHF TV transmitters, repeaters, or other sources of local noise. Will this rf be a problem with spurious beats or noise? If so, choose another location or bring adequate external preselector filters with you just in case!

Portable contest operation involves several other considerations. Are you sure that when you arrive at the location, somebody else won't already be there? Always have a plan for a back-up location! Are sleeping accommodations available, or must you provide your own? Is camping permitted? Do you need written or verbal permission to operate a transmitter or a generator at the location?

Can you operate at the chosen location overnight? Though overnight use of facilities is frequently not allowed at national or state parks, it can sometimes be negotiated before you go; try to get written verification before you go. Whatever you do, don't leave the local natives restless. And definitely — as the Boy Scouts say — always leave the area in the same shape or better than it was when you arrived. Remember, either you or some other Amateur may want to return.

establishing records

Record setting is surely one of the big reasons serious VHF/UHF and microwavers seek out portable locations. It's well known that the elevated locations will often add the extra low-angle takeoff so critical for record setting — not to mention the extended line-of-sight propagation on the upper microwave and millimeter-wave bands. Coastal locations are acceptable, especially if over-water paths are contemplated.

Some operational pitfalls deserve discussion. It's usually advisable to conduct some sort of rf liason, typically on 2 meters or 70 cm. Often, however, I've heard of disasters — especially if the path is long (over 20 miles or line-of-sight). For instance, if 2-meter fm is used for liason, will its signal be strong enough over the path?

Believe it or not, some operations have been unable to establish two-way 2-meter communications between high locations with a 10-watt fm rig operating into a quarter-wave car-mounted vertical antenna. In this case, even a small (three to four element) Yagi would have been sufficient to complete the path.

A Yagi antenna on a liason frequency has a second advantage. If it has high enough gain, it can be used as a crude direction finder so you'll at least know in what general direction other higher frequency antennas should be aimed! Typically, a ten-element or longer Yagi will have less than a 40-degree beamwidth — not as narrow as the typical record setting antenna, but definitely a confidence builder, especially if a visible sighting isn't possible.

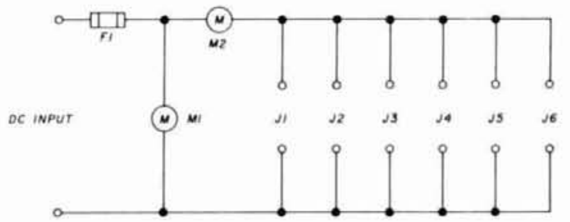

fig. 2. Recommended power distribution and monitoring circuit. M1 is a 0-25 volt dc meter. M2 is a dc ammeter, typically 10-20 amperes. F1 is the fuse, which is set by the current limit of the supply and/or ammeter. J1 through J6 are output terminals, as discussed in text.

choice of frequency and gear

Before you get too far along in your portable operation plans, the frequency and gear must be carefully selected. If single-band operation is chosen, the problems are considerably simplified. Do you have your own gear, or will you have to borrow some or all for the operation? Are you interested in just the more populated bands such as 6 and 2 meters, 70 cm (432 MHz) and 23 cm (1296 MHz)? Or do you want to go higher, or on one of the lower, less populated bands such as 135 cm (220 MHz) or 33 cm (903 MHz)? The more populated bands may yield more QSOs, but the less populated bands can often offer more satisfaction.

There's plenty of self-contained commercial gear available such as the "multimode" rigs that offer easy operation in a single compact package. Units manufactured by ICOM, Kenwood, and Yaesu — the most popular manufacturers — offer VHF/UHF coverage from 50 to 1300 MHz on CW, SSB, and fm. Some of these manufacturers even offer dual or multiband operation in the same package. Most of these rigs will operate on either 115 VAC or 12 to 13 volts dc.

Some operators prefer up/down converters or transverters, which can often be optimized for the ultimate in sensitivity, selectivity, and/or high dynamic range. References 3 through 10 provide typical circuitry for "rolling your own."

Many commercial manufacturers offer this type of gear from 50 MHz to 10.368 GHz! Popular suppliers are ARR, Microwave Modules, Mutek, and SSB Electronics. Remember that if an up/down converter is used, an extra hf transceiver or appropriate i-f will also be required.

power sources

It almost goes without saying that if commercial power is available at the proposed portable location, you're in luck. If not, there are several alternatives. Most low-power (less than about 100 watts) VHF/UHF gear will also operate on 12 to 13 volts dc. For short periods of time (i.e., a few hours), especially at lower power levels (100 watts maximum), the power can be taken from the battery in your automobile.

However, if this is done, extreme care must be taken. It's best to install a separate large diameter (No. 10 AWG minimum) wire connected directly to the battery terminals and kept to the minimum possible length to prevent large voltage drops. I'd also recommend that a circuit breaker or fuse be installed in this line as close as possible to the positive terminal of the battery.

Furthermore, I'd recommend that a power distribution and monitor box be fabricated. A schematic of a recommended type is shown in **fig. 2**. Note that it also has a fuse for double protection. The voltmeter is used to monitor the voltage regulation and warn of possible loss of battery charge. The ammeter monitors the current drawn by the gear in use. This will also aid in any troubleshooting exercise.

It's always wise to keep your automobile's gas tank as close to filled as possible. Be careful that you don't run the battery down too low, or you won't be able to start the car when your operation is completed! Start the car occasionally to let the battery recharge a little or bring along an extra charged battery just in case a backup is required.

Finally, the outputs of the power distribution box will give a flexible option for connecting and disconnecting units. I use the GR (General Radio) type of dual plugs on all equipment. GR plugs are specially marked for polarity, can carry heavy current with a minimum of voltage drop, and are very versatile and easy to install. They're also compatible with most dc power supplies.

If you're using a small antenna rotator, it may be wise to have a low-power 115-VAC source. I'm told that Radio Shack has a small 12-volt dc to 115-VAC power inverter that's just fine for this application. However, I'd be wary of using this type of inverter on a regular transceiver because the voltage waveform may not be sinusoidal and could cause voltages to be higher or lower than expected.

If all else fails, or if higher power is desired, a gasoline-powered generator may be advisable. These can be rented, but they're also quite affordable nowadays and may represent a prudent investment if you plan many portable operations. (Such a purchase can be simplified by first convincing your spouse of its unquestionable value as a source of electricity during power failures!)

AC generators are sold in many types and power ratings. Always choose one that has at least a 25- to 50-percent power reserve. Generators can be temperamental, so a few pointers are in order. Using a generator near its normal maximum load can cause instabilities and other erratic operation. Always test yours out before your trip to verify its reliability. Bring plenty of extra gasoline, spare spark plugs, and extra oil (if oil is required).

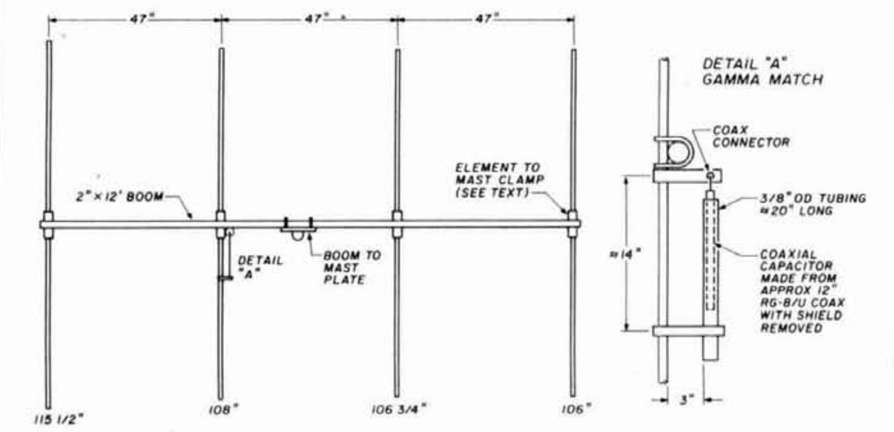

fig. 3. Construction details for the simple four-element, 6-meter Yagi described and recommended in the text. Element diameters are 1/2 to 3/4 inches. (See text and reference 13.)

portable antennas

Next to the selection of your location, the most important key to success is your antenna. While you're not likely to be running high power, every bit of antenna gain will be important to attract attention. You'll probably hear all the more powerful home stations. But will they be able to hear you?

There are many factors to consider in choosing a portable antenna. Unless you're going to operate on just one band, a moderate-sized Yagi would almost certainly be your best choice. Although a large antenna would obviously be hard to aim and keep aloft, especially if you're operating alone, your antenna should be as long as conveniently manageable, since the apparent path attenuation increases with frequency unless the physical aperture of the antenna is the same.[11]

I've seen poor results on 70 cm when a portable station took down a 20-foot boom, 2-meter Yagi and replaced it with a 10-foot boom, 70-cm antenna. Try using the same boom-length antennas on each band. Your performance on the higher bands will be either the same or improved.

Some operators prefer to change antennas each time they change bands; if you do this, you can use a larger antenna on each band. Others may operate two or three bands, but prefer to mount all antennas on a single mast. In this case, the size of the individual antennas will probably have to be smaller. The choice is really one of convenience versus performance.

Another antenna constraint is transportation. If you have roof racks, you may be able to support a fully assembled 12- to 15-foot boom Yagi. If the antennas are transported inside a car or in a car trunk, they may have to be limited in size or broken down into shorter lengths not exceeding 5 to 8 feet. In the latter case, it may be possible to design the boom so that it can be conveniently broken down into shorter sections.

Try using Yagis that are easily assembled and preferably symmetrical. Most, but not all, Yagi designs use either similar length or a downward director taper. These designs are preferred for portable operation since there's less likelihood of positioning the directors on the boom incorrectly. Mounting and assembly are also simplified.

If beams are broken down for transporting, place electrical tape or its equivalent on the elements or boom before transporting to mark the proper location of elements for reassembly. Steve Murray, K1KEC, taught me another trick: when transporting antennas, always tape down any loose nuts so they won't shake off and get lost.

114

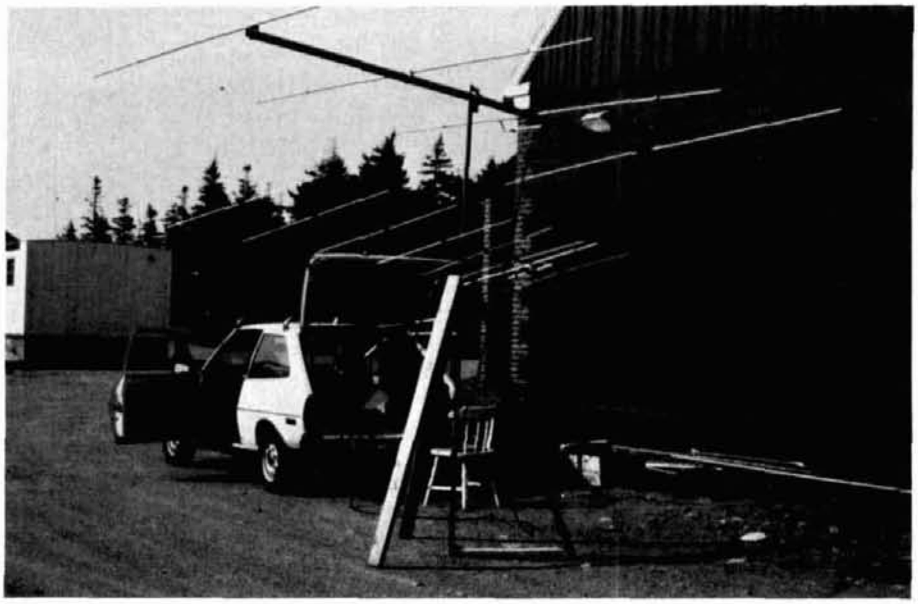

fig. 4. Portable operation by W1JR/1 in FN54 in the June, 1983 ARRL QSO party. Operation is from the car's tailgate. Notice the tripod as detailed in fig. 5. The antenna on the bottom is the eight-element, 2-meter Yagi described in reference 13. The antenna on the top is the four-element, 6-meter Yagi shown in fig. 3.

Finally, just in case you do lose some hardware during transportation, bring along a few spare nuts, bolts, and screws in your tool box. You'll never regret it.

For 6-meter operation I prefer a 12-foot boom Yagi. This is a convenient length for a four-element design. I also prefer a 1-3/4 to 2-inch diameter boom so that the elements won't spin. A single piece of tubing can be used, but you may prefer to use a two-piece boom with a center joining section. WD4BUM* can provide a suitable boom with 6-foot sections.

My 6-meter antenna follows a symmetrical design with equal element spacing and is based on an unpublished 0.6-wavelength NBS design.[12] It offers gain of just under 10 dBi, and — along with other VHFers in the W1/VE1 area — I've used it extensively to put out rare grid squares. It's also been used to work not only the USA and Canada, but Europe, the Caribbean and South America, all with low power!

The mechanical details for this design are illustrated in **fig. 3**. The finished product is shown in **fig. 4**. My antenna was built from an old CB antenna, but parts from an old 6- or 10-meter beam are sufficient. The construction techniques are similar to those described in last month's column.[13] The elements can be any diameter between 1/2 and 3/4 inches or tapered (as discussed in reference 13). A gamma match is used because it's small and easy to fabricate. You may have to adjust the length of the driven element, the length of the coaxial capacitor, or the shorting bar slightly for optimum VSWR.

Many small 6-meter or "hilltopper" Yagis are available commercially. For 2 meters, there are also many choices: if you're a homebrew artist like myself, the eight-element Yagi design described in last month's column is highly recommended.[13] It has a great pattern, about 13.5 dBi of gain, and fits on a 12-foot boom. What could be simpler?

Many NBS Yagi designs are also described in reference 12. The 0.8-, 1.2-, and 2.2-wavelength designs are particularly recommended for 2 meters because they offer manageable lengths and reasonably good gain and radiation patterns. Likewise, there are plenty of commercial 2-meter Yagis available in many different boomlengths and prices. Some are even specifically designed for mountaintopping.

Stan Jaffin, WB3BGU, originally became interested in 2-meter antennas suitable for mountain-topping. He therefore devised Yagi analysis programs which later resulted in several articles on optimized 50- through 450-MHz Yagi designs.[14] His articles discuss a number of optimized designs in this frequency range.

Stan offers a few suggestions for 2-meter portable antennas. Yagis measuring 72 inches are suitable for carrying in an automobile, but 50-inch booms are good if you want to transport your antenna in your trunk, where it's out of sight. Stan also prefers wooden booms at least 3/4 inch wide, since wooden boom antennas don't require boom corrections and work fine as long as they're not exposed to the elements for extended periods of time. Stan also feels that the elements should be substantial enough (at least 3/16 inch diameter) so that the elements don't break or bend during transportation or in the wind.

Designs for 135-cm Yagis are available in references 12 and 14. The NBS 4.2-wavelength design is particularly recommended if a 19-foot boom is used. Several commercial 135-cm Yagi designs are also on the market.

Many 70-cm Yagi designs are readily available. The NBS Yagi designs allow choices of up to 4.2-wavelength booms.[12] The DL6WU Yagi designs can be used for boomlengths of 2 or more than 10 wavelengths.[15] On several expeditions I used the 24-foot boom Yagi design described in last December's column.[16] The K2RIW 19-element and the new K1FO 22-element Yagi designs are excellent for 13- to 14-foot boomlengths.[17] Kits of parts for the W1JR, K1FO, and K2RIW designs are now available from Tom Rutland, K3IPW**. Many commercial 70-cm Yagis are also available.

* George Shira, WD4BUM, Route 7, Box 258, Anderson, South Carolina 29624.

** Tom Rutland, K3IPW, 1703 Warren Street, New Cumberland, Pennsylvania 17070.

*** Down East Microwave, W3HQT, Box 1655A, RFD 1, Burnham, Maine 04922.

The loop Yagi, surely one of the most popular antennas on 23 and 33 cm, can be built on a 12-foot boom. Gain is high and the size is quite manageable. Details on loop Yagi design can be found in references 9, 10, and 18. Loop Yagis are available from Down East Microwave.*** Several other sources manufacture Yagis for both bands.

Fewer antennas are available for 13 cm (2304 MHz) and above. The 45-element loop Yagi is a good choice.[18,19] Down East Microwave*** offers this loop Yagi.

Parabolic dishes are also popular on 13 cm and above. However, if solid dishes are used, they may require a good mount because windload can be severe. Smaller dishes (18 to 24 inches in diameter) are often used on 3 cm (10 GHz) and can often be mounted on a good tripod similar to those used by surveyors. This also will allow some degree of azimuth calibration if a compass rose is available on the tripod mounting. Design of parabolic dishes and feeds for 13 cm and above are discussed in references 20 and 21.

towers and masts

By now it should be obvious that the type and size antenna used in portable operation is determined largely by the way it's supported. Several methods in widespread use include towers, tripods, and masts. Regular towers are great, but they're usually bulky and require guys and possibly special mounting techniques such as attachments to the side of a camper.

Some Amateurs prefer to use just a simple mast mounting. They usually attach some sort of pipe fitting near the end of a large plank and fit a 10- to 15-foot mast into the pipe flange. If the plank is large enough and the flange is near one end, it can be supported by driving over the top of the end with one wheel of an automobile. The support can consist of multiple sections of the 5-foot TV type masts that are readily available at Radio Shack and suppliers of TV antenna accessories.

There's at least one technical problem with this mounting method. An antenna mounted near an automobile may suffer pattern distortion. The larger the antenna and the closer to an automobile, the greater the problem. As a rule of thumb, antennas should be spaced at least 25 to 50 percent of their boomlength away from any local objects. This is particularly important for those who use masts or towers attached to a camper. Furthermore, antennas should always be mounted at least 1 to 2 wavelengths above the ground for tropo work or at least 7 to 14 feet high on 2 meters.

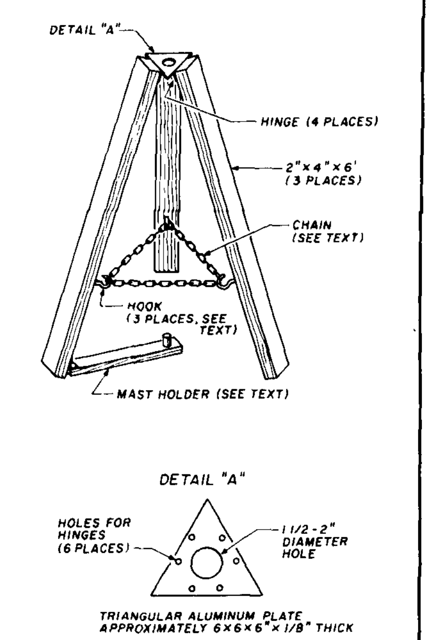

fig. 5. This figure shows details of a homebrew tripod suitable for portable operation (see text).

I prefer tripods or small self-supporting towers for portable operation. Several manufacturers now supply four-legged free-standing towers. I use the one shown in **fig. 4** of last month's column[13] on my portable EME station. These small towers usually have hooks at the top to allow guy lines to be added if necessary.

Figure 5 shows construction details for a simple tripod that I use for portable operation and back yard antenna testing. It consists of three 6-foot lengths of 2 X 4 lumber joined at the top to a triangular aluminum plate using small hinges available in hardware stores. A hole large enough to pass a mast through is drilled in the plate. An inexpensive piece of chain link is used to hold the shape and it is attached between the legs with hook eyes.

This tripod (**figs. 1** and **4**) is relatively compact, and the weight of the lumber makes it very stable even in a mild wind. The antenna mast can be sections of the 5-foot TV type just described, which can rest on the ground. For a more substantial mast holding method, I sometimes use a plank such as the one described above, which can be attached with another hinge to one of the tripod legs (see **figs. 1** and **4**). For peace of mind, I sometimes attach a rope to the antenna in use to hold it in position, but I'm sure there are better safety methods.

Amateurs who go portable devise many different ways to hold their antennas. Antenna rotators can be used, but will require 115 VAC, as discussed earlier. Others attach a lever arm to the mast to allow quick steering. Whatever method you use, do consider something that will allow a relatively accurate azimuth indication such as a compass rose, since this may mean the difference between success and failure of your operation.

transmission lines and VSWR indicators

One big advantage of portable operation is that transmission lines are usually short. Hence, lower cost coax such as RG 8/U or RG 213/U may be perfectly acceptable. The newer 9913 coax is especially recommended if you want very low loss or expect to work on 70 cm and above.

Because you sometimes don't know how long a feedline will be required at the site, I prefer to take several short cables as well as a few 10- and 25-foot feedlines, all fitted with type-N connectors. If the first feedline is too short just add another section, joining them with a coax barrel adapter.

Another suggestion: if you keep the number of connector types to a minimum, you won't have to bring too

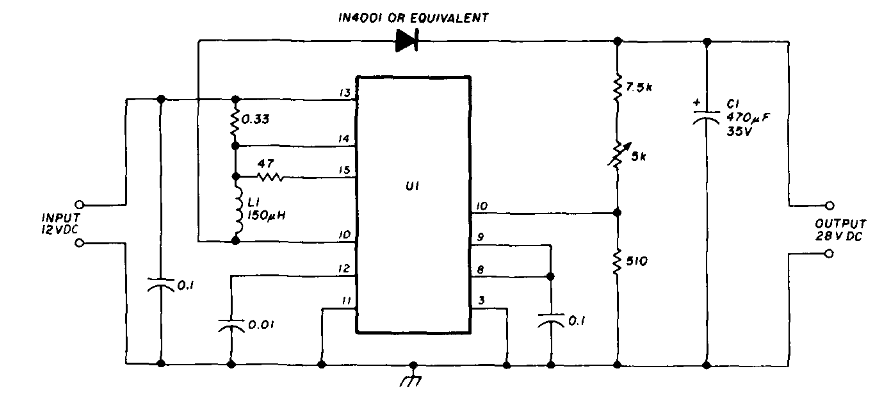

fig. 6. Switching regulator capable of operating with a 12-volt input and providing a nominal 28-volt output sufficient to drive a typical 28-volt t/r relay. U1 is a Fairchild 78S40 IC and L1 is a 150 μH high-current inductor.

many different types of adapters. I prefer to use either type-N or BNC connectors in portable operation. Furthermore, bring along several short coax cables with the correct type of connectors so you can easily bypass rigs in case of unexpected equipment failure.

One indispensible accessory is a VSWR/power meter. Don't leave home without it! Not only will it tell you that your transmitter is putting out the correct power, but it will give you a quick indication of VSWR that may tell you if the antenna system is functioning properly. This is particularly important on portable operation because the antenna may have been improperly assembled in a hurry to get on the air. If only a VSWR meter is used, try to have it calibrated before leaving home so that you'll at least be able to know that the power indicated is in the ballpark.

antenna relays

Most of the popular multimode transceivers have built-in t/r relays. However, if an external preamplifier or power amplifier is used, an additional t/r relay may be necessary. Since most portable operation requires a 12-volt dc relay, you should obtain one well ahead of time and check it out, especially with respect to integration with the t/r switching. I may be old-fashioned, but I use a footswitch on all operation because I feel it's more reliable and allows me other freedoms. I have a small box with the switching and voltages all wired beforehand.

If you can't find a 12-VDC t/r relay you can use the 28-volt type, which is more readily available. But how do you use it on 12 volts? The answer is that you need an external 24- to 28-volt supply that's powered from 12 VDC. **Figure 6** shows a schematic of such a supply which will operate on 12 to 13 VDC and deliver a nominal 28 VDC. It uses one of the newer IC chips and will easily provide enough current to drive a single 26-volt t/r relay. This circuit works as a "switching regulator." Such a device is really an oscillator that operates very efficiently in supplying power to the output filter capacitor, C1, on demand. Normally the internal diode between pins 2 and 1 of the IC is used to connect to the output filter/divider. However, I used an external diode to keep chip dissipation to a minimum. One caution: switching regulators generates rf spikes. Therefore, it's best to place the circuit in a shielded box and filter the dc input and output lines.

The circuit shown in **fig. 6** is quite straightforward. The only special components are the IC chip (a Fairchild 78S40) and the switching inductor. The inductor should be of the very high current type made with large gauge wire such as the J. W. Miller type 5506 or equivalent. If you can't locate these parts, Circuit Cellar offers a package deal of the 78S40 and the Miller inductor for $15.00.****

Recently a new series of switching regulator chips with higher output current capabilities was introduced by Linear Technology Corporation. Several choices such as the LT1070CK, LT1071CK, and LT1072CK, with specified output currents of 5, 2.5 and 1.25 amperes, respectively, are offered.

I built the circuit in **fig. 7** using the higher current device, the LT1070CK, which costs $12.74 in small quantities and the same inductor as used in **fig. 6**. I haven't completely put this circuit through its paces, but it looks as if it will have considerably more output current capability than the 78S40 circuit. Therefore, if high current isn't required, you may want to use one of the lower-cost chips in this series.

power amplifiers

So far I haven't mentioned power amplifiers. They aren't always needed for portable operation. However, there are many choices if solid-state amplifiers are used. Reference 7 describes circuitry that will work for solid-state power up to the 100-watt level through 70 cm. Many different solid-state amplifiers are available commercially.

If you really want to go high power, tubes are still king. However, you'll probably need to use either local power or bring along a generator so that the filament and high voltages can be generated conveniently.

A couple of years back there were some AM6154 and AM6155 tube-type power amplifiers on the surplus market. They can be adapted to operation on 144, 220, and 432 MHz.[22] This amplifier seems like just the ticket for high-power portable operation because it's relatively small, fully self-contained, and can deliver 300 to 500 watts of rf with 10 to 20 watts of drive.

field repairs

Because it can be very frustrating working in the field, especially if a

**** Circuit Cellar, P.O. Box 428, Tolland, Connecticut 06084.

Table 2. Items recommended for a trouble-free portable operation. This list is by no means complete; you may want to expand some categories as you make your own list.

Antennas, transmission lines, and accessories:
antennas
tripod/tower
rotator
feedlines — short, medium and long
link antennas
masts
rope
coax cable adapters

Equipment:
radios
link gear
HT
t/r relay and power source
straight key and keyer
spare fuses
spare preamplifiers
power amplifiers
master control system
preselector filters
earphones
power distribution box (**fig. 2**)

Power generation:
ac generator (plus spare plugs, gasoline, oil)
dc to ac inverter
batteries
extension cords and ac outlet strips
power supplies (if required)

Tools and supplies:
tools (make a long list)
hookup wire
hardware
pipe cleaners
soldering iron and solder
electrical tape
ruler/tape measure
clip leads

Test equipment:
multimeter
noise generator
power/VSWR meter
frequency calibration source

Miscellaneous:
compass
pens, pencils, scratch paper
folding table
operating platform
beverage cooler stocked with water
manuals on gear being used
camera and film
logbooks
tent/tarpaulin
folding chairs
first-aid kit, aspirin, insect repellent
beverages and snacks
lamps/flashlight
maps

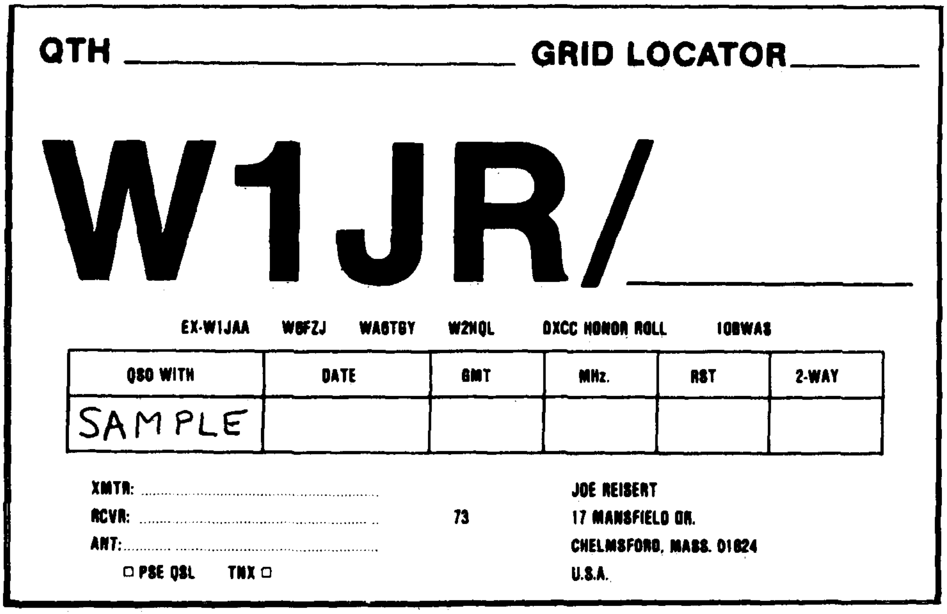

fig. 8. QSL card used by W1JR for portable operations.

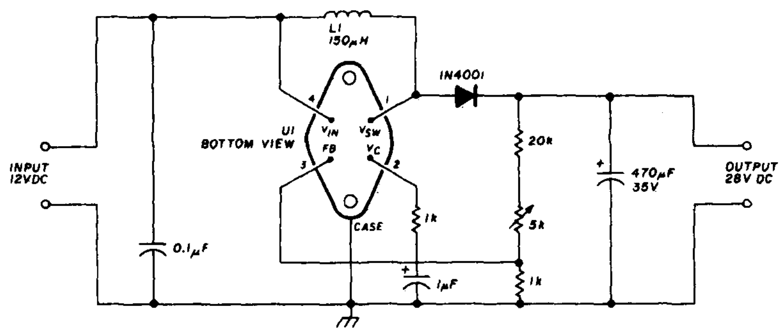

fig. 7. Circuit for a higher power switching regulator. U1 is a LT1070CK and L1 is the same as in fig. 6. Provide a good heatsink for the IC, which is a TO-3 package. Keep grounds and returns around the IC as short as possible.

failure occurs, always bring along extra gear, tools, and supplies. A multimeter is a *must*. Many inexpensive hendheld types are available. A crystal calibrator is also nice for checking if you're on frequency.[23] I also carry a simple noise generator made with a diode, battery, and coax attenuator. It isn't accurate, but it can tell you in one quick test if your preamplifier or receiver is inoperative!

It's also a good idea to bring along a soldering iron. On one expedition I needed one to repair a broken relay coil. Luckily I was able to borrow a battery-operated one locally, and it saved the day! At the same time I needed a light. I had a flashlight, but I was alone and didn't have three hands. I recommend a lamp that operates from a car cigarette lighter. It can also help by providing light for filling out your log.

If you're working on 115 VAC, don't forget to bring extension cords and extra power outlet strips. Extra leads with alligator clips are great for makeshift patching. I also recommend that you carry a package of ordinary pipe cleaners. They're great for removing water or other debris that can get into coax connectors.

amenities

I really haven't discussed creature comforts. If you're going to operate from a car, bring along a board or platform on which to mount your rig, key, and logbook. If your car has a tailgate you can set the gear on it, but don't forget to bring a folding chair. Of course, campers or vans can be ideal for portable operation since they usually have a built-in table and seat.

If you're not fortunate enough to obtain the use of a local building, bring along a tent or tarpaulin to not only help in inclement weather, but shield you and your gear from the high temperatures of direct sunlight.

Table 2 lists these and other items necessary (or advisable) for a successful portable operation. This list may not be complete. Suggestions and information on mountain-topping from another perspective is also available in reference 24.

If you decide on portable operation, first generate your own list and check off each item before you go out into the field. Even better yet, set your entire station up in your back yard or driveway and try it out. When all is working to your satisfaction, review your checklist and pack everything in sight into your car!

the final courtesy

Once you've completed operation from that special location, go home, unpack, and wait for the mailman to arrive with all the QSL requests! Yes, that's what it's all about. Just think of all those VHF/UHFers who struggled to work you for a new state, grid, or DX record!

It's really not hard to confirm a QSO, but many portable operations want to send out special QSLs or some great memento. This could take many months and cost plenty, especially if photographic QSL cards are desired. Special QSLs are fine, but the ham waiting for the card couldn't care less. (Don't forget all the phone calls and duplicate letters asking whether you received the QSLs and why you haven't QSLed yet.)

One quick way to QSL is to just mark up one of your own regular station cards or fill out one of those often offered as an advertising gimmick. But why not make up a universal QSL card instead — especially if you contemplate multiple operations or multiple QTHs?

With the help of Steve Gilbert, WA1AYS, who has his own printing business, I've done just that. It's simple and effective, and it does the trick with a minimum of work and expense. The final result is shown in **fig. 8**. All you have to do is to fill in the QTH and grid square along with the usual information. Think about it the next time you're planning a trip; it certainly simplifies QSLing.

summary

Portable operation on the VHF/UHF, microwave, and millimeter-wave bands is becoming quite a popular sport. I've tried to provide suggestions on how to improve your success rate; obviously, the most successful operations are those that were planned, tested, and integrated at home instead of on location.

acknowledgments

I'd particularly like to thank those who suggested a column on this subject, and especially Stan Jaffin, WB3BGU, for his helpful suggestions about antennas.

Important VHF/UHF Events

June 7	*Predicted peak of the daytime Arietids meteor shower at 1900 UTC.*
June 10	*Predicted peak of the Zeta Perseids meteor shower at 0400 UTC.*
June 13	*EME perigee.*
June 13-15	*ARRL June VHF QSO party.*
June 20-21	*SMIRK Party Contest (contact KA0NNO).*
June 21	*Peak of sporadic-E propagation (± 1 month).*
July 1	*Look for European 6-meter opening (± 1 month).*
July 11	*EME perigee.*
July 18-19	*CQ Magazine VHF WPX Contest.*
July 20	*Look for 2-meter sporadic-E propagation (±2 weeks).*
July 23-26	*Central States VHF Conference, Arlington, Texas (contact KD5RO).*
July 29	*Predicted peak of the Delta Aquarids meteor shower at 1500 UTC.*

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test DBMs for diode leakage

Decreased performance indicates damaged diodes

Commercially manufactured diode double-balanced mixers (DBMs) are popular with experimenters and equipment designers because of their low cost, predictable performance, and versatility. They're used as mixers, all kinds of modulators, and current-controlled attenuators.

But mixers can suffer from failure that degrades performance without catastrophic destruction. This damage, caused by transient inputs exceeding ratings, may go unnoticed unless mixer performance characteristics are specifically tested.

It's important to be aware of this effect when using an old mixer in a new design, or when performance seems to decrease. This article provides a method for making quick functional checks of mixer performance that can prevent a lot of frustrating troubleshooting.

mixer abuse

The obvious solution to the problem raised in the previous paragraph is to not exceed the manufacturer's specifications. However, we're all experimenters and tinkerers — and we just might install a mixer in a new configuration, inadvertently causing problems that aren't immediately apparent. We might use the same damaged mixer in a number of different projects, with disappointing, seemingly inexplicable results. And we *are* known for trying to squeeze maximum performance from a component by exceeding its ratings.

Mixers can be used in several different applications. A DBM makes a very simple and trouble-free balanced modulator for generating a DSB signal. The DBM doesn't require external adjustment of balance controls, and since these controls aren't used, it doesn't require subsequent readjustment to compensate for drift. The DBM balanced modulator is connected as shown in **fig. 1.** I used this scheme to generate a DSB signal using an LM386 IC audio amplifier driving the DBM i-f port. This worked perfectly, and its simplicity made it seem ideal. However, carrier suppression deteriorated after a period of use, and was cured by replacing the DBM. I was confused; a quick ohmmeter check on the mixer diodes indicated that they were still intact. The DBM had to be soldered into the circuit to determine that its balance had changed.

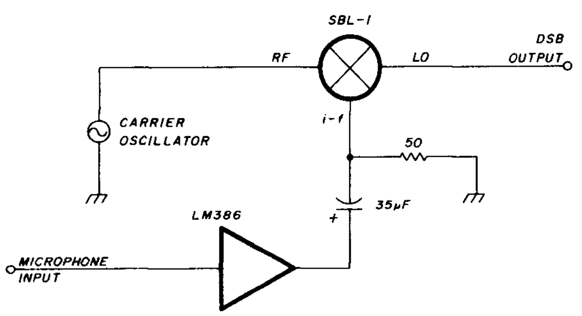

fig. 1. Balanced modulator using SBL-1 dBm.

But how was the DBM damaged? **Figure 2** shows the schematic of a Mini-Circuits SBL-1 mixer with the equivalent circuit for dc representation of the diodes. There is direct access to the diodes through the i-f port, making them most vulnerable to damage when the i-f is used as an input, which often occurs where a low frequency rf input is required but only a high frequency DBM is available. The LM386 power amplifier could easily generate transients that exceeded the DBM's 40 mA maximum i-f current rating. These glitches only happened when making connections or touching the amplifier input leads. Normal microphone input resulted in normal modulation.

testing

Checking the damaged mixers with an ohmmeter didn't seem to reveal much difference between a bad and a good mixer. Continuity checks are done to test for typical semiconductor failures — opens and shorts. The resistance measurements shown in **table 1** were carefully made to document results. I used a Micronta 22-204A meter; other meters will provide different but similar results. Study of the actual resistance measurements reveals that mixer damage tends to progressively deteriorate the diode reverse leakage and cause imbalance. A good mixer has higher (and equal) reverse resistances than a damaged mixer. Continuing to operate with additional mixer damage causes the reverse resistance to decrease. When it reaches 20 or 15 ohms per diode, the DBM will pass virtually no signal.

I knew that I was in big trouble because I had a collection of used DBMs that might or might not have been damaged. The familiar balanced modulator

Cliff Klinert, WB6BIH, 1126 Division Street, National City, California 92050

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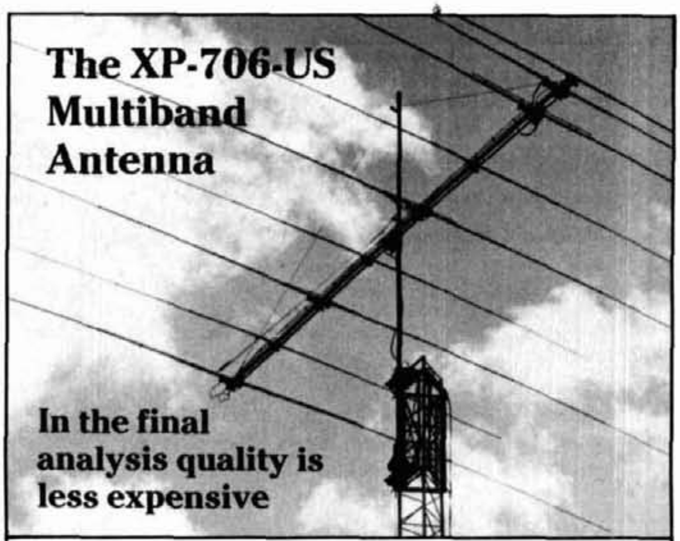

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Table 1. Mixer test data.

Resistance on Pins:	Bad Mixer 1 Forward	Bad Mixer 1 Reverse Ω	Bad Mixer 2 Forward	Bad Mixer 2 Reverse Ω	Good Mixer Forward	Good Mixer Reverse Ω
3-5	7.0	35	8.0	42	7.5	45
5-4	7.0	30	7.5	34	7.5	45
4-6	7.5	35	8.0	45	7.5	45
6-3	7.5	35	8.0	33	7.5	45
Isolation R-L at 10 MHz	15 dB		20 dB		Unmeasurable (>>30 dB)	
Loss 10 mA i-f current	10 dB		7 dB		3 dB	

Note: Check ohmmeter current before making resistance measurements. To prevent damage, current into a diode shouldn't exceed about 40 mA.

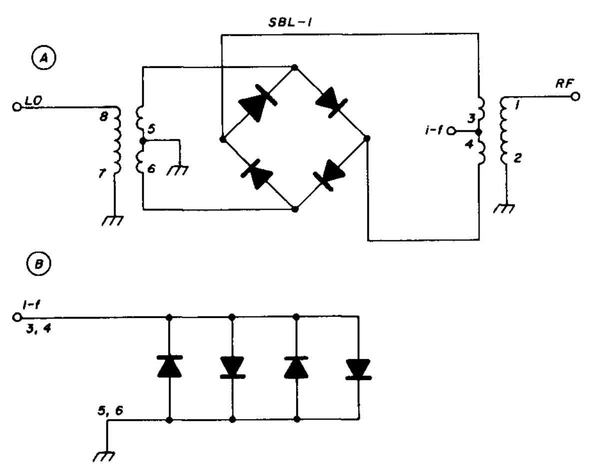

fig. 2. Double balanced: (A) mixer schematic, (B) dc equivalent circuit.

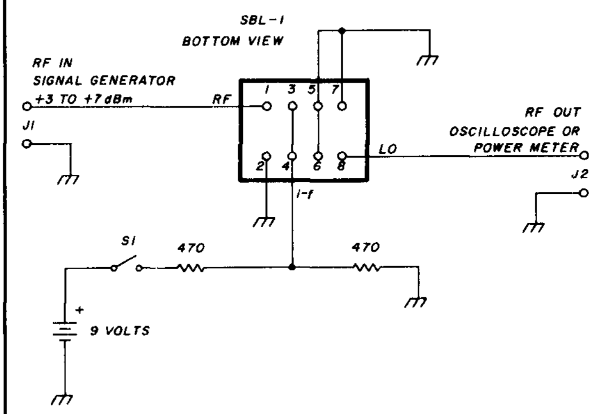

fig. 3. Mixer test fixture using more than 0 dBm input ensures that the mixer diodes have adequate drive power.

seemed like a good basis for a test fixture, so I settled on the circuit shown in **fig. 3**. Constructed on a perforated board, this circuit was used to prepare the rf measurements listed in **table 1**.

Mixer sockets aren't available, so I made one by cutting up some IC sockets. This approach wasn't entirely successful because the pin sizes don't match. Crystal sockets have the same problem, so it may not be practical to build a permanent test jig. Applying 10 to 20 mA of current to a DBM i-f port will reduce rf-LO isolation to 3 dB or less. The resistors shown in **fig. 3** terminate the i-f port with about 50 (specifically, 47) ohms, and the 9-volt battery supplies about 10 mA of i-f current. Press S1 to make the **table 1** loss measurements. J1 and J2 can be reversed with similar results. This mixer output should be terminated with a 50-ohm load for precise results, but even a high input impedance oscilloscope is adequate to differentiate between good and bad mixers. A receiver with a calibrated variable attenuator could perhaps be used to measure a good mixer's typical 50-dB isolation accurately.

summary

I was amazed to find a semiconductor failure mode resulting in gradual damage rather than complete instant destruction. It's necessary to make a careful check of mixer diode resistances, or a quick rf test to identify this problem. Precise measurements could be made, but aren't necessary for functional testing.

bibliography

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WISCONSIN: July 18. The South Milwaukee ARC will hold its annual Swapfest, American Legion Post 434, 9327 South Shepard Avenue, Oak Creek. 7 AM to 3 PM. Parking, picnicking, food, refreshments and free overnight camping available on grounds. Admission $3.00 includes "happy time" with free beverages. License exams. Packet meeting. For details write South Milwaukee ARC, PO Box 102, South Milwaukee, WI 53172-0102.

MARYLAND: June 21. The Frederick ARC will hold its 10thannual Hamfest, Frederick Fairgrounds. 8 AM to 4 PM. Admission $3.00. Tailgaters $2.00 extra. Non-hams and kids free. For information: Clyde C. Wachter, WB3KQV, 7317 Ridge Road, Frederick, MD 21701.

MINNESOTA: June 6 and 7. The North Area Repeater Association will sponsor the upper Midwest's largest Swapfest and exposition for Amateur Radio operators at the Minnesota State Fairgrounds, St. Paul. Admission $4.00 advance; $5.00 at the door. Free overnight parking for self-contained campers June 5 and 6. Giant outdoor flea market. License exams. For information: Amateur Fair, PO Box 857, Hopkins, MN 55343 (612) 566-4000.

INDIANA: June 14. The 41st annual Wabash Valley Amateur Radio Association's Hamfest, Vigo County Fairgrounds, Terre Haute. Saturday night camping $5.00. Sunday 8:00 AM EST. Free outdoor flea market. Covered flea market $3.00. Food and refreshments. Advance tickets $2.00 or 3/$5.00. $3.00 at the gate. FCC exams by pre-registration only. Children under 12 free. Talk in on 147.69/09 and 146.52 simplex. For tickets and information SASE to WVARA Hamfest, PO Box 81, Terre Haute, IN 47808.

PENNSYLVANIA: July 5. 8th annual Wilkes-Barre Hamfest & Computerfest sponsored by Murgas ARC, Ica-A-Rama Coal Street Sports Complex, Coal Street. General admission 8 AM. Donation $3.00. Outdoor tailgating $2.00. Indoor space $8.00. Non-hams and kids under 16 free. FCC exams. Talk in 146.61, 53.61, 146.552. For information K3SAE and KB3GB, Rd 1, Box 214, Pittston, PA 18643. (717) 388-6863.

NEW JERSEY: June 20. The Raritan Valley Radio Club's 16th annual Hamfest, Columbia Park, Dunellen. Gates open 8 AM. Sellers spots $5.00 for one. $10.00 two or more. No tables supplied. Talk in on Club repeater W2QW/R 146.025/.625 and 146.52 simplex. For information call Dave, KA2TSM (201) 763-4849 or Bil, KD2XK (201 467-7342, 8 AM to 5 PM.

PENNSYLVANIA: June 14. Milton AMateur Radio Club's 13th annual Hamfest, Winfield Firemen's grounds, Rt. 15 Lewisburg. Rain or shine. Admission $3.00. Non-hams and kids free. Talk in on 146.97, 146.625 and 146.52. Contact Jerry Williamson, WA3SXQ, 10 Old Farm Lane, Milton, PA 17847.

MICHIGAN: June 6. The Independent Repeater Association is sponsoring its annual Hamfest, National Guard Armory, 44th Street, Grand Rapids. Free tables for dealers and sellers. For table reservations: Independent Repeater Association, 562–92nd Street, SE, Byron Center, MI 49315 (616) 455-3915.

NEW JERSEY: GILFER SWL FEST/FLEA MARKET: Saturday, June 13 rain/shine. 9 AM to 3 PM. Shortwave only. Free admission for all visitors. Sellers: $3.00 (tailgate only, bring own table). Reservation deadline: June 1. Location: GILFER SHORTWAVE, 52 Park Avenue, Park Ridge, NJ 07656. For further information please call (201) 391-7887.

MARYLAND: June 10-13. The Antique Radio Club of America will hold its 15th annual National Convention, SHERATON HOTEL AND EXHIBITION CENTER, RT. 450, New Carrollton, 10 miles NE of Washington, DC. The public is cordially invited to attend this 4-day event. Membership information can be obtained from ARCA, 81 Steeplechase Road, Devon, PA 19333.

KENTUCKY: June 7. The Northern Kentucky ARC's "Ham-O-Rama '87", Erlanger, Kentucky, Lions Park. Open to public 8 AM. Admission $5.00. Children under 13 free. Flea market spaces $3.00 each, no tables provided. Contact WA4WNF c/o NKARC, PO Box 281, Florence, KY 41042 (606) 371-2255.

INDIANA: June 21. The Lake County ARC will hold its 15th annual Dad's Day Hamfest, Lake County Fairgrounds, Crown Point. All tickets $3.00. Gates open 8 AM. Talk in on club repeater 147.60/00 and 146/52. Contact: Ken Brown, WD9HYF, 918 Chippewa Drive, Crown Point, IN 46307.

ILLINOIS: June 14. The Six Meter Club of Chicago announces its 30th annual Hamfest, Santa Fe Park, 91st and wolf Road, Willow Springs, SW of downtown Chicago. Advance tickets $3.00. At the gate $4.00. Talk in on K9ONA 146.52 or K9ONA/R 37-97. For advance ticket Mike Corbett, K9ENZ, 606 South Fenton Avenue, Romeoville, IL 60441 or any club member.

CENTRAL ALBERTA RADIO LEAGUE annual Picnic and Hamfest. June 19, 20 and 21.

PENNSYLVANIA: July 4. The annual Firecracker Hamfest sponsored by the Harrisburg RAC, Bressler Fire Company picnic grounds, Harrisburg. Admission $3.00 includes tailgating. Non-ham spouse and kids free. VE exams. For information: Dave, KC3MG, 131 Livingston Street, Swatara, PA 17113 (717) 939-4957.

WASHINGTON: June 6 and 7. Apple City Radio Club's "Come Have a Picnic With Us" Hamfest, Rocky Reach Dam, 7 miles north of Wenatchee, US 97. Free Camping/Trailer space at the Park, Saturday evening banquet, Sunday potluck dinner, Swap Shop, VE exams.

WEST VIRGINIA: July 19. The 9th annual TSRAC Wheeling Hamfest/Computer Fair, Wheeling Park. 9 AM to 4 PM. WV's largest. Dealers welcome 30,000 square feet under roof; 5 acres flea market. Family activities at Park. Admission $3.00 in advance; $4.00 at door. To reserve space contact: Carl Williams, WD8PPS, 9 East High St, Flushing, OH 43977. For tickets: TSRAC, Box 240, RD 1, Adena, OH 43901 (614) 546-3930.

NEW HAMPSHIRE: June 20. Fly-in to New Hampshire's 2nd largest Amateur Radio/electronic flea market, Manchester Municipal Airport. Sponsored by the NH FM Association. Rain date Sunday, June 21. Starts 9 AM. General admission $1.00. Sellers $5.00. Bring table or tailgate. License exams. Talk in on 146.52 FM. For further information on flea market contact Steve Morin, WB1BXB (603) 663-4019 or Dick Desorsiers, W1KGZ, 173 Maplehurst Avenue, Manchester, NH 03103 (603) 668-6868.

PENNSYLVANIA: June 7. The 33rd annual Breeze Shooters Hamfest, White Swan Amusement Park, Rt 60, near Pittsburgh International Airport. Free admission and Flea Market, family amusement park. 9 Am to 4 PM. For information and table reservations Bud Faulhaber, N3DOS, 1059 Balmoral Drive, Pittsburgh, PA 15237 (412) 366-5097.

COLORADO: June 20. The Grand Mesa Repeater Society will hold its 8th annual Western Slope Amateur Radio and Computer Swapfest, 9 AM to 4 PM, National Guard Armory, 482-28 Road, Grand Junction. Free admission. Swap tables $5.00 each. Indoor swapfest, Amateur Radio exams, auction and refreshments. Talk in on 146.22/.82 and 449.20. For tables or information SASE to Les Scott, NV0F, 2105 Yellowstone Rd, Grand Junction, CO 81503 or call (303) 242-5296.

1987 "BLOSSOMLAND BLAST" Sunday, September 20, 1987. Write "BLAST" PO Box 175, St. Joseph, MI 49085.

VIRGINIA: June 7. The Ole Virginia Hams present the Annual Manassas Hamfest, Prince William County Fairgrounds. 8 AM to 4 PM. General admission $4.00. Children under 12 free. Tailgating $5.00/space. Dealers, ARRL booth, CW proficiency award. Talk in on 146.37/97, 146.52. For information write: Ole Virginia Hams ARC, POB 1255, Manassa, VA 22110. John Gunsett, KI4VP (703) 361-5255 or Gene Roberts, N4HFW (703) 361-3983.

MICHIGAN: June 7. The Chelsea Swap and Shop, Chelsea Fairgrounds, Chelsea. Sellers 5 AM. Buyers 8 AM to 1 PM. Donation $2.50 advance and $3.00 at the gate. Children under 12 and non-ham spouses free. Talk in on Chelsea Repeater 146.980. For information: Robert Schantz, 416 Wilkinson St, Chelsea, MI 48118. (313) 475-1795.

OPERATING EVENTS

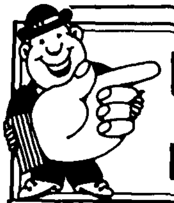
"Things to do . . ."

June 19 to 21: The Six Meter International Radio Klub, Inc. announces their 12th annual SMIRK PARTY Contest. SASE for log requests to Lisa Lowell, KA0NNO, PO Box 547, Hugo, CO 80821.

June 6 and 7: The Wireless Institute of Northern Ohio (W.I.N.O.) will have a special events station to commemorate Ohio Wine Month. The station will be operating from a winery in Madison, Ohio and will use callsign K080. For a special certificate send legal SASE to K080 WINO Weekend, 7126 Andover Drive, Mentor, Ohio 44060.

June 26—28: The Ottawa ARC will operate W8MCB from 1700Z to 2300Z to celebrate the 175th anniversary of establishment of the Fort during the War of 1812. For a commemorative certificate send QSL and SASE to WD8RJR, Paul Baumgarte, RR #3, Box 341, Delphos, Ohio 45833.

July 11 and 12: Oklahoma Amateur Radio Operators will conduct their 4th annual "Field Day" exercises at Lake Canton, OK. Activites begin 2 PM Saturday through noon Sunday. For additional information contact Tim Mauldin, WA5LTM, Lake Canton Field Day, PO Box 19097, Oklahoma City, OK 73144 (405) 521-5048.

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ELMER'S NOTEBOOK

Tom McMullen, W1SL

elmer's notebook

Welcome to *ham radio*'s new feature: Elmer's Notebook. You're going to find it informative, interesting, and — we hope — useful in many ways.

who's Elmer?

Elmer is the person who helped us at one time or another, either in our efforts to get started or in trying something new in Amateur Radio. Although he wasn't necessarily an old-timer, he had considerably more experience than we did. Who was he?

Maybe *you*! Many of you have been Elmers without realizing it. Some would have been mildly embarrassed if caught in the act. But Elmers you have been, nevertheless.

For some, being an Elmer is actually a hobby within the hobby. Dedicated Elmers spend large amounts of time helping newcomers bone up for exams and acquire their first rigs. They're always available to critique the new fist or help calm the first-contact jitters.

That's what this new column is all about — to provide guidance, encouragement, and useful material for the Elmers among *ham radio*'s readers. Of course, if Novice or other licensees find Elmer's Notebook helpful or thought-provoking, that's great too!

novice enhancement

Novice Enhancement has been in the works since April, 1986, when the FCC adopted a Notice of Proposed Rule Making (NPRM) in response to several petitions. After several hearings and response periods, it finally became official on March 21, 1987: Novices now have expanded privileges that provide immense possibilities for communication and enjoyment on the 10-meter band, and new privileges in the 220- and 1270-MHz bands. **Figure 1** shows the relationship of these segments to other parts of the Amateur Radio spectrum. The shaded areas indicate the modes Novices are permitted to use on those band segments. Power levels are 200 watts PEP on 28.1 to 28.5 MHz (this same power restriction applies to Technician class licensees on this band), 25 watts PEP on 222.1 to 223.91, and 5 watts PEP on 1270 to 1295 MHz.

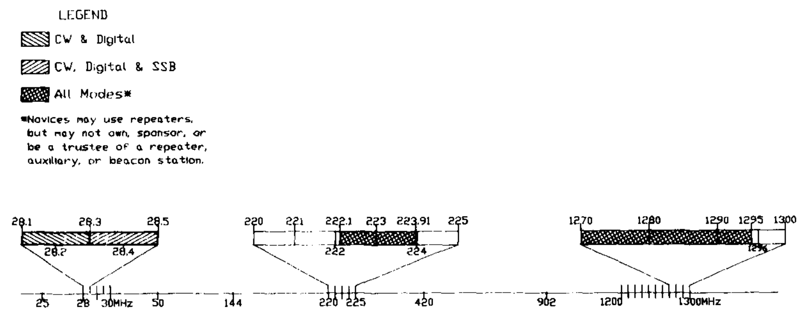

fig. 1. New Novice band privileges.

These power levels are reasonable. They're adequate for plenty of exciting communications, either direct or through repeaters, yet still offer incentive to upgrade to a higher license in order to expand capabilities. Though the 5-watt limit at 1270 MHz may seem low at first glance, it's ample for use through repeaters and for direct communication via hand-held equipment or mobile and fixed stations. There is a concern for safety at these higher frequencies; until the operator has learned enough to understand why caution is essential, low power levels are prudent indeed. We'll talk more about this aspect of operation in future columns.

the challenge

These new privileges and frequencies not only give Novices room for growth, but also generate a challenge for us Elmers: to help Novices respond to the FCC's strong recommendation, voiced in its Report and Order, that current licensees "become knowledgeable in the new requirements before using the new privileges." It's up to us to, advise them about techniques, equipment, and procedures required for the new modes of communication and on the new bands so they'll be comfortable when they try them — and so they can enjoy these privileges without creating problems simply because they haven't been there before.

Along with this primary challenge

comes a second one — to prepare prospective Amateurs for the ten new questions to be incorporated into the revised Element 2 exam. (All Novices licensed before March 21 will be "grandfathered" into the new privileges.) If we do our homework and work toward meeting the primary goal, we'll be better prepared for meeting the second.

There shouldn't be much trouble in explaining voice modes (with the possible exception of answering the questions about PEP). Novices have been waiting to try voice for a long time, and have had plenty of time to listen to voices on the high-frequency bands, just a twist of the dial away from their own CW segments.

Digital modes? Now it gets interesting. Digital communications is a relative newcomer to the Amateur Radio bands. The newest facet of that mode is packet radio, with AMTOR a close second. RTTY has been with us for quite a while, but its image has changed dramatically over the years. I can still recall the heavy, noisy, cranky monster that I assembled back in the late 1940s — but that's another story.

As I peruse the exhibitor's booths and the flea markets at hamfests, I note many small, neat, RTTY demodulators that fit handsomely on the operating desk, work with almost any common computer setup, and make very little noise. They use less power than it took to just light the filaments in the tubes in my early rig. (Filaments? Oh, they were like heating elements down inside the tube, and their function was to get the adjacent metal hot enough to excite the electrons so they'd be easier to manipulate. Filaments also made a nice cozy glow in a darkened room, made the watt-hour meter spin merrily, and told you immediately that the tube was on.) Although today's digital equipment is as far ahead of RTTY as the new RTTY demodulators are ahead of the military surplus that clanked out endless RYRYRY messages in the 1950s, RTTY is still an attractive means of communication.

Obviously, the Novice license is taking beginners into much more interesting and complex technology, and we should be prepared to provide answers and guidance. The new segments on 220 and 1270 MHz offer many exciting possibilities. Just a few of the inevitable questions include "What can be done at these frequencies?" "What's their communication range?" "Where do I get equipment?" "What about antennas?" And — here's a good one — "Can I send television on 1200 megs?" There are many answers to search for and lots of exciting territory to explore. We're here to help.

Next month, we'll take a closer look at the specific privileges indicated in **fig. 1**. In future issues, we'll discuss equipment and operating procedures, and provide information to help you prepare would-be Amateurs for the new Element 2 exam questions.

ham radio

Welcome Back, Tom

With this first installment of "Elmer's Notebook," we welcome Tom McMullen, W1SL, former managing editor of *Ham Radio Horizons*, back to *ham radio*.

Tom's involvement in radio began during his days as a Navy radio operator on a cruiser in the Pacific during World War II. First licensed in 1947, Tom credits much of his early growth in Amateur Radio to *his* Elmer, the late W8GBF.

Although his initial interest was in handling traffic on 80 meters, Tom moved on to VHF and microwave communications in the early 1970s and remains active in those areas today. He and his wife Eleanor, W1RNT, live in Florida, where Tom is employed as publications manager for a major electronics firm. — Ed.

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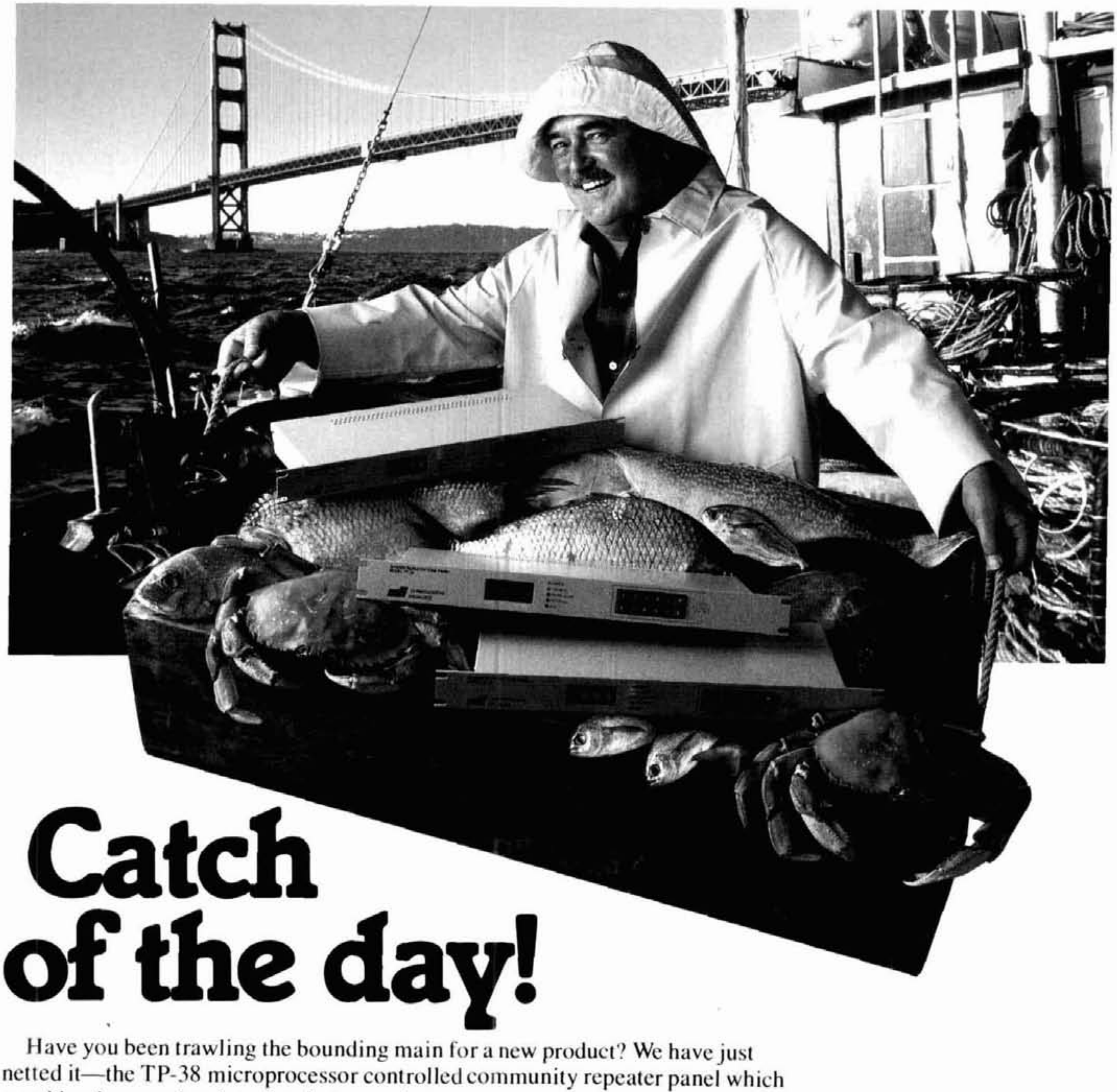

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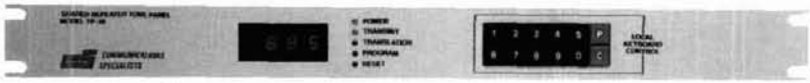

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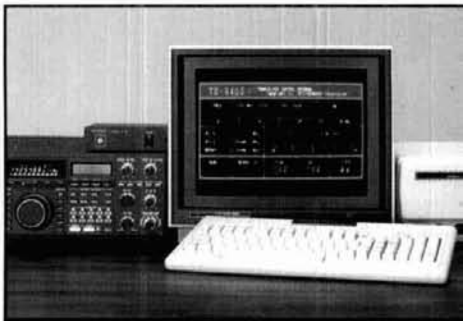

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