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On January 20, 1983, the FCC proposed the most important Amateur rules change in many years — the proposal to delegate the responsibility for Amateur license examinations to the Amateur community. Unfortunately, the emotion-laden issue of a no-code license has all but obscured this other crucial Notice of Proposed Rule Making.

In consideration of the ARRL's Petition for Rule Making on exam administration, the FCC has proposed a three-man team headed by an Extra Class licensee to administer individual exams. Examiners would have to be certified by one of several recognized supervisory organizations called Volunteer Examiner Coordinators. They would have to be over 18 years old and could not work for a manufacturer or distributor of Amateur equipment or a publisher of training materials. Questions would be chosen from a list made up by the Commission from submissions by individual Amateurs and groups of Amateurs.

There are a lot of hard questions that must be asked about this proposed system. Three-man examining teams (for all licenses except Novice) are fine for major urban areas like Los Angeles, Chicago, or Washington, D.C., but what happens to the would-be upgrader in remote parts of the country? Should there be a mechanism provided to deal with such cases, for example an examining team led by an Amateur but including non-Amateur examiners, such as elected public officials, when three licensed Amateurs aren't available? Should a formal procedure for giving exams at hamfests or in classrooms be included in the new rules?

What should the qualifications for a Volunteer-Examiner-Coordinator (VEC) be? There has been definite interest in this program shown by some non-Amateur groups. How should the long-term integrity of the VECs be ensured?

It seems that the FCC would prefer to have more than one VEC overseeing the exam-administration effort. How could anyone be sure that the different organizations all hew to the same standards? How would the overseeing groups finance their administration costs? The ARRL is already well aware of what this program is going to cost it, and it questions whether it's fair to the League's members to have them pick up the bill. Should there be a fee charged for giving Amateur exams? Who should set the fee, and to whom — the examiners, their overseeing group, or both — should it go?

Should the FCC include the Novice exam in this new overall program, instead of establishing the less demanding Novice exam program they proposed in an NPRM late last year? The ARRL wants Novices included, yet the Commission has indicated its approach would be simpler, faster, and cheaper. The Commission received very few comments on its Novice exam NPRM; does that mean Amateurs want the Novice exam a part of the larger program, or was the FCC's proposed Novice exam program simply overlooked in the concern generated by the no-code license proposal?

There are other considerations as well. It takes time to establish workable procedures (look how long the FCC had). Might not inordinate delays occur at every step of the process, resulting in longer delays in getting licensed? Right now it's a hot topic, but what about one or two years downstream? Might not interest wane among the exam administrators — with newcomers to the hobby being the losers? Most of all, we should be concerned about the possibility that the ham ticket might be devaluated by an inequitable, non-uniform examination procedure. How simple it seems now, to go down to the nearest FCC office and take the exam. Might not a small licensing fee underwrite the cost of FCC-administered exams?

Write the FCC with your opinions. Comments on the exam administration proposal, FCC PR Docket 83-27, are due at the Commission by April 8th. Address them to the Secretary, Federal Communications Commission, Washington, D.C. 20554. You'll need to send an original neatly typed with wide margins, plus five copies (eleven is better, since each Commissioner will receive one). Your name and the Docket number should appear on each page.

What we, as individual Amateurs and through our clubs and organizations, tell the Commissioners may do more to influence the future of Amateur Radio in the United States than anything else we will ever do!
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filters for Amateur use

Dear HR:

In his letter to the ham radio editor (February, 1983, page 8), Ed Mariner, W6XM, mentioned a problem the Radio Amateur too frequently ignores — the need to comply with the FCC requirement that transmitter harmonics be down by 40 dB or more from the fundamental. Ed further explained that to accomplish this on all bands a lowpass filter for each band is necessary. The customarily used 30-MHz lowpass filter, widely advertised by J.W. Miller, Drake, and B&W, is effective, he said only for the Amateur 10-meter band.

A “best solution” offered by Ed was for the Amateur to install low-pass filters designed to cut off just above the upper end of the band being used; however, the recommended designs were from the June, 1957, issue of GE Ham News — designs that are more than twenty-five years old!

During the past twenty-five years, the Radio Amateur has witnessed many changes, the most obvious being the transition from vacuum tube to solid state, and more recently the introduction of the personal computer to ham operation. Less obvious was the transition from filter design using the image-parameter-design procedure invented by Otto Zobel to the modern filter (network-synthesis) design procedure. The modern design filter has a simpler configuration and a more precise performance than the older image-parameter type. Modern lowpass designs (Chebyshev and elliptic) have been developed in which standard-value capacitors are used, thus making them simple for the Amateur to build. These designs have been widely published in the Amateur Radio handbooks, in trade handbooks, and in the Amateur and trade periodicals. I think Ed will agree that these designs are a better solution to the Amateur lowpass filtering requirements than are the old designs.

Ed also mentioned the problem of obtaining suitable high-voltage, low-loss capacitors for use in constructing lowpass filters for Amateur high-power applications. I, too, have experienced this problem, and I have continually been searching for a better high-voltage capacitor than the Ceramabead ceramic TVL type that Ed mentioned. I think I have finally found a suitable alternative to the TVL capacitor, but the manufacturer of the high-voltage capacitor, KD Components Inc. (3016 S. Orange Ave., Santa Ana, California 92707), sells only in quantities greater than ten and has a minimum billing of $50. Also, the maximum capacitance available in the 2-3 kV range is 100 pF, so several capacitors will have to be paralleled to get the larger capacities required by the filters for the lower Amateur bands. The approximate cost of the 2-kV, 100-pF, 10 percent capacitor in quantities of 10-99 is $4. In quantities above 500, the price drops to $1.44! Consequently, this capacitor type, although excellent for the application, appears to be financially practical only for a high-volume manufacturer of lowpass filters.

A filter designed from the data in reference 4 (QST, December, 1979) was constructed and operated at a 1-kW power level without a failure, but this is feasible only when the VSWR can be carefully controlled, otherwise the voltage rating of the capacitors may be exceeded and the filter damaged if the VSWR becomes excessive. For power levels below 500 watts, the polystyrene and mica capacitors seem suitable. So, contrary to Ed’s concluding statement, there does seem to be hope, and I suggest that those not having a filter for each band should review the references included with this letter, and then construct any filters that may be required.

references


Ed Wetherhold, W3NQN
Annapolis, Maryland
**MFJ CW/SSB/Notch Filters**

MFJ-722 ALL MODE audio filter for CW/SSB has tunable 70 dB notch, no ring 80 Hz CW bandwidth, steep SSB skirts (18 poles total), 2 watts for speaker plus more.

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Other models: MFJ - 721, $55.95. Like 722, less notch. MFJ - 720, $39.95. Like 723, less notch.

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More Details? CHECK—OFF Page 129

April 1983
LEGAL PROBLEMS WITH BOTH ANTENNAS AND RFI are continuing for a number of Amateurs in various communities, and should be of concern to Amateurs throughout the country. Continuing to resist new antennas, local authorities in California, Long Island, Oklahoma City, and National City have resisted the introduction of new antennas through a Notice of Proposed Rule Making to assess Amateur reaction. In addition, efforts to rescind its ordinance, in view of the federal assumption of such regulation continues. Although reunification of various communities, and should be of concern to Amateurs throughout the country.

TWO VITAL AMATEUR RULES CHANGES PROPOSED BY THE FCC are up for comments during April. The proposal to establish a volunteer examining procedure for all Amateur licenses, PR Docket 83-27, has a comment closing date of April 8, which leaves little time to consider its implications (see this month's Reflections, page 6). The no-code license proposal, PR Docket 83-28, is open for comments until April 29. The ARRL's Board of Directors has appointed Paul Rinaldo, W4RI, to study the no-code proposal, PR Docket 83-28, and report to the board at its May meeting. The ARRL has already responded objecting to the no-code proposal, PR Docket 83-28.

Amateur Exam Administration At This Year's Dayton Hamvention had been sought by the Hamvention Committee, and initial FCC reaction had been positive. However, it now appears that, though exams will be given at the Hamvention, they will be administered under the supervision of the FCC. Barring unforeseen problems, the earliest a complete volunteer program could be put together and set in motion would be late next fall, leaving too many variables to be settled in time for even a dry run at this year's Hamvention.

RICH ROSEN, K2RR, HAS BEEN APPOINTED EDITOR-IN-CHIEF OF HAM RADIO effective February 5. Rich joined Ham Radio last fall, as Senior Technical Editor.

ARRL's New Technical Department Manager is Paul Rinaldo, W4RI, who's replacing Doug DeNaw, WIFPS, upon Doug's retirement in May. Paul currently edits QEX, the ARRL experimenters' newsletter, and is the president of ARGRAD.

TEN SCHOLARSHIPS FOR GENERAL CLASS (OR HIGHER) AMATEURS planning to attend (or already attending) college or technical school are available through the Foundation for Amateur Radio. Full details and an application form can be obtained from Hugh Turnbull, W4RBC, 6903 Rhode Island Ave., College Park, MD 20740. May 31 is closing date for requests.

THE PHONE BAND EXPANSION IS STILL IN PROCESS within the Commission, with expectations that it will be finished and released by late spring. Just which bands will (and which won't) be changed isn't yet clear, though it seems very likely that 20 and 10 will both see some expansion of their phone subbands.

Deregulation Of The CB Service Is Also In The Mill, with the new rules (or non-rules) to be announced at about the same time as Amateur phone band expansion.

Extension Of Amateur License Terms To 10 Years from the present five is likely to surface soon. Though the FCC now has the authority to make the change, it will probably be introduced through a Notice of Proposed Rule Making to assess Amateur reaction.

PROFANE AND INDECENT LANGUAGE IS NO LONGER GROUNDS FOR REVOKING an Amateur's license, according to the FCC's Review Board. The license of N6BHU had been revoked last fall by an FCC Administrative Law Judge for such violations, but on January 26 that decision was overturned and his license reinstated. With a suburban Washington, D.C., broadcast station now airing uncensored "party" records, it appears the Commission concern with the content of transmissions may be a thing of the past. However, the ARRL is seeking a review of the subject with the FCC staff in hopes of restoring some standards for Amateurs.

THE SOLAR FLUX SLUMPED TO ITS LOWEST LEVEL SINCE JANUARY, 1978, at mid February, to give a hint of things to come as this sunspot cycle deepens. Solar activity remained low through CW DX Contest weekend, with 10 meters of little value and 15 spotty.

Deteriorating HF Band Conditions Highlight The Value of Beacons, particularly the new 14,100 MHz worldwide system sponsored by the Northern California DX Foundation. In addition, the many beacons in the 28.2-28.3 MHz portion of 10 meters and those operating between 50.0 and 50.1 MHz on 6 will continue to signal openings to users of those bands. See Technical Forum, page 46, for information on a beacon on 28.208 MHz.
Ham operators know that EIMAC started in power tube development with the 150T in 1934. While the 150T is now a collector's item, EIMAC, a division of Varian, still holds leadership in power tube design with its 4CX250B, 8874, 3-500Z, 8877 and 3CX400U7; modern examples of EIMAC's continuing, innovative solutions to tough communication requirements.

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inexpensive video monitor

Bypassing rf and i-f sections to resurrect old TVs for modern use

The current interest in home computers, slow-scan and fast-scan TV, RTTY, and automatic CW keyboards — not to mention home video movies and games — creates a need for an inexpensive display device for the ham shack. Many commercial video products are designed to work with a standard TV, typically using channels 2, 3, or 4 with a video modulator. There are some drawbacks to this procedure, though; for one thing, the family TV is not likely to be located in the ham shack. And, more importantly, the performance of a TV set is less than optimum if high resolution is needed.

I first considered the problems of TV sets when I acquired a TRS-80 Model I microcomputer a few years ago. I figured I could save some money by converting an old black and white TV set for use as a monitor. Typical computer-grade monitors sell for $100 or more, but a flea-market TV can be found for next to nothing. And TV sets have a 15 to 20 inch screen, unlike the typical 12-inch monitor. Sounds like a bargain, but there's a hitch.

The problem is bandwidth, or resolution, depending on your point of view. Commercial CRTs use an 80-character display, and many home computers settle for 48, 32, or even 24 characters per line. The resolution of TV is typically much less. The TRS-80 uses a sixty-four character display, which is why Radio Shack sells a dedicated monitor. Those sixty-four characters occupy roughly 80 percent of the horizontal scan line. Each character is five dots (pixels) wide, and there is a one-pixel space between letters. So, we have $6 \times 64 = 384$ pixels per line. In a conventional (U.S.) TV scanning system, one line is scanned in 63.5 microseconds. Only 80 percent of this time is available for the letters, so the pixels are scanned at a rate of $(384 \text{ pixels/line})/(0.8 \times 63.5 \text{ microseconds}) = 7.6$ million pixels/second, or 130 nanoseconds/pixel! The situation is even worse for an eighty-character line. (The longer lines are desirable for RTTY — where seventy-two character machines are common — and word-processing.) Furthermore, in order that the pixels reach full brightness when on, and return to the black video baseline when off, the rise and fall times must be much less than the 130-nanosecond duration of a pixel. Otherwise they will run together in the bars on the letters T, E, B, and so on, and fade out in the vertical part of letters I, L, etc., as noted by W9CGI.\(^1\) We require a bandwidth at least twice the pixel rate, or 15 to 20 MHz!

Broadcast TV uses a 6-MHz channel width. The i-f strip is designed to have sharp cutoff, to minimize adjacent channel interference. The video carrier is already 1.25 MHz above the lower band edge in the

By Carl Gregory, K8CG, 203 Trappers Place, Charleston, West Virginia 25314
vestigial sideband system. The maximum available video bandwidth is a bit more than 4 MHz, if we use the video-modulated rf carrier approach. It should have been no surprise to me when my TRS-80 display was illegible unless I used the expanded (thirty-two character per line) display. The problem was compounded by snow (low signal to noise ratio) from the aging rf section.

How to remedy this? Several approaches are possible:

1. Slow down the scan rate. This method has two drawbacks in that it causes annoying flicker in the display, and requires major modifications to the TV and the video display-generating circuitry.

2. Pre-process the video signal, emphasizing high frequencies. This approach was used by W9CGI. But you can compensate for only so much high frequency roll-off. The match between compensation and i-f roll-off must be exact.

3. Bypass the problem by skipping the rf and i-f sections of the TV set. This is my approach; it is the simplest, the most effective, and potentially the cheapest, since you can use a TV with a defunct tuner.

Let's consider the modification of a typical tube-type TV set for use as a wideband video display. Fig 1 shows the pertinent parts of the video amplifier stage. (The circuit is from my Sachtell-Carlson set)³. Note that the cathode of the picture tube is driven. Fig. 2 shows the typical video signal level available from the computer, demodulator, or other source. Our problem is to match the two devices.

simplest approach

The first method uses the existing video amplifier and bypasses the rf and i-f stages. In my set, the detector output (TP-1) was brought out to a test point on top of the chassis. I determined that, since the typical detector level is a couple of volts peak-to-peak, the new video source could just be hooked in parallel here.

Fig. 3 shows the circuit. The signal comes from the computer, VCR, or other source, via the coax. Some 50 or 75-ohm cable is all right as long as it's not more than a few feet long. I used RG-174, which is a nice size — not too stiff. A blocking capacitor is
needed since the 2200-ohm grid leak would otherwise be shorted by the 75-ohm video source. This capacitor must pass frequencies as low as the vertical sync pulses at 60 Hz. For 50- or 75-ohm systems this means \( X_C = 50 \text{ ohms} \) (maximum), so \( C = \frac{1}{2 \times \pi \times 60 \times 50} = 53 \text{ microfarads} \) (minimum). Note the polarity of the capacitor: the grid is negative. Be cautioned: This circuit will not work on a transformerless TV with a hot chassis unless an ac isolation transformer is installed, because there is no place to safely install the shield side of the video cable!

I installed this circuit (cost was less than $3.00 for cable, connectors, and capacitor) in my TV set, and was using my new computer in a day or so. I used it that way for about a year before I had time to try to improve the performance. There was still considerable blurring of pixels, the brightness and contrast needed continuous adjustment as the set warmed up, and the contrast was a bit low.

**second approach**

A note in *Byte* magazine suggested the solution. A new video amplifier improves the high-frequency response, and provides the needed gain to get the desired contrast. Unfortunately, the circuit in the magazine had some drawbacks, and I finally came up with my own. The circuit in fig. 4 has the following properties: no separate power supply needed; adequate gain; sufficient bandwidth to give well-formed characters at 80 per line; linear enough to use for a video-tape or ATV monitor; uses the existing brightness control circuit; no exotic devices required. (Any modern PNP and NPN transistor should work fine.)

**circuit description**

The video cable is terminated in a resistive pad, R1-R3, which also serves as part of the bias circuit for Q1. C1 passes the signal to the video amplifier (for the benefit of the sync circuitry only). Q1 operates as a linear common-emitter amplifier. The gain is about 5 at low frequencies. The emitter bypass (C2) boosts the gain above 5 MHz and compensates for the transistor's reduced beta. It is important to operate all the transistors in the linear region. Saturation of any transistor (clipping) will load the base with charge, requiring time to discharge, resulting in slow switching or reduced bandwidth.

Q2 acts as an inverter and level shifter. The gain is about 0.7. The level shifting is necessary since dc coupling is used to get wide bandwidth, and the gain need not be high since we have one more stage to go. Q3 is another common-emitter amplifier, with a gain of 3 at the collector. The signal has now been inverted three times, so it is inverted overall. The white peaks of the video input are negative peaks at the output (cathode) which drive off many more electrons and make a white spot on the screen.

The cathode of the picture tube is a low current point, so we can use a relatively small capacitor to couple the signal to it (C3). We also need dc here, but the value (+80 volts) is a bit high for the transistors, so I derived it from the existing bias circuit via a filter (R11-12 and C4). The filter removes the video information from the old amplifier, but passes the dc cathode current.

The overall gain is about -15, so a 1-volt peak-to-peak input yields about 15-volts peak-to-peak output. This means the power supply must provide considerably more than 20 volts. By trial and error, dropping resistors (R13-14) were found which gave an acceptable picture without overheating the transistors. (It is difficult to calculate the value, since the current drain of the amplifier varies with Vcc and the nature of the video signal.) C5 filters the resulting 40 volts or so and keeps it relatively constant during each frame. This unregulated supply is the least satisfactory aspect of the circuit, but the heat from the dropping resistors is hardly noticed in a tube-type set.

**construction**

This amplifier can be built in a breadboard format, since parts placement is not critical. I used a simple printed circuit board (cover the foil with masking tape and remove some with a knife, leaving large islands where the components are to be attached). The board was installed in the back of the set below the base of the picture tube. I just cut the yellow cathode lead in the middle (point A in fig. 1) and attached the two ends to the board. This is probably the only semi-critical item — it wouldn’t do to go to all that trouble to get a sharp video signal and then...
run it through a long inductive lead. But 6 to 8 inches doesn’t seem to hurt. **Caution:** This circuit will not work on a transformerless TV with a hot chassis unless an ac isolation transformer is installed, because there is no place to safely install the shield side of the video cable!

**adjustment**

There are no adjustments in the new video amplifier. However, we can improve performance a bit by adjusting the TV set. So far, only the video characteristics associated with the horizontal sweep have been discussed. Another problem with TV is that the scan is not necessarily linear. That is, the picture may be bunched up at one side or the top or bottom of the screen, and spread out elsewhere. This would be intolerable in a color set, but is common in old black and white sets. There should be a pair of pots for adjusting top and bottom vertical linearity, and there are two tabs mounted on the yoke which can be rotated independently to position the picture properly. It should be possible to find a combination in which the part of the picture you want to use the most is conveniently displayed.

Finally, you may find that the focus is not uniform over the screen. The focus control and those positioning tabs may interact, and it should be possible to get a reasonably crisp picture over the most important parts of the screen. (For use as a computer or RTTY display, the right side is less important than the left, for instance.)

I have been using the circuit in **fig. 4** with the TRS-80, and more recently with a homebrew S-100 system using an eighty-column display, for about a year now. It sure is nice to not have a lot of short, left-over lines on RTTY — you can see most of the last transmission all at once with the eighty-column display. The large screen is easy on the eyes, although the contrast is a bit low if the room is sunlit. And word-processing is handy, too; this article was written on the big screen. A test with a Panasonic portable VCR and camera showed an excellent picture of the shack. (Everything perfect except the color!)

An old TV set can be given a new lease on life as a modern video monitor for the shack at relatively low cost. The effort required will depend on the bandwidth needed for your application. I hope the principles presented here will save you a good deal of time and frustration as you attack that tube. This project is worthwhile for any experimenter on the more modern modes, such as RTTY, slow or fast-scan TV, or computer communications.

**references**

3. Schematics for older TV sets can be obtained from your local TV-repair parts supplier. Ask for Howard W. Sams "Photofact" sheets by model number.

*ham radio*
Morse time synthesis

This software routine lets your micro speak the time in Morse code

Talking microcomputers are becoming common as more companies develop hardware modules for voice synthesis. Most are reasonably priced, starting from $100. If you want vocal feedback from your computer and need only a vocabulary limited to the decimal integers, you might consider a software alternative: voice synthesized telegraphy.

The program described here synthesizes a 24-hour clock which provides an audible read-out in Morse code characters. The clock produces Morse characters for the time in hours and minutes on demand, and automatically on the hour. It is especially useful to the blind or seeing-impaired. Even to those unfamiliar with Morse code, the numerals are easy to learn.

This program was conceived on a single-board computer based on the 1802 microprocessor, running at a frequency of 1.7897725 MHz. The program depends upon only a few hardware features: 256 bytes of RAM, a speaker amplifier on the Q line, and a push-button switch on the EF4 external flag line. All the routines in the program are straightforward, and they can be easily translated into machine code for other microprocessors.

the program

The main program begins by initializing registers to point to subroutines, locations for binary time, BCD time, and a table of Morse code patterns. The program then enters the time loop (fig. 1). This loop iterates until sixty seconds elapse, at which time binary minutes are incremented. During each iteration, the program checks to see whether the time has been requested by testing external flag EF4, and it checks to see whether sixty minutes have elapsed. In either case program control passes to register R3 for the out subroutine. The time loop also checks for twenty-four hours, at which point the clock is reset to 00:00.

The out routine (fig. 2) is the main subroutine, and produces the Morse code characters. It first clears the old BCD time. Then, after getting binary hours, the program jumps via R4 to the BCD subroutine. On return, the program gets binary minutes and again

By Lawrence G. Souder, N3SE, 4539 Manayunk Avenue, Philadelphia, Pennsylvania 19128
jumps to the BCD subroutine (fig. 3). Now that the program has the time in BCD, control passes to R5 for the Code routine, which converts the BCD digits into Morse characters. On return, program control reverts to R0 to resume the time loop.

BCD is a fairly conventional binary-to-BCD subroutine which converts by successively subtracting ten from the binary value. Every time it subtracts ten, it increments the BCD ten's value and retains the difference as the new binary value. If the subtraction yields a negative difference, the previous binary value is stored as the BCD one's value.

For each BCD digit the code subroutine (fig. 4) finds the bit pattern which corresponds to the appropriate Morse code digit. It then takes this bit pattern and ring-shifts it right, into DF (the 1802's carry flag) five times. After each shift, the code subroutine tests DF. If DF is 0, a dot is fetched; if DF is 1, it returns a dash. For instance, for the numeral 2 (· · ·) the bit pattern fetched from the table will be XXX1100. (The higher-order three bits are not used.) The code routine will also generate a space between Morse digits.

The routine which produces the tones is called...
<table>
<thead>
<tr>
<th>Register</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Main program counter</td>
</tr>
<tr>
<td>1</td>
<td>Not used</td>
</tr>
<tr>
<td>2</td>
<td>Not used</td>
</tr>
<tr>
<td>3</td>
<td>Pointer to OUT (0055)</td>
</tr>
<tr>
<td>4</td>
<td>Pointer to BCD (0076)</td>
</tr>
<tr>
<td>5</td>
<td>Pointer to CODE (0088)</td>
</tr>
<tr>
<td>6</td>
<td>Pointer to bit pattern for Morse digits.</td>
</tr>
<tr>
<td>7</td>
<td>Pointer to DOT/DASH (00B6)</td>
</tr>
<tr>
<td>8</td>
<td>Scratch pad</td>
</tr>
<tr>
<td>9</td>
<td>Not used</td>
</tr>
<tr>
<td>A</td>
<td>Not used</td>
</tr>
<tr>
<td>B</td>
<td>Pointer to Binary Hours (00D0)</td>
</tr>
<tr>
<td>C</td>
<td>Pointer to Binary Minutes (00D1)</td>
</tr>
<tr>
<td>D</td>
<td>Not used</td>
</tr>
<tr>
<td>E</td>
<td>Not used</td>
</tr>
<tr>
<td>F</td>
<td>Pointer to top of table of bit patterns for Morse digits (starting at 00D6)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Address</th>
<th>Code</th>
<th>Label</th>
<th>Mnemonic</th>
<th>Operand</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000</td>
<td>F800</td>
<td>INIT</td>
<td>LDI</td>
<td>00</td>
<td>Set high order of registers to 00.</td>
</tr>
<tr>
<td>0002</td>
<td>B3</td>
<td>PHI</td>
<td>R3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0003</td>
<td>B4</td>
<td>PHI</td>
<td>R4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0004</td>
<td>B5</td>
<td>PHI</td>
<td>R5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0005</td>
<td>B6</td>
<td>PHI</td>
<td>R6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0006</td>
<td>B7</td>
<td>PHI</td>
<td>R7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0007</td>
<td>B9</td>
<td>PHI</td>
<td>R9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0008</td>
<td>BA</td>
<td>PHI</td>
<td>RA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0009</td>
<td>BB</td>
<td>PHI</td>
<td>RB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>000A</td>
<td>BF</td>
<td>PHI</td>
<td>RF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>000B</td>
<td>F855</td>
<td>LDI</td>
<td>R3</td>
<td></td>
<td>R3 points to OUT (0055).</td>
</tr>
<tr>
<td>000C</td>
<td>A3</td>
<td>PLD</td>
<td>R3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>000D</td>
<td>F856</td>
<td>LDI</td>
<td>76</td>
<td></td>
<td>R4 points to BCD (0076).</td>
</tr>
<tr>
<td>000E</td>
<td>F876</td>
<td>LDI</td>
<td>R4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0010</td>
<td>A4</td>
<td>LDI</td>
<td>R5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0011</td>
<td>F888</td>
<td>LDI</td>
<td>R5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0013</td>
<td>F886</td>
<td>LDI</td>
<td>B6</td>
<td></td>
<td>R7 points to DOT/DASH (00B6).</td>
</tr>
<tr>
<td>0014</td>
<td>A7</td>
<td>PLO</td>
<td>R7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0015</td>
<td>F8D0</td>
<td>LDI</td>
<td>D0</td>
<td></td>
<td>R9 points to Binary Hours (00D0).</td>
</tr>
<tr>
<td>0016</td>
<td>A9</td>
<td>PLO</td>
<td>R9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>001A</td>
<td>F8D1</td>
<td>LDI</td>
<td>D1</td>
<td></td>
<td>RA points to Binary Minutes (00D1).</td>
</tr>
<tr>
<td>001C</td>
<td>AA</td>
<td>LDI</td>
<td>RA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>001D</td>
<td>F8D2</td>
<td>LDI</td>
<td>D2</td>
<td></td>
<td>RB points to BCD Time (00D2).</td>
</tr>
<tr>
<td>001F</td>
<td>AB</td>
<td>PLO</td>
<td>RB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0020</td>
<td>F8D6</td>
<td>LDI</td>
<td>D6</td>
<td></td>
<td>RF points to Table of Morse digits.</td>
</tr>
<tr>
<td>0022</td>
<td>AF</td>
<td>PLO</td>
<td>RF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0023</td>
<td>F83C</td>
<td>LDI</td>
<td>3C</td>
<td>6D</td>
<td>Load minute count in RC.0.</td>
</tr>
<tr>
<td>0025</td>
<td>AC</td>
<td>PLO</td>
<td>RC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0026</td>
<td>F86D</td>
<td>LDI</td>
<td>6D</td>
<td></td>
<td>Load second count in RD.1.</td>
</tr>
<tr>
<td>0028</td>
<td>BD</td>
<td>PHI</td>
<td>RD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0029</td>
<td>2D</td>
<td>DEC</td>
<td>DEC</td>
<td>GETSEC</td>
<td>Decrement second count. Anyone want the time?</td>
</tr>
<tr>
<td>002A</td>
<td>3F32</td>
<td>BN4</td>
<td>GETSEC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>002C</td>
<td>372C</td>
<td>B4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>002E</td>
<td>F855</td>
<td>LDI</td>
<td>55</td>
<td></td>
<td>If yes, set OUT sub pointer</td>
</tr>
<tr>
<td>0030</td>
<td>A3</td>
<td>PLO</td>
<td>R3</td>
<td>0055</td>
<td>R3 to 0055 andgosub OUT.</td>
</tr>
<tr>
<td>0031</td>
<td>D3</td>
<td>SEP</td>
<td>R3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0032</td>
<td>9D</td>
<td>GHI</td>
<td>RD</td>
<td></td>
<td>Get second count.</td>
</tr>
<tr>
<td>0033</td>
<td>3A29</td>
<td>BNZ</td>
<td>SEC</td>
<td>DECSEC</td>
<td>If = 0, go to DECSEC again.</td>
</tr>
<tr>
<td>0035</td>
<td>2C</td>
<td>DEC</td>
<td>RC</td>
<td></td>
<td>Decrement minute count.</td>
</tr>
<tr>
<td>0036</td>
<td>8C</td>
<td>GLO</td>
<td>RC</td>
<td></td>
<td>Get minute count.</td>
</tr>
<tr>
<td>0037</td>
<td>3A26</td>
<td>BTNZ</td>
<td>SEC</td>
<td></td>
<td>If = 0, go to SEC again.</td>
</tr>
<tr>
<td>0039</td>
<td>0A</td>
<td>LDN</td>
<td>RA</td>
<td></td>
<td>Get binary minutes.</td>
</tr>
<tr>
<td>003A</td>
<td>FC01</td>
<td>ADI</td>
<td>01</td>
<td></td>
<td>Increment binary minutes.</td>
</tr>
<tr>
<td>003C</td>
<td>5A</td>
<td>STR</td>
<td>RA</td>
<td></td>
<td>Store new binary minutes.</td>
</tr>
<tr>
<td>003D</td>
<td>FF3C</td>
<td>SMI</td>
<td>3C</td>
<td></td>
<td>Have 60 minutes elapsed yet?</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Address</th>
<th>Code</th>
<th>Label</th>
<th>Mnemonic</th>
<th>Operand</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>003F</td>
<td>3A23</td>
<td></td>
<td>BNZ</td>
<td>TIME</td>
<td>If not, get another minute.</td>
</tr>
<tr>
<td>0041</td>
<td>F800</td>
<td>LDI</td>
<td>RA</td>
<td>00</td>
<td>If yes, clear binary minutes and ...</td>
</tr>
<tr>
<td>0043</td>
<td>5A</td>
<td>STR</td>
<td>RA</td>
<td></td>
<td>increment binary hours.</td>
</tr>
<tr>
<td>0044</td>
<td>09</td>
<td>LDN</td>
<td>R9</td>
<td>01</td>
<td>—</td>
</tr>
<tr>
<td>0045</td>
<td>FC01</td>
<td>ADI</td>
<td>R9</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>0048</td>
<td>FF1B</td>
<td>SMI</td>
<td>1B</td>
<td>18</td>
<td>Have 24 hours elapsed yet?</td>
</tr>
<tr>
<td>004A</td>
<td>3A4F</td>
<td>BNZ</td>
<td>GONG</td>
<td></td>
<td>If not, output hourly gong.</td>
</tr>
<tr>
<td>004C</td>
<td>C4</td>
<td>NOP</td>
<td>R9</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>004D</td>
<td>5A</td>
<td>STR</td>
<td>RA</td>
<td></td>
<td>If yes, reset time to 00:00</td>
</tr>
<tr>
<td>004E</td>
<td>F856</td>
<td>GONG</td>
<td>LDI</td>
<td>55</td>
<td>Set OUT sub pointer R3 to 0055 and ...</td>
</tr>
<tr>
<td>0051</td>
<td>A3</td>
<td>PLO</td>
<td>R3</td>
<td></td>
<td>gosub OUT.</td>
</tr>
<tr>
<td>0052</td>
<td>D3</td>
<td>SEP</td>
<td>R3</td>
<td></td>
<td>Back to TIME.</td>
</tr>
<tr>
<td>0053</td>
<td>3023</td>
<td>BR</td>
<td>TIME</td>
<td>00</td>
<td>Clear BCD 10’s Hours.</td>
</tr>
<tr>
<td>0055</td>
<td>F800</td>
<td>OUT</td>
<td>LDI</td>
<td>00</td>
<td>—</td>
</tr>
<tr>
<td>0057</td>
<td>5B</td>
<td>STR</td>
<td>RB</td>
<td></td>
<td>Clear BCD 1’s Hours.</td>
</tr>
<tr>
<td>0058</td>
<td>1B</td>
<td>INC</td>
<td>RB</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>0059</td>
<td>5B</td>
<td>STR</td>
<td>RB</td>
<td></td>
<td>Clear BCD 10’s Minutes.</td>
</tr>
<tr>
<td>005A</td>
<td>1B</td>
<td>INC</td>
<td>RB</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>005B</td>
<td>5B</td>
<td>STR</td>
<td>RB</td>
<td></td>
<td>Clear BCD 1’s Minutes.</td>
</tr>
<tr>
<td>005C</td>
<td>1B</td>
<td>INC</td>
<td>RB</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>005D</td>
<td>5B</td>
<td>STR</td>
<td>RB</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>005E</td>
<td>F8D2</td>
<td>LDI</td>
<td>D2</td>
<td></td>
<td>Restore BCD Time Pointer RB to 00D2.</td>
</tr>
<tr>
<td>0060</td>
<td>A8</td>
<td>PLO</td>
<td>RB</td>
<td></td>
<td>Restore BCD sub pointer R4 to 0076.</td>
</tr>
<tr>
<td>0061</td>
<td>F876</td>
<td>LDI</td>
<td>76</td>
<td></td>
<td>Get Binary Hours and ...</td>
</tr>
<tr>
<td>0063</td>
<td>A4</td>
<td>PLO</td>
<td>R4</td>
<td></td>
<td>gosub BCD.</td>
</tr>
<tr>
<td>0064</td>
<td>09</td>
<td>LDN</td>
<td>R9</td>
<td></td>
<td>Restore BCD sub pointer R4 to 0076.</td>
</tr>
<tr>
<td>0065</td>
<td>D4</td>
<td>SEP</td>
<td>R4</td>
<td></td>
<td>Get Binary Minutes and ...</td>
</tr>
<tr>
<td>0066</td>
<td>F876</td>
<td>LDI</td>
<td>76</td>
<td></td>
<td>gosub BCD.</td>
</tr>
<tr>
<td>0068</td>
<td>A4</td>
<td>PLO</td>
<td>R4</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>0069</td>
<td>OA</td>
<td>LDN</td>
<td>RA</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>006A</td>
<td>D4</td>
<td>SEP</td>
<td>R4</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>006B</td>
<td>F8D2</td>
<td>LDI</td>
<td>D2</td>
<td></td>
<td>Restore BCD Time pointer RB to 00D2.</td>
</tr>
<tr>
<td>006D</td>
<td>A8</td>
<td>PLO</td>
<td>RB</td>
<td></td>
<td>Restore CODE sub pointer R5 to 0088.</td>
</tr>
<tr>
<td>006E</td>
<td>F888</td>
<td>LDI</td>
<td>88</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>0070</td>
<td>A5</td>
<td>PLO</td>
<td>R5</td>
<td></td>
<td>Gosub CODE.</td>
</tr>
<tr>
<td>0071</td>
<td>D5</td>
<td>SEP</td>
<td>R5</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>0072</td>
<td>F8D2</td>
<td>LDI</td>
<td>D2</td>
<td></td>
<td>Restore BCD Time pointer RB to 00D2.</td>
</tr>
<tr>
<td>0074</td>
<td>A8</td>
<td>PLO</td>
<td>RB</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>0075</td>
<td>DO</td>
<td>SEP</td>
<td>R0</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>0076</td>
<td>A8</td>
<td>BCD</td>
<td>PLO</td>
<td>R8</td>
<td>Put Binary in scratch pad R8.0</td>
</tr>
<tr>
<td>0077</td>
<td>FF0A</td>
<td>SMi</td>
<td>OA</td>
<td></td>
<td>Subtract 1010 from binary.</td>
</tr>
<tr>
<td>0079</td>
<td>3BB3</td>
<td>BNF</td>
<td>BCD1’S</td>
<td></td>
<td>Use Binary as BCD 1’s if result ≤ 0. Otherwise store result ...</td>
</tr>
<tr>
<td>007B</td>
<td>A8</td>
<td>PLO</td>
<td>R8</td>
<td></td>
<td>and increment BCD 10’s.</td>
</tr>
<tr>
<td>007C</td>
<td>OB</td>
<td>LDN</td>
<td>RB</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>007D</td>
<td>FC01</td>
<td>ADI</td>
<td>01</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>007F</td>
<td>5B</td>
<td>STR</td>
<td>RB</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>0080</td>
<td>88</td>
<td>GLO</td>
<td>R8</td>
<td></td>
<td>Get new Binary and try to subtract 10 again.</td>
</tr>
<tr>
<td>0081</td>
<td>3077</td>
<td>BR</td>
<td>SUB10</td>
<td>RB</td>
<td>Since Binary is less then 10 store it as BCD 1’s</td>
</tr>
<tr>
<td>0083</td>
<td>1B</td>
<td>INC</td>
<td>RB</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>0084</td>
<td>8B</td>
<td>GLO</td>
<td>R8</td>
<td></td>
<td>10 store it as BCD 1’s</td>
</tr>
<tr>
<td>0085</td>
<td>5B</td>
<td>STR</td>
<td>RB</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>0086</td>
<td>1B</td>
<td>INC</td>
<td>RB</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>0087</td>
<td>D3</td>
<td>SEP</td>
<td>R3</td>
<td></td>
<td>Return to OUT.</td>
</tr>
<tr>
<td>0088</td>
<td>F830</td>
<td>CODE</td>
<td>LDI</td>
<td>30</td>
<td>Delay between Morse digits.</td>
</tr>
<tr>
<td>008A</td>
<td>B8</td>
<td>PHI</td>
<td>R8</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>008B</td>
<td>2B</td>
<td>DEC</td>
<td>R8</td>
<td></td>
<td>Decrement delay value.</td>
</tr>
<tr>
<td>008C</td>
<td>9B</td>
<td>GHI</td>
<td>R8</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>008D</td>
<td>3A8B</td>
<td>BNZ</td>
<td>DECDEL</td>
<td></td>
<td>Time up yet?</td>
</tr>
<tr>
<td>008F</td>
<td>8B</td>
<td>GLO</td>
<td>RB</td>
<td></td>
<td>Check to see if the last</td>
</tr>
</tbody>
</table>

April 1983
<table>
<thead>
<tr>
<th>Address</th>
<th>Code</th>
<th>Label</th>
<th>Mnemonic</th>
<th>Operand</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>0090</td>
<td>FFD6</td>
<td>SMI</td>
<td>D6</td>
<td></td>
<td>Morse digit has been output.</td>
</tr>
<tr>
<td>0092</td>
<td>C6</td>
<td>LSNZ</td>
<td></td>
<td></td>
<td>If it has, return to OUT.</td>
</tr>
<tr>
<td>0093</td>
<td>D3</td>
<td>SEP</td>
<td>R3</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>0094</td>
<td>C4</td>
<td>NOP</td>
<td></td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>0095</td>
<td>0B</td>
<td>LDN</td>
<td>RB</td>
<td></td>
<td>Get BCD value.</td>
</tr>
<tr>
<td>0096</td>
<td>1B</td>
<td>INC</td>
<td>RB</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>0097</td>
<td>FCD6</td>
<td>ADI</td>
<td>D6</td>
<td></td>
<td>Add offset.</td>
</tr>
<tr>
<td>0099</td>
<td>A6</td>
<td>PLO</td>
<td>R6</td>
<td></td>
<td>Put result in R6 as Code pointer.</td>
</tr>
<tr>
<td>009A</td>
<td>F805</td>
<td>LDI</td>
<td>06</td>
<td></td>
<td>Put Morse character count in RE.0.</td>
</tr>
<tr>
<td>009B</td>
<td>AE</td>
<td>PLO</td>
<td>RE</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>009D</td>
<td>06</td>
<td>LDN</td>
<td>R6</td>
<td></td>
<td>Get Morse pattern via R6.</td>
</tr>
<tr>
<td>009E</td>
<td>BE</td>
<td>PHI</td>
<td>RE</td>
<td></td>
<td>Store it temporarily in RE.1.</td>
</tr>
<tr>
<td>009F</td>
<td>BE</td>
<td>CHR</td>
<td>GLO</td>
<td>RE</td>
<td>Have five Morse characters been output yet?</td>
</tr>
<tr>
<td>00A0</td>
<td>3288</td>
<td>BZ</td>
<td>CODE</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>00A2</td>
<td>9E</td>
<td>GHI</td>
<td>RE</td>
<td></td>
<td>If not, get code pattern</td>
</tr>
<tr>
<td>00A3</td>
<td>2E</td>
<td>DEC</td>
<td>RE</td>
<td></td>
<td>out of temporary storage in</td>
</tr>
<tr>
<td>00A4</td>
<td>76</td>
<td>SHRC</td>
<td></td>
<td></td>
<td>RE.1 and shift character bit</td>
</tr>
<tr>
<td>00A5</td>
<td>BE</td>
<td>PHI</td>
<td>RE</td>
<td></td>
<td>into DF.</td>
</tr>
<tr>
<td>00A6</td>
<td>33AD</td>
<td>BDF</td>
<td>DASH</td>
<td></td>
<td>If bit = 1 load a dash.</td>
</tr>
<tr>
<td>00A8</td>
<td>FB19</td>
<td>DOT</td>
<td>19</td>
<td></td>
<td>Otherwise load a dot.</td>
</tr>
<tr>
<td>00AA</td>
<td>A8</td>
<td>PLO</td>
<td>R8</td>
<td></td>
<td>Restore DOT/DASH sub pointer R7</td>
</tr>
<tr>
<td>00AB</td>
<td>3BB0</td>
<td>BNF</td>
<td>EXIT</td>
<td></td>
<td>to 00B6 and ...</td>
</tr>
<tr>
<td>00AD</td>
<td>F80B</td>
<td>DASH</td>
<td>LDI</td>
<td>6B</td>
<td>Gosub DOT/DASH.</td>
</tr>
<tr>
<td>00AF</td>
<td>A8</td>
<td>PLO</td>
<td>R8</td>
<td></td>
<td>Back for another character.</td>
</tr>
<tr>
<td>00B0</td>
<td>F886</td>
<td>EXIT</td>
<td>LDI</td>
<td>B6</td>
<td>Load pitch value of tone.</td>
</tr>
<tr>
<td>00B2</td>
<td>A7</td>
<td>PLO</td>
<td>R7</td>
<td></td>
<td>&quot;ON&quot;</td>
</tr>
<tr>
<td>00B3</td>
<td>07</td>
<td>SEP</td>
<td>R7</td>
<td></td>
<td>Dec increment pitch value.</td>
</tr>
<tr>
<td>00B4</td>
<td>30F9</td>
<td>BR</td>
<td>CHR</td>
<td></td>
<td>If &quot;ON&quot; time is not up, dec again.</td>
</tr>
<tr>
<td>00B6</td>
<td>F835</td>
<td>DT/DSH</td>
<td>LDI</td>
<td>35</td>
<td>If it is, load pitch value again.</td>
</tr>
<tr>
<td>00B8</td>
<td>7B</td>
<td>SEQ</td>
<td></td>
<td></td>
<td>&quot;OFF&quot;</td>
</tr>
<tr>
<td>00B9</td>
<td>FF01</td>
<td>DECP1</td>
<td>SMI</td>
<td>01</td>
<td>Dec increment pitch value.</td>
</tr>
<tr>
<td>00BB</td>
<td>3AB9</td>
<td>BNZ</td>
<td>DECP1</td>
<td></td>
<td>If &quot;OFF&quot; time is not up, dec again.</td>
</tr>
<tr>
<td>00BD</td>
<td>F835</td>
<td>LDI</td>
<td></td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>00BF</td>
<td>7A</td>
<td>REQ</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>00C0</td>
<td>FF01</td>
<td>DECP2</td>
<td>SMI</td>
<td>01</td>
<td></td>
</tr>
<tr>
<td>00C2</td>
<td>3AC0</td>
<td>BNZ</td>
<td>DECP2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>00C4</td>
<td>28</td>
<td>DEC</td>
<td>R8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>00C5</td>
<td>88</td>
<td>GLO</td>
<td>R8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>00C6</td>
<td>3AB6</td>
<td>BNZ</td>
<td>DT/DSH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>00C8</td>
<td>F80A</td>
<td>SPACE</td>
<td>LDI</td>
<td>0A</td>
<td>Has the character been sent yet?</td>
</tr>
<tr>
<td>00CA</td>
<td>8B</td>
<td>PHI</td>
<td>R8</td>
<td></td>
<td>If not, go back for more.</td>
</tr>
<tr>
<td>00CB</td>
<td>28</td>
<td>DECS</td>
<td>DEC</td>
<td>R8</td>
<td>Load value for space between</td>
</tr>
<tr>
<td>00CC</td>
<td>98</td>
<td>GHI</td>
<td>R8</td>
<td></td>
<td>characters in R8.1.</td>
</tr>
<tr>
<td>00CD</td>
<td>3ACB</td>
<td>BNZ</td>
<td>DECS</td>
<td></td>
<td>Decrement space value.</td>
</tr>
<tr>
<td>00CF</td>
<td>D6</td>
<td>SEP</td>
<td>R5</td>
<td></td>
<td>Is the space up yet?</td>
</tr>
<tr>
<td>00D0</td>
<td>—</td>
<td>BINHRS</td>
<td></td>
<td></td>
<td>Return to CODE.</td>
</tr>
<tr>
<td>00D1</td>
<td>—</td>
<td>BINMIN</td>
<td></td>
<td></td>
<td>Binary Hours stored here.</td>
</tr>
<tr>
<td>00D2</td>
<td>—</td>
<td>10'sHR</td>
<td></td>
<td></td>
<td>Binary Minutes stored here.</td>
</tr>
<tr>
<td>00D3</td>
<td>—</td>
<td>1'sHR</td>
<td></td>
<td></td>
<td>BCD 10's Hours stored here.</td>
</tr>
<tr>
<td>00D4</td>
<td>—</td>
<td>10'sMN</td>
<td></td>
<td></td>
<td>BCD 1's Hours stored here.</td>
</tr>
<tr>
<td>00D5</td>
<td>—</td>
<td>1'sMN</td>
<td></td>
<td></td>
<td>BCD 10's Minutes stored here.</td>
</tr>
<tr>
<td>00D6</td>
<td>1F</td>
<td>DIGIT</td>
<td>TABLE</td>
<td></td>
<td>&quot;0&quot;</td>
</tr>
<tr>
<td>00D7</td>
<td>1E</td>
<td>&quot;1&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>00D8</td>
<td>1C</td>
<td>&quot;2&quot;</td>
<td></td>
<td></td>
<td>&quot;11&quot;</td>
</tr>
<tr>
<td>00D9</td>
<td>18</td>
<td>&quot;3&quot;</td>
<td></td>
<td></td>
<td>&quot;12&quot;</td>
</tr>
<tr>
<td>00DA</td>
<td>10</td>
<td>&quot;4&quot;</td>
<td></td>
<td></td>
<td>&quot;13&quot;</td>
</tr>
<tr>
<td>00DB</td>
<td>00</td>
<td>&quot;5&quot;</td>
<td></td>
<td></td>
<td>&quot;14&quot;</td>
</tr>
<tr>
<td>00DC</td>
<td>01</td>
<td>&quot;6&quot;</td>
<td></td>
<td></td>
<td>&quot;15&quot;</td>
</tr>
<tr>
<td>00DD</td>
<td>03</td>
<td>&quot;7&quot;</td>
<td></td>
<td></td>
<td>&quot;16&quot;</td>
</tr>
<tr>
<td>00DE</td>
<td>07</td>
<td>&quot;8&quot;</td>
<td></td>
<td></td>
<td>&quot;17&quot;</td>
</tr>
<tr>
<td>00DF</td>
<td>0F</td>
<td>&quot;9&quot;</td>
<td></td>
<td></td>
<td>&quot;18&quot;</td>
</tr>
</tbody>
</table>
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dot/dash (fig. 5). After the code routine fetches a dot or dash, this subroutine generates a tone of proper duration. (A dash is about three times longer than a dot.) The dot/dash routine also generates a space after each character. This space is a period of silence about as long as a dot.

**operation and fine-tuning**

Before running the program, set the clock by entering the time. To do this, convert the hours and minutes values to hexadecimal. Then enter the hours at location 00D0 and the minutes at location 00D1. Now execute the program from location 0000. The program will give the time whenever the EF4 flag is activated, and automatically on the hour.

Although the program should keep accurate time, you may have to adjust its speed if your microprocessor's clock frequency is different. Do this by varying the value at location 0027. Also, you can tune the pitch of the tone by changing the values at locations 00A9, 00AE, and 00C9. Finally, if you prefer a twelve-hour format, change the value at location 0049 to 0C.

**summary**

The basic feature of this program is the routine which converts BCD digits into Morse code characters, and in this case, the BCD digits represent time. However, the same routine with some modification could be used where the BCD digits represent something else, like temperature, pressure, voltage, or resistance. You would need more elaborate hardware in these cases, since they involve A/D conversion, but any measuring device could be made to talk with this method.

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- **HB43SP**: Boom Length: 19’ 8” • Turn Radius: 16’ 9” • Wind Area: 6.6 • Wind load lbs @ 80 mph: 132 • Boom Dia.: 2” • Weight: lbs: 38 • Price: $239.95
- **HB33SP**: Boom Length: 13’ 2” • Turn Radius: 15’ • Wind Area: 4.7 • Wind load lbs @ 80 mph: 102 • Boom Dia.: 1-5/8” • Weight: lbs: 27 • Price: $199.95

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- **DET-1** AM DET, Am Envelope Detector With AGC Output
- **DET-2** FM DET, LM-3065 FM Detector (455 KHz or 4-11 MHz)
- **DET-3** SSAM DET, LM-1496 SSB Detector (Needs OSC-1 or OSC-4)
- **IFA-1** IF AMP, CA3028 30 DB Gain, Optional AGC (455 KHz or 9-11 MHz)
- **IFA-2** IF AMP, CA3028 30 DB Gain 1-100 MHz Optional AGC
- **IFA-3** IF AMP, CA3028 30 DB Gain 1-100 MHz Optional AGC
- **IFA-4** IF AMP, CA3028 30 DB Gain 1-100 MHz Optional AGC

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April 1983
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YAESU FT-208R handheld FM transceiver
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269.95 List Price 319.00 Item No. YAEF208R
Add 1.94 shipping & handling

KENWOOD TR-8400 UHF
FM mobile transceiver
Fully synthesized operation makes operation on 440 MHz as easy as 2 meters with the TR-8400! It covers 440-450 MHz in 25 kHz steps and features a bright, LED frequency display, twin VFO’s and five memories with memory scan. A multicolored bar meter indicates received signal level and relative RF output. And the supplied microphone features an up/down control for manually scanning the entire band in 25 kHz steps, so you can safely change frequencies while you drive! The TR-8400 is very compact, measuring only 5.9” x 2.1” x 7.7” and comes with a quick release mounting bracket. RF power output: 10 watts and 1 watt. Requires 13.8V DC for operation. Special purchase. Limited quantities!

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What the system will do:
Enables you to receive up to 60 channels of satellite TV programs delivered directly to your home receiver. Movies, sporting events, news, religious programs, other TV stations and much more.

What the system includes:
1. A 10 foot parabolic antenna constructed of reflective metal bonded with fiberglass. Weather resistant and virtually maintenance-free. Comes in four sections for ease of shipment and assembly.
2. Polar mount complete with azimuth and elevation adjustments for precise satellite-to-satellite tracking. Patented linkage allows antenna to travel from horizon to horizon.
3. LNA mount with rotor and control console for remote polarity adjustment. Tubing for mount legs not included.
4. KLM Sky Eye V satellite receiver with downconverter. Downconverter mounts outdoors, near the LNA and linked to receiver by remote cable. Receiver features the latest single conversion electronics and SAW filter for superb video. Also has large signal strength meter, video invert and variable audio subcarrier tuning (5.5-7.5 MHz). Optional RF modulator available.
5. Drake 120° low noise amplifier. Takes the weak signals gathered by the parabolic antenna and boosts them to a level usable by the downconverter. Uses GaAs FET transistors for maximum performance. Powered via coax feed line. Complete weatherproof.
6. Scalar feed horn. Delivers 0.5 dB more gain than conventional rectangular types. Virtually eliminates system noise.

Note: Interconnecting cables between components not included. Your VCR's RF modulator can be used with this system, otherwise an RF modulator will be required. Approximate cost, $59.

Read all about Satellite TV!

9.95
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At last! A complete guide to satellite TV! "Build a Personal Earth Station for Worldwide Satellite TV Reception"

A complete guide to gaining access to the large amount of TV programming available from satellite transmissions. You can choose to build your own system or purchase one ready-to-operate, and both ways are thoroughly covered in this book. It begins with a review of basic television fundamentals and satellite transmission and reception. Building your own system is covered and the complicated task of installing the antenna and aiming it to pick up the signals you want is simplified. There's even a complete list of available satellite programming.

Call Toll Free 1-800-633-3410

IN ALABAMA CALL 1-800-292-8668 9 AM TIL 5:30 PM CST, MONDAY THRU FRIDAY

More Details? CHECK — OFF Page 129

April 1983 25
**WORK THE FULL-BAND®**
free of narrow band antenna limitations
WITHOUT ANTENNA TUNERS

![TYPICAL FULL-BAND PERFORMANCE](image)

<table>
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<th>SWR</th>
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<td>26.9 MHz</td>
</tr>
<tr>
<td>2.0</td>
<td>48.5 MHz</td>
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</table>

**FULL-BAND® MONOBAND DIPOLES**
EXTREME BANDWIDTH WITHOUT COMPROMISE

All Full-Band Antennas look alike, except for length. Pictured is the model FB-40 which, when extended, measures 66’3” from tip to tip (including end insulators).

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Length (in)</th>
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<td>FB-6</td>
<td>9</td>
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</tr>
</tbody>
</table>

Prices include shipping in continental U.S.—Canada, HI and AK add $5.00 shipping and handling. CA residents add sales tax. Write or phone for specifications and prices for antennas for other frequency bands.

---

**FT-ONE**

- Three selectivity positions for CW (two for FSK) using optional filters
- 73 MHz first IF
- 0.3 UV sensitivity
- full break in
- Curtis 8044 keyer available as option
- front panel keyboard
- ten VFO’s
- one year factory warranty

Madison Price - $2300.00
with RAM, FM, 4 Filters

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---

Tell 'em you saw it in HAM RADIO!
a state-of-the-art
Touchtone® decoder

Using Silicon Systems Inc.'s single-chip solution

Silicon Systems Inc.'s DTMF (dual-tone, multiple frequency) decoder IC is revolutionizing the way Amateurs use TouchTones®. With this device, it's possible to build a decoder with as few as three ICs, and the resulting circuit (see photo) is small, requires little power, and is very reliable.

a brief history

It wasn't too long ago that every DTMF decoder used and built by Amateurs was made with the NE567 phase-locked loop-tone decoder. At the time, that was the only way to decode dual-tone audio into a useful digital signal; it required tedious adjustment of a potentiometer for every frequency and that adjustment would rarely remain stable when temperature varied.

About five years ago, Mostek released a product that eliminated all the adjustments and made DTMF decoding relatively simple, but rather costly. In the Mostek system, the incoming audio signal is split into the two components of DTMF (i.e., the high-frequency group and the low-frequency group). These two components are then limited and squared before being applied to the Mostek DTMF decoder. Although the cost of the splitting filters is high, this remains a superior system to multiple 567s, as the dynamic range is tremendously improved and no adjustments are necessary.

The next logical step in DTMF decoders was to put the filters, limiters, and squarers on the same chip as the decoder. This was accomplished by Silicon Systems Incorporated (SSI) with their SS1201, a single-chip solution that requires only two small bypass capacitors and a 3.58 MHz color-burst crystal.

operation of the decoder

The major problem was to incorporate rather large capacitors and resistors needed for the filters onto the silicon chip. The largest size capacitor that can be integrated onto a chip is about 100 pF, and even this size requires a large area. Large resistors are not realizable for the same reason. However, a small capacitor can be made to perform, electrically, like a large resistor.

Fig. 1 illustrates the principle of a switched capacitor to realize a large resistor. At time zero, the capacitor is connected to voltage $V_1$ and the capacitor charges toward the value $Q = CV_1$. At some later time, $t_c$, the capacitor is switched to voltage $V_2$ and the value of the charge is $Q = CV_2$. The equations in the figure show the mathematics used to manipulate the values; the last equation is the most interesting: $R = 1/Ct_c$, in other words, a large resistor can be made (electrically) by just using a small capacitor and switching it between voltages at a very fast rate!

This led to the development of the switched-capacitor filtering used in the SS1201 DTMF decoder. (MOS transistors are used as the switches.)

The block diagram of the entire decoder is shown in fig. 2. As in the multiple-chip Mostek system, the audio is first split into upper and lower bands. These signals are further filtered to determine the two tones present. Next, the output-decoder circuitry converts this information to digital form, and produces BCD (binary-coded decimal), or optional 2-of-8 outputs. A 3.579545 MHz color-burst crystal is used for the frequency references as well as for the switched-capacitor filter networks.

By Mark Forbes, KC9C, 1000 Shenandoah Drive, Lafayette, Indiana 47905
fig. 2. Block diagram of the Silicon Systems, Inc., SSI201 DTMF decoder.
To make the SSI201 easier to interface to remote-control and repeater circuits, I have added two IC and four LEDs in this DTMF decoder design. The schematic diagram is shown in fig. 3. Audio input is coupled to the SSI201 through a 0.1 μF disk capacitor. The BCD output of the decoder is further decoded into individual "tone-pad" digits by an MC14514B 4-to-16 line demultiplexer.

One useful signal available from the decoder is the DV (data valid) signal. This signal goes high when the output data is in a predefined window of time, and is useful in determining when to sample the outputs of the MC14514 (although these outputs are latched, so the last data remains on the outputs until new data is presented).

As a convenience, LEDs that show the binary value of the decoded output, are included (note: the values for *, 0, and # are 11, 10, and 12, respectively). A CMOS 4049 inverting buffer is used to drive the LEDs and remove the load from the SSI201.

All the ICs in the project are powered from 12 Vdc. A note of caution here — the SSI201 requires 12 volts and not 13.8 volts as found on many power supplies. A small IC voltage regulator will provide the proper 12 volts if you don’t have such a power supply (an LM340-12 is one such regulator). If the outputs are to be interfaced to 5-volt logic such as TTL, a voltage converter circuit such as that shown in fig. 4 can be employed.

Construction of the circuit is very simple, using the printed circuit artwork provided in fig. 5. All that is necessary is to solder the ICs and apply 12 volts. Sockets are recommended to keep the heat of soldering off the ICs and to facilitate replacement should any of the components fail.

**applications**

The applications of a DTMF decoder seem almost limitless, especially when no adjustments are neces-
The most obvious application is in repeater control. This circuit is highly reliable and not subject to degradation by temperature or variation of signal levels. These features, coupled with the compact size of this circuit, make it perfect for use in repeaters.

A reliable circuit like this one also opens the door to an underexplored facet of Amateur radio: remote control. Remote control of more than just repeaters is allowed by the FCC. In fact, almost anything can be remotely controlled via Amateur radio. Types of applications include remote HF stations, models, or even your house lights.

Another good use of the DTMF decoder is in autopatch circuits. Most autopatches couple the DTMF tones directly to the telephone line from the receiver.

This results in two things: the user needing to adjust his Touch Tone pad to tight telephone company specifications, and frequently misdialed numbers. By decoding the signal first, then re-encoding with a DTMF generator chip, the telephone line will always have a perfect and precise tone for dialing. And, with the wide dynamic range of the SS1201, adjustment of the user’s tone pad is almost never necessary. An additional problem can also be solved: in areas where DTMF dialing is not yet available, a pulse dialer chip in conjunction with the SS1201 can provide autopatch functions.

### conclusion

The parts list in table 1 gives the price and availability of each of the parts at the time of writing. Additionally, I have complete parts kits available for the prices shown, so there should be no trouble in finding all the necessary parts.

The SS1201 is, in my opinion, the best DTMF decoder introduced to date. The Amateur press seems to be behind in the DTMF decoder field. In fact, one book on repeaters published in 1980 still showed 567 circuits for decoding DTMF. The switched capacitor has revolutionized the DTMF scene, and will soon find its way into other areas.

### references


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**table 1. Parts and Prices List.**

<table>
<thead>
<tr>
<th>part</th>
<th>description</th>
<th>source</th>
<th>price</th>
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<td>IC 1</td>
<td>SS1201 DTMF decoder</td>
<td>SAI Marketing*</td>
<td>60.00</td>
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<tr>
<td>IC 2</td>
<td>4049 inverter</td>
<td>Digikey</td>
<td>0.47</td>
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<tr>
<td>IC 3</td>
<td>MC14514 (4514B)</td>
<td>Digikey</td>
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<td>LED 1-4</td>
<td>Light Emitting Diodes</td>
<td>Radio Shack</td>
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<td>C 1</td>
<td>0.1 (\mu F) disk capacitor</td>
<td>Radio Shack</td>
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</tr>
<tr>
<td>C 2,3</td>
<td>0.01 (\mu F) disk capacitor</td>
<td>Radio Shack</td>
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<tr>
<td>R 1</td>
<td>10 Megohm resistor</td>
<td>Radio Shack</td>
<td>2 for 0.19</td>
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<td>X 1</td>
<td>3.579545 MHz crystal</td>
<td>Radio Shack</td>
<td>1.99</td>
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<tr>
<td>PCB</td>
<td>printed circuit board</td>
<td>Author</td>
<td>8.50</td>
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**Total Cost**: 67.10
**Total w/PCB**: 75.60

---

*Note: Complete parts kits are available from the author for $75.60 plus $1.00 shipping. Or, the ICs and/or PCB may be purchased individually at the listed price plus $1.00 shipping.*

*The address of SAI Marketing is: SAI Marketing, Attn. Jim Taylor, 5610 Crawfordsville Road, Indianapolis, Indiana 46224.*

---

*Ham Radio* April 1983
POWER TRANSFORMERS

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<thead>
<tr>
<th>Part #</th>
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<th>SV</th>
<th>Size</th>
<th>WT</th>
<th>Price</th>
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<td>3 phase with taps to allow sec. to be varied from 5900 to 7700 VDC @ 600 Ma out of rect.</td>
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PLATE TRANSFORMERS

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FILTER CHOICES

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<td>4.5 H @ 950 Ma, 25 KV ins.</td>
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</tr>
<tr>
<td>2 H @ 130 Ma, DC resistance</td>
<td>2</td>
<td>2</td>
<td>$2.95</td>
</tr>
<tr>
<td>155 ohms, 2,000 V ins. (Production quantities in stock)</td>
<td>155</td>
<td>155</td>
<td></td>
</tr>
<tr>
<td>5 H @ 500 Ma, 700 V ins.</td>
<td>5</td>
<td>5</td>
<td>$22.00</td>
</tr>
<tr>
<td>4 H @ 350 Ma, Collins</td>
<td>4</td>
<td>4</td>
<td>$3.95</td>
</tr>
<tr>
<td>1 H @ 1.5 H @ 1.2 A swinging</td>
<td>1</td>
<td>1</td>
<td>$125.00</td>
</tr>
<tr>
<td>13 x 17 x 17, 18 KV insulation</td>
<td>13 x 17 x 17</td>
<td>13 x 17 x 17</td>
<td>$125.00</td>
</tr>
<tr>
<td>2 H @ 1.6 A, 15 KV insulation</td>
<td>2</td>
<td>2</td>
<td>$49.00</td>
</tr>
</tbody>
</table>

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remote control hf operation

An Apple II and Collins KWM-380 talk to each other via the telephone

You can have remote high-frequency radio operation from a TouchTone™ telephone. In this article I explain this design, including the interface used to control the radio and computer; the interface plugs into the radio and computer without modification to either. A remote operator can thereby use a telephone to turn on and off primary power; use a private access code; tune the radio to any discrete frequency or scan up and down; transmit; and have optional fm radio capability. The interface has a safety shutdown feature in case the power or telephone is interrupted.

The remote system is illustrated by the block diagram in fig. 1. The center of the system is the interface control, which includes a phone patch, a dual tone multi-frequency (DTMF) decoder, audio amplifiers, and control logic. I use a Rockwell-Collins KWM-380 transceiver with the control interface option, and an Apple II Plus microcomputer with an eight-bit input/output card. A regular phone-answering unit detects the telephone ring. A ring-detection circuit could be incorporated into the interface control, but I prefer having a tape recorder tied to the system for logging. A twelve-button TouchTone™ keypad provides local control. A primary power relay, that includes transient protection, turns on the KWM-380 and the Apple. The phone-answering unit and interface control remain on at all times. An interface device that connects between the Apple’s game port and the KWM-380’s frequency-control interface connector provides frequency control. An optional fm audio-decoder is also included to provide additional system control and operation from a VHF/UHF fm radio.

By Dick Sander, K5QY, 110 Starlite Drive, Plano, Texas 75074
The frequency-control circuitry is in a case that contains the KWM-380's sixteen-button keypad. The case also contains a switch that selects +5 volt power from either the radio or the Apple. There are two reasons for interfacing the frequency control separately: the first is that this portion can be a separate project; and the second is that fewer parts are required to build an interface compared to an I/O card to insert into one of the Apple's card slots. The purpose of the interface device is to convert the four binary-outputs and strobe available from the Apple's game port to an eight-bit two-of-eight code required by the KWM-380 (see fig. 2 for the schematic diagram of the frequency interface). The output of each 74259 decoder is tied directly with the sixteen-button keypad to allow frequency input to the radio while the Apple is running. The negative strobe of the Apple triggers a 74121 one-shot and clocks the data into the radio. If only frequency control from the Apple is going to be used, lines 2000 through 2650 of the program listing form a routine for operating only frequency control for the KWM-380; delete lines 2030 through 2070 and replace them with a GET F statement from the keyboard.

The remote control interface is the heart of the system; fig. 3 is its functional block diagram and fig. 4 is its schematic. The phone-answering unit has an earplug that I use to connect the telephone audio to the interface control. After the unit hooks onto the telephone line and sends its outgoing message, it

---

fig. 2. Apple II to KWM-380 interface schematic. It converts a four-bit binary code to a 2-of-8 code with a strobe to load the data into the radio.

fig. 3. High-frequency remote-control functional block diagram. Each relay function is shown as a dotted line box.
Fig. 4. The interface-control schematic diagram. Note that the AGC amplifier and optional FM audio decoder schematic are shown separately.
TRANSMITTER AUDIO

Ito TO OUTPUT OF INAPPLE II

TO INPUT OF APPLD I/O CARD

PRI POWER RELAY SEE FIGURE 6

(fig. 4 cont'd)
allows twenty seconds for an incoming message. During this time you must access the system. The incoming audio is tied through the normally closed contacts of relay K1B directly to U5, a 741 operational-amplifier. U2 is an SSI 201 DTMF CMOS receiver that decodes the incoming audio tones, and U3, a CMOS-to-TTL buffer that passes the data to the eight-bit TTL input of the Apple’s I/O card. If the proper access code is present, the output of the Apple pulls in relay K1 and connects the telephone line to the phone patch. The answering unit will drop off by now.

The phone patch contains a transformer-type hybrid with a balancing network. The hybrid transformers that I used were surplus, and no part number is available; the builder must decide upon his own transformers. I’m using a 1-kilohm pot for null adjustment. Some situations may require some series capacitance to null out the telephone line inductance; the system will not work without proper balance. The DTMF decoder requires at least a 12-dB signal-to-noise ratio, which is why a null is important. An AGC amplifier is needed to maintain a constant level to the hybrid. If you were to measure the output of your receiver, you would find the audio level varies by as much as 20 dB. Fig. 5 is the schematic diagram of the AGC amplifier I’m using. It uses an SL1626 voice-operated gain adjusting device (VOGAD) that drives a simple 2N2222 transistor amplifier. The output is extremely constant and maintains proper audio level. Because the VOGAD operates at low levels, resisting dividers are used to reduce the input to the proper levels. The AGC amplifier controls only outgoing audio, which includes the hf received, the beeps, and possibly a voice synthesizer. Throughout the program, beeps from the Apple’s speaker tell the operator where he is during operation. For connecting audio to the system, I couple to the Apple using a 0.47 μF capacitor wrapped between the audio high side of the speaker connector and the interface. For audio low, I connect the grounds together. In the Apple, the speaker is dc-coupled to +5 volts, so be careful when connecting to the Apple’s speaker connector (refer to the Apple II reference manual).

Incoming audio (tones and voice) from the phone line via the hybrid, the local TT keypad, and optional fm control go to U5, the audio mixer. The output of U5 goes to the DTMF decoder and to the KWM-380 transmit audio.

The control-logic portion of the interface control consists mainly of a timer, a latch, and four control relays. Timer U4, a 555, stays on for one and one-half minutes. It is reset from the data valid (DV) output of U2. If there isn’t any key activity before timeout, relays K1 (phone line) and K2 (transmit/receive) drop off. Latch U1, a 4001 quad NOR gate, enables relay K4 (primary power) and turns on the radio and Apple. A shut-off command from data-out 5 causes relay K4 to drop out when U4 times out, and the radio and the Apple will turn off. Relay K3 mutes the high-frequency-received audio when a command from data-out 4 appears. Muting is used when you wish to hear only the beep or voice synthesizer (if used). Relay K2 is the transmit key relay; it sends a ground to the KWM-380’s keyline and maintains a 600-ohm load across the input side of the hybrid during transmit. Table 1 gives a detailed description of each data line and its address (I/O card in slot 4) from BASIC.

Fig. 6 is the schematic for the primary power relay. It contains varistor transient suppressors and...
table 1. This table lists the I/O data lines used to interface the KWM-380 and Apple II and gives a description and address from BASIC of each.

<table>
<thead>
<tr>
<th>data line</th>
<th>description</th>
<th>address (slot 4) from BASIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>input: D0- D7</td>
<td>Parallel eight-bit binary input, MSB is data valid (DV)</td>
<td>PEEK (50175)</td>
</tr>
<tr>
<td>output out 7</td>
<td>Pulls in transmit/receive relay K2</td>
<td>POKE 49359.1, POKE 49359.0</td>
</tr>
<tr>
<td>output out 6</td>
<td>Pulls in telephone relay K1</td>
<td>POKE 49358.1, POKE 49358.0</td>
</tr>
<tr>
<td>output out 5</td>
<td>Sets input bit to latch U1C and U1D to turn off primary power relay K4</td>
<td>POKE 49347.1, POKE 49347.0</td>
</tr>
<tr>
<td>output out 4</td>
<td>Pulls in high-frequency receiver mute relay K3</td>
<td>POKE 49336.1, POKE 49336.0</td>
</tr>
<tr>
<td>output out 3</td>
<td>Resets the fm decoder</td>
<td>POKE 49334.0, POKE 49334.1</td>
</tr>
<tr>
<td>output out 2</td>
<td>Future control to be used to change the KWM-380 mode, between USB, LSB, and CW</td>
<td>POKE 49241.0, POKE 49241.1</td>
</tr>
<tr>
<td>output out 0</td>
<td>AN0 Parallel four-bit binary code to the two-of-eight code converter to drive the KWM-380</td>
<td>POKE 49243.0, POKE 49243.1, POKE 49245.0, POKE 49245.1</td>
</tr>
<tr>
<td>output out 1</td>
<td>AN1 Parallel four-bit binary code to the two-of-eight</td>
<td>POKE 49242.0, POKE 49242.1, POKE 49244.0, POKE 49244.1</td>
</tr>
<tr>
<td>output out 0</td>
<td>AN2 code converter to drive the KWM-380</td>
<td>POKE 49247.0, POKE 49247.1, POKE 49246.0, POKE 49246.1</td>
</tr>
<tr>
<td>output out 0</td>
<td>AN3 STROBE Clocks data into the KWM-380</td>
<td>PEEK (-16320)</td>
</tr>
</tbody>
</table>

an EMI filter. These aren't necessary, but I had them in my junk box, so I used them. Power is switched on when K4 supplies +12 volts to relay K1, located in the primary power-relay box. When the system is on and I'm away from home, I feel secure knowing there is some protection. Not shown is a 115-Vac antenna change-over relay that grounds the input to the receiver when power is off; when power is on, the antenna is ungrounded. The power supply uses 7812 and 7805 voltage regulators. The entire interface control operates from +12 volts and +5 volts. Fig. 7 is the diagram of the interconnection between the interface control and the Apple's eight-bit I/O card. An optional goodie is the fm audio-decoder, whose schematic is shown in fig. 8. It allows direct access to the computer through the DTMF decoder via fm radio. This is used in case you want to operate remotely from VHF or UHF. The tone decoders are 567s and can be adjusted to detect any dual tone; I'm using tones from my keypad. It is activated by holding the proper key for eight seconds; both the telephone and fm radio operate the system, or the fm radio can operate alone. A command from data-out 3 resets the decoder (turns the fm audio off).
system operation

For testing, replace the telephone line with a 900-ohm resistor to provide balance to the hybrid. Fig. 9 is the BASIC program. The program as listed will not autoboot; after the program is typed in and saved, insert a new disk and type: INIT HELLO. Apple DOS will create an autoboot disk. If the radio and Apple are off, push the digit 6 on the local TT keypad for five seconds. This allows U1A to charge the 10-μF delay capacitor to set latch U1C and U1D and enable relay K4. System power will now be on. Line 70 is the three-digit access code; this can be changed at will. I use 789 in this program.

Enter the access code and the program menu, which give prompts to each of the functional subroutines that will appear. This portion of the program is lines 400 through 540. There are six

![Optional fm audio-decoder schematic diagram. Any pair of tones can be selected. The tones must be held on for about eight seconds before relay K1 pulls in. This permits the system to be operated by an fm radio or telephone link.](image)

This picture shows all the components that compose the high-frequency remote-control system. See fig. 1 for the block diagram.

![This picture shows the remote control interface. This unit contains a phone patch, a DTMF decoder, level amplifiers, control logic and relays. See fig. 4 for its schematic. Note that space is available on the circuit board to fully remote the KWM-380.](image)

This picture shows the frequency interface. It connects between the KWM-380 control interface connector and the Apple game port. See fig. 2 for its schematic.
subroutines, each of which can jump to its particular function when called. Lines 7000 through 7050 show how the Apple gets incoming data that is not from the keyboard.

For the Mute subroutine, enter 1; one beep sounds. This allows the * key to silence the KVWM-380 or # key to return the audio. The subroutine will automatically return to the menu.

For the Frequency Enter subroutine, enter 2; two beeps sound. This subroutine allows the operator to enter any frequency. A * is used for the decimal place and # loads the KWM-380 and returns to the menu. An example for entering 14.225 MHz is 14*225#.

For the Scan subroutine, enter 3; three beeps sound. Entering 1 makes the radio scan up. Entering 2 stops the radio from scanning. Entering 3 starts the radio scanning down. Entering * bumps the radio up 1 kHz; 7 bumps it up 100 Hz. Entering # bumps the radio down 1 kHz; 9 bumps it down 100 Hz. To return back to the menu, enter 0.

For the Control Option subroutine, enter 4; four beeps sound. The Control Option subroutine allows # to reset the fm radio or * to shut off the primary power after you exit the program. This subroutine automatically returns to the menu.

fig. 9. BASIC program listing.

```
10 HOME; VTAB 12
20 PRINT "<<<<< REMOTE CONTROL >>>>>"
30 HTAB 10; PRINT "WRITTEN BY DICK SANDER"
35 POKE 49358,1
40 FOR D = 1 TO 50; NEXT D
45 CALL - 198
50 POKE 49350,0
52 HOME
54 REM UNKEY;POKE 49357,1
55 POKE 49356,1; POKE 49347,0
60 PRINT "INPUT ACCESS CODE (3 DIGITS)"
70 AI = 7;AY = B;AZ = 9
75 PRINT 1 PRINT "ACCESS CODE IS;": PRINT 1 PRINT
80 PRINT AI,AY,AZ
90 GOSUB 7000
100 IF B < AI OR D > AI THEN BOTO 90
110 GOSUB 7000
120 IF B < AI OR D > AI THEN BOTO 90
130 GOSUB 7000
140 IF B < AI OR D > AI THEN BOTO 90
150 POKE 49356,1
160 POKE 49357,1
170 REM MUTE;POKE 49356,1
180 REM PWOM;POKE 49347,0
400 REM MENU
410 HOME
420 VTAB 3; HTAB 16; PRINT "MENU": PRINT
430 PRINT 1 HTAB 10
440 PRINT "1. ENABLE RECEIVER"
450 PRINT 1 HTAB 10
460 PRINT "2. ENTER FREQUENCY"
470 PRINT 1 HTAB 10
480 PRINT "3. SCAN FREQUENCY"
490 PRINT 1 HTAB 10
500 PRINT "4. CONTROL OPTIONS"
510 PRINT 1 HTAB 10
520 PRINT "5. TRANSMIT"
530 PRINT 1 HTAB 10
540 PRINT "6. EXIT"
590 A = PEEK (50176)
700 IF A < 128 THEN 690
710 A = A - 128
720 IF A = 10 THEN A = 0
730 IF PEEK (50176) > 127 THEN 730
740 IF A < 1 OR A > 6 THEN CALL - 198; BOTO 690
750 IF A = 1 THEN BOTO 1000
760 IF A = 2 THEN BOTO 2000
770 IF A = 3 THEN BOTO 3000
780 IF A = 4 THEN BOTO 4000
790 IF A = 5 THEN BOTO 5000
800 IF A = 6 THEN BOTO 6000
1000 REM ENABLE RCVR
1010 CALL - 198
1020 HOME; PRINT "& ENABLES RCVR & DISABLES RCVR "
1030 GOSUB 7000
1040 IF B = 11 THEN POKE 49356,1; CALL - 198; BOTO 410
1050 IF B = 12 THEN POKE 49348,0; BOTO 410
1060 IF B > 12 THEN BOTO 1000
1070 IF B < 11 THEN BOTO 1000
2000 REM INPUT FREQUENCY
2010 CALL - 198; CALL - 198
2020 HOME; PRINT "ENTER FREQUENCY"
2025 SF0 = **
2030 F = PEEK (50176)
2040 IF F < 128 THEN 2030
2050 F = F - 128
2060 IF F = 10 THEN F = 0
2070 IF PEEK (50176) > 127 THEN 2070
2080 IF F = 0 THEN GOSUB 2230;SF6 = SF0 + 0*
2090 IF F = 1 THEN GOSUB 2280;SF6 = SF0 + 1*
2100 IF F = 2 THEN GOSUB 2310;SF6 = SF0 + 2*
2110 IF F = 3 THEN GOSUB 2340;SF6 = SF0 + 3*
2120 IF F = 4 THEN GOSUB 2370;SF6 = SF0 + 4*
2130 IF F = 5 THEN GOSUB 2400;SF6 = SF0 + 5*
2140 IF F = 6 THEN GOSUB 2430;SF6 = SF0 + 6*
2150 IF F = 7 THEN GOSUB 2460;SF6 = SF0 + 7*
2160 IF F = 8 THEN GOSUB 2490;SF6 = SF0 + 8*
2170 IF F = 9 THEN GOSUB 2520;SF6 = SF0 + 9*
2180 IF F = 11 THEN GOSUB 2580;SF6 = SF0 + **
2190 IF F = 12 THEN BOTO 2220
2200 PRINT F
2210 BOTO 2030
2220 GOSUB 2350
2230 BOTO 400
```
IF Clk1
RETURN
POKE 80SUB 1
RETURN
PRINT 'PUSH
PNE 809UB
MSUB
OOSUB
BOSUB 6010
FOR W = 1 TO 9
IF W = "E" THEN 3370
NEXT W
IF WW = "O" THEN 3395
B0 = MID$(C9,1,1): BOSUB 3375
IF B0 = "H" THEN 3540
IF B0 = "I" THEN IF LEFT$(C9,1) = "." THEN B0 = "O": BOSUB 3375
IF B0 = "M" THEN 3540
IF B0 = "E" THEN 3370
NEXT B0
RETURN
8010
809UB
THEW 808UB
6010
609UB
8010
3000 REM SCAN FREQ
3125 CALL - 198: CALL - 198: CALL - 198
3130 HOME: PRINT "STARTING FREQUENCY";
3135 PRINT: PRINT
3140 HOME: VTAB 24: HTAB 20: PRINT SF0
3145 VTAB 5i: HTAB 10
3150 PRINT "PUSH 1 TO INCREASE FREQUENCY"
3155 VTAB 71: HTAB 10
3160 PRINT "PUSH 2 TO STOP SCANNING"
3165 VTAB 91: HTAB 10
3170 PRINT "PUSH 3 TO DECREASE FREQUENCY"
3175 PRINT: PRINT
3180 T = PEEK (50176)
3185 IF T < 120 THEN 3180
3190 T = T - 128
3195 IF T = 10 THEN T = 0
3200 IF T = 1 THEN 80TO 3225
3205 IF T = 2 THEN 80TO 3210
3210 IF T = 3 THEN 80TO 3215
3215 IF T = 4 THEN 80TO 3220
3220 IF T > 3 THEN CALL - 198: 80TO 3180
3225 REM SCAN UP
3230 X = VAL (SF0)
3235 Y = X + 100
3240 FOR U = X TO Y STEP 0.00030
3245 REM CHECK FOR NEW KEY
3250 IF PEEK (50176) < 128 THEN 3260
3255 IF PEEK (50176) = 128 THEN HOME: CALL - 198: 80TO 3140
3260 VTAB 20: HTAB 10
3265 PRINT U: J = U: BOSUB 3495
3270 SF0 = STR$(U)
3275 NEXT U
3280 80TO 3140
3285 REM SCAN DOWN
3290 X = VAL (SF0)
3295 Y = X - 100
3300 FOR DN = X TO Y STEP -0.00030
3305 REM CHECK FOR STOP KEY
3310 IF PEEK (50176) < 128 THEN 3325
3315 IF PEEK (50176) = 128 THEN HOME: CALL - 198: 80TO 3140
3320 VTAB 20: HTAB 10
3325 PRINT DM: J = DM: BOSUB 3495
3330 SF0 = STR$(DM)
3335 NEXT DM
3340 80TO 3140
3345 FOR I = 1 TO 9
3350 IF I = 1 THEN IF LEFT$(C9,1) = "." THEN B0 = "0": BOSUB 3375
3355 B0 = MID$(C9,1,1): BOSUB 3375
3360 IF B0 = "E" THEN 3370
3365 NEXT I
3370 RETURN
3375 K = VAL (B0) + 1
3380 IF K > 1 THEN 3395
3385 IF WW = "O" THEN 3395
3390 80TO 3405
3395 DM K BOSUB 3440,3455,3470,3485,3500,3515,3530,3545,3560,3575
3400 RETURN
3405 IF B0 = "A" THEN BOSUB 3590
3410 IF B0 = "B" THEN BOSUB 3605
3415 IF B0 = "C" THEN BOSUB 3620
3420 IF B0 = "D" THEN BOSUB 3635
3425 IF B0 = "E" THEN BOSUB 3650
3430 IF B0 = "." THEN BOSUB 3665
3435 RETURN
3440 POKE 49241,0: POKE 49242,0: POKE 49245,0: POKE 49247,0
3445 BOSUB 3680
3450 RETURN
3455 POKE 49240,0: POKE 49242,0: POKE 49244,0: POKE 49246,0
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- 3 dB
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3600 BOSUB 3680
3605 RETURN
3610 POKE 49241,0; POKE 49242,0; POKE 49244,0; POKE 49246,0
3615 GOSUB 3680
3620 RETURN
3625 POKE 49241,0; POKE 49242,0; POKE 49244,0; POKE 49246,0
3630 GOSUB 3680
3635 RETURN
3640 POKE 49241,0; POKE 49242,0; POKE 49244,0; POKE 49246,0
3645 RETURN
3650 POKE 49241,0; POKE 49242,0; POKE 49244,0; POKE 49246,0
3655 GOSUB 3680
3660 RETURN
3665 POKE 49241,0; POKE 49242,0; POKE 49244,0; POKE 49246,0
3670 GOSUB 3680
3675 RETURN
3680 REM STROBE ROUTINE
3685 IX = PEEK (-16320)
3690 RETURN
3695 C0 = STR$ (J) + "00000000"
3700 IF J < 1 THEN X = 6: GOTO 3715
3705 IF J < 10 THEN X = 7: GOTO 3715
3710 X = B
3715 C0 = LEFT$ (C0,1) + "$"
3720 GOSUB 3345
3725 RETURN
3730 REM BUMP FREQUENCY UP OR DOWN
3735 ST = VAL (SF0)
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This picture shows the primary power relay. Note the transient protection varistors and rfi filter. Relay K4, located inside the remote interface, controls power relay K1. See fig. 6 for its schematic.

For the Transmit subroutine, enter 5; five beeps sound. Entering * keys the transmitter; # unkeys the transmitter. Any digit will return to the menu.

For the Exit subroutine, enter 6; the interface control will disconnect the telephone line, tune the radio to WWV, and wait for another call; and turn off power if the control option sets power to off.

There are several smaller projects within this project. I have just touched on each, but I feel there is enough information here to reconstruct my system. The program listing does not contain any voice synthesizer coding; my system does, and it also contains the proper card. I use the voice talker to echo back the frequency after I've entered it, or when I stop scanning.

The system described in this article works reliably without a voice synthesizer. The KWM-380's remote interface allows frequency control only; so for now, I only operate 10/15/20 meters USB with the antenna connected to my tri-band beam. Fortunately, the engineers at Collins left the door open for full remote-control.

I'd like to mention what the future holds for this system. I will add mode selection for the KWM-380, to switch USB, LSB, or CW, along with the proper filter and passband tuning. Also, as an addition to this system or as a stand-alone project for the Apple, I will have an interface to my rotator for beam-heading control.

I really enjoy operating during my breaks at work; so far I've worked about twenty countries remotely. I've found one DX-pedition by using the scan mode.

I would also like to thank Tom McDermott, N5EG, for his technical assistance in this project.

ham radio
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technical forum

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diesel generator repair

Our organization has a government-surplus 10-kW diesel generator in need of repair. The battery recharging circuitry has been completely destroyed. The unit bears the following markings and information.

Unit markings:
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Generator markings:
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LC7470B16 Type 6J
Model # SSJ4254P22Y12 Figure 2 generator
Dia/cen. 2261 Frame 254Y

Damaged unit markings:
Fermont # 6064-0001

Please contact us if you have a unit like this. We are in great need of any schematics, manuals, or other information on this unit, and will gladly make arrangements to obtain copies of this information.

The Division of Disaster and Emergency Service is a volunteer search-and-rescue group. We would greatly appreciate any assistance that can be supplied by the readers of ham radio.

Wayne Richardson
Lebanon Junction Area Coord.
Bullitt Co. Div. Disaster & Emergency Services
Main Street
Lebanon Junction, KY 40150

another 10-meter beacon

I am writing to inform you that I have designed and built a beacon controller and transmitter and that it is currently in (what I hope will be) permanent operation on 28.208 MHz. The beacon runs twenty-four hours a day, seven days a week, with an input power of 75 watts CW. QSL information is transmitted along with the beacon transmission.

I hope that ham radio readers will find this a propagation aid; and the presence of this signal should indicate when the band is open into New England. The antenna is a ground plane at a height of 20 feet (6.1 meters) with 16 one-wavelength long radials.

(I am presently looking for donations of old Novice transmitters which might make a suitable replacement for my current transmitter, should the need arise. Keeping a transmitter on the air continuously can be quite taxing to transmitters designed for Amateur use. I would particularly like to find a Drake 2NT or a DX-60A.)

Leonard J. Umina, WA110B
607 Sudbury Street
Marlboro, MA 01752

I am considering transistorizing my old Drake TR-3 transceiver. I do not wish to build or buy the plug-in units that operate from the 250-volt supply in the TR-3. I propose to rectify and filter the 12.6-volt ac originally used for the heaters.

The TR-3's i-f stages use 12BA6 tubes, with plate resistance of 1 meg-ohm and transconductance of 4400 micromhos. I haven't found any single transistor which will match these characteristics, along with high input impedance. Of course I would like to use a single transistor, but I am willing to use two per stage if necessary. Can you help? — Farrell A. Buckley, AK7N

One solution to your question is to use the Solid State Tubes sold by Sartori Associates, P.O. Box 2085, Richardson, Texas 75080. They offer a replacement for the 12BA6. Other solutions are no doubt possible. Perhaps one of our readers can offer a suggestion?

ham radio
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14AVQ/WBS (40-10 meters) Offers very similar construction and the same excellent broadband performance as 18AVT over the entire 40, 20, 15 and 10 meter bands; automatic band switching with mechanically superior large-coil Hy-Q traps and very low angle radiation pattern. The smaller, low visibility size also makes the 14AVQ very suitable for roof mounting. The optional 14RMO roof mounting kit includes base plate, mast and radial/guy wires. All antenna hardware is stainless steel.

18 HTS (80-10 meters. 160 meters with optional loading coil) The superb reliability of the 18 HTS is manifest in installations now over 20 years old. And, with the improvements we made over the years, the 18HTS is now better than ever. Automatic band selection is achieved through a unique stub decoupling system which effectively isolates various sections of the antenna so that an electrical ½ wavelength (or odd multiple ¼ wavelength) exists on all bands. For example, outstanding broadband performance on 20, 15 and 10 meters is achieved with an extended ¾ wave coil. On 80 meters bandwidth is approximately 250 kHz at 2:1 VSWR. With the optional base loading coil exceptional performance is also provided at 160 meters. The galvanized tower requires no guying and withstands winds to 100 mph (160 km/h). A special hinged base allows complete assembly at ground level and permits easy raising and lowering. Includes stainless steel hardware. WARC kits to be available.

Other Hy-Gain vertical multiband antennas are available though not shown here. The 12AVQS (20, 15, 10 meter) is similar to 18AVT above but with VSWR of 1.5:1 or less on all bands. The 18VS (80-10 meter) comes with a base loading coil and may be installed on a short mast driven into the ground. All include stainless steel hardware.

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April 1983
More and more Amateurs are faced with the problem of getting on the air from a location where a full-size antenna cannot be erected. What's the answer? Stay on 2 meters and work the local repeater? If only the high-frequency antenna could be magically reduced in size!

Mini-antennas have been used on the high-frequency bands for a long time, the most compact type being the loaded whips for mobile service. While these ultra-short antennas do work, their efficiency is very low (of the order of one or two percent) and their bandwidth is very restricted. As the antenna shrinks in size, compared to the length of the radio wave, efficiency drops and bandwidth decreases. However, it is possible to strike a compromise and achieve good efficiency in an antenna that is smaller than the classic half-wave dipole.

**the loaded antenna**

Serious investigation of the coil-loaded short antenna started about 1933 when the General Electric Company developed experimental radios for the new mobile police communications system working on the “ultra-high” frequency of about 35 MHz. A summary of the results appeared in the September, 1934, issue of QST. The investigation was continued in 1940 by the National Park Service. The N.P.S. wanted 2-4 MHz mobile operation for the mountainous regions of the National parks, many of which exhibit VHF blind spots.

The conclusions of both these investigations point out that a very short, loaded antenna could be made to work well provided it was properly designed. One of the main requirements of proper design was that a high-Q loading coil be used, and that it be placed near the center of the antenna section.

It was there that the matter rested until Jerry Hall, K1PLP, published a classic article in the September, 1974, issue of QST, giving a procedure for determining the inductance of a loading coil no matter where it was placed in an antenna. Jerry's example used a dipole instead of a mobile whip. This interesting mathematical exercise was converted into a computer program by Dick Sander, K5-QY, and published in the December, 1981, issue of CJQ. The short, loaded antenna had finally arrived.

**loaded dipole program for the TRS-80**

Dick's program was designed to be

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**loaded dipole program for the TRS-80**

Dick's program was designed to be
used with an Apple II computer, but my good friend Dick Rasor, W6EDE, easily converted it for use with the TRS-80 (fig. 1). A little work with the program showed up some interesting aspects of the loaded dipole which previously had been obscured by the difficulty of the mathematics. These difficulties were now reduced to punching a few computer keys!

An illustration of the loaded dipole is given in fig. 2. For simplicity, the loading coils are located midway down the arms of the dipole: early experiments indicated this was the best place to put a loading coil if the assembly was to avoid becoming mechanically too complex.

A computer run of the antenna design shows why coil placement is critical. Fig. 3 plots coil placement against coil inductance. One limit on where the coil can be placed is seen at point 1, the feedpoint of the antenna. A feedpoint-loaded dipole places the coil at the point of maximum current, where the stored magnetic energy is high. A minimum value of inductance is required to establish resonance there, but unfortunately the portion of the antenna that does the most radiating is the portion with the maximum current. Winding it up into a coil reduces the radiation resistance, reduces bandwidth drastically, and leads to high antenna losses, principally because the coil will have relatively high loss no matter how well it is built.

Farther out along the antenna, the stored magnetic energy decreases and the inductance required in any coil placed there increases. At the same time, more of the high-current center section of the antenna is permitted to radiate. Antenna efficiency rises and the radiation resistance increases. Good!

But observe what happens when the coil passes the center point of the dipole leg (point 2). Now instead of increasing somewhat linearly with distance, the coil inductance increases rapidly. When the coil is placed near the end of the antenna (0.3) the required inductance value is more than seven times the value required for center (base) loading, and more than three times the value required when the coil is placed near the midpoint of the element.

It is tempting to place the loading coil near the tip of the antenna element; then, the whole element section has a high value of current in it, and this is thought best for antenna efficiency. But imagine a 925-\(\mu\)H inductor at 3.5 MHz. It would be four inches in diameter and have nearly two-hundred turns on it. The length would be over a foot, depending upon wire size. Placing such a coil at a high potential point in an antenna would result in fireworks: corona and brush discharge would occur with but a few watts of power applied. (And the coil would probably burn up after dust and dirt collected on it. In fact, all that would be required to do the job would be fog or rain.)

Fig. 4 shows the inductance of coils needed to make a half-size dipole for the various high-frequency bands. Although the antenna is not thereby reduced to its theoretically smallest size, this will show how an antenna can be cut fifty percent in size and still do a good job.

The computer printout that derived fig. 4 was based on an antenna using No. 16 wire for the coils and flattop. If a larger size wire is used, the tip sections of the antenna should be shortened a few inches (this is not critical).

With this data, a short dipole for 3.8 MHz works out to be about 61 feet 6 inches (18.94 m) long. The
loading coils are each 40.1 \( \mu \)H, and they are placed 15 feet 4 1/2 inches (4.69 m) from the center of the insulator.

How do you wind a 40.1-\( \mu \)H coil? There’s a computer program for that, no doubt, but I don’t have one at hand. However, the simple formula shown in fig. 5 will do the job.

**feeding the loaded dipole antenna**

With a portion of the antenna wound up into a loading coil \( L_2 \), the radiation resistance of the antenna drops drastically. For this design, the feedpoint resistance (composed of the radiation resistance plus the loss resistance of the coils) is about 22 ohms. This figure varies with height of the antenna above ground. Taking this value as par, the inductor-match system (hairpin match) developed by Gootch, Gardner, and Roberts will do the job. For this antenna design, an inductor of about 44-ohms reactance \( L_2 \) is placed across the antenna feedpoint. At 3.8 MHz, this corresponds to a coil of 1.86 \( \mu \)H. The reactance of the coil is derived from the graph in fig. 6.

Since the inducto-match is a simple L-network, the capacitive portion of the circuit is achieved by slightly shortening the antenna. Four inches off each end is about right, and the completed antenna is shown in fig. 7.

**complete TRS-80 program for all bands**

Using this information as a starting point, some smart computer programmer can develop a complete TRS-80 program which includes the design of the inducto-match coil. And, in addition, the program might be further expanded to include large-diameter elements. This will permit vertical antennas composed of aluminum tubing to be quickly designed for the lower frequency bands. I’ll be happy to hear from anyone who completes this task.

**no-code ham license?**

A lot of flak is flying around about the so-called no-code license proposed by the FCC. The arguments against a no-code license seem to fall into two categories:

1. I had to pass a code test, so why shouldn’t the next guy?
2. A no-code license will open the door to CB operators, who will ruin the ham bands.

I won’t comment on the first argument, or the accompanying argument over tradition; others can fight that battle. But I would like to discuss the second argument that a no-code license would open the door to CB operators, who will ruin the ham bands.

Perhaps this is true. But perhaps the CBers don’t want to work in a VHF ham band! How about that!

It is very instructive to tune across the hf spectrum with an “all-wave” receiver. Anyone who does will note that there’s a tremendous amount of illegal sideband activity between 26.2 MHz and 27.99 MHz. I believe there are more unlicensed stations in this portion of the spectrum than there are licensed stations in all the ham bands, at any one given time. This portion of the spectrum is jammed with thousands of signals.

These pirate operators are called “CBers.” Perhaps this is an inaccurate epithet. I doubt if the majority of them have a CB license, and I prefer the term pirate. That does not imply CB operation. Be that as it may, the point I am bringing out is that these pirates operate wherever they wish, using modified ham gear. If they want to work on 144 MHz, or 220 MHz, they will do so — regardless of whether or not a no-code license exists.

When the sunspot count drops and the MUF falls, the 11-meter region will be barren of long-distance contacts. What will the tens of thousands of pirate operators do then? Go to the new no-code ham license? I doubt it.

Already many pirate operators in Europe are using the 6.6 to 6.8 MHz portion of the spectrum for SSB operation. The pirates tend to avoid the ham bands. They operate in the large
fig. 6. The coil-loaded dipole forms a portion of a network whose input impedance over a small frequency range is close to 50 ohms. The loaded dipole, A, has a low value of radiation resistance and loss resistance, which appears at feedpoint A-B. This low impedance can be made part of an equivalent parallel resonant circuit in which the total feedpoint resistance appears in series with the reactive branch of the circuit. B: The input impedance of such a circuit varies nearly inversely with the radiation resistance of the dipole, thus the low value of feedpoint impedance can be transformed to a larger value to match the line impedance. C: The dipole appears as a capacitive reactance by shortening the element past its resonant length. The inductor L2 consists of a small coil placed across the terminals of the dipole. The reactance of the matching coil is a function of the feedpoint resistance of the antenna. D: The dashed line is the example given in the text. Apply reactance value to formula given in fig. 5.

fig. 7. Compact, coil-loaded dipole for 3.80 MHz. Tip length is adjusted for minimum SWR at design frequency. Coil is wound with No. 16 (M1.3) wire per data in fig. 5.
Our radio club recently relocated its 2-meter repeater to a site with a much higher antenna. The repeater committee decided to make major improvements in the control system to accommodate this move. We had a 220-MHz repeater also under construction, and would need a controller for that system as well.

The original controller was a small, wire-wrapped board using 556 timers, some counters, and a ROM for the CW identification. Remote control was by phone line and was not sophisticated. Past experience with this system indicated that adding any simple function would be a major task. Microprocessor enthusiasts in the club had the solution: build one microprocessor-based controller for both bands!

The final design may be expanded upon easily. In addition to the hardware description, I would like to

By Bill Warner, KB5F, 5418 Vineridge Place, Garland, Texas 75042
share some of our thoughts and decisions that went into creating the final design.

the design approach

Deciding to use a microprocessor as a controller was easy. In the long run it would be cheaper, and it’s easier to add features by reprogramming than to add separate pieces of specialized hardware. Some new circuitry would be needed as features were added, but such circuitry would be simple interfaces.

Reliability would be good, thanks to the high reliability of digital circuits and the lower parts count per function (compared with standard small and medium-scale integrated circuits). Two decisions had to be made: which microprocessor to use, and what features to include in the new controller.

selecting a microprocessor

The microprocessor we finally decided on would have to be easy to program in assembly language, have a simple input/output (I/O) structure, and be supported by good development software. The microprocessor instruction set should be able to handle reentrant programming, allowing one program module to share multiple data sets.

The Intel 8080, Zilog Z80, Motorola 6800, and Texas Instruments 9900 microprocessors were all candidates for our application. The 8080 or Z80 at first appeared to be the best choice. A friend had built an 8080 controller six years ago for the WR8ANW repeater in Columbus, Ohio. The program listing used for that controller was available and could have been converted for our needs. Several club members had 8080 systems that they used for software and hardware development. A major drawback of the 8080 was its I/O structure and the difficulty of writing clean, reentrant code for it.

The Z80 has few of the shortcomings of the 8080. It can set and test single bits in operands, has an indexed addressing mode, and allows I/O port addresses to reside in one of its internal registers. Reentrant programming is easier with it. Unfortunately, none of the club members had Z80 support software at that time.

The 6800 was not really in the running. None of the club members were familiar with it; we would be starting from scratch. This doesn’t mean the 6800 won’t work for this application. The WR8ANW repeater group, mentioned earlier, has completed a 6800-based controller.

The TMS9980 was our final choice. It is easy to write reentrant code for the 9900 family since any register may be an index. Interrupts are easily handled. Since all general purpose registers are in memory, the only registers saved on interrupt are the program counter, status register, and workspace pointer. These three restore automatically after interrupt servicing, reducing the programming load. And, support software which became available to the club on a larger microcomputer proved to be a valuable tool when it came time to assemble and edit the controller programs.

a choice of features

A list of the minimum functions required for our application was drawn up. These included CW identification, a variable time-out timer, a beep to indicate time-out, timer reset, and a status-logging rou-
time to print hourly status reports on a terminal. The time of day was added to the CW ID since there would be a counter keeping track of time in the program.

Keeping the original controller, modified to operate as a backup, would retain telephone line shutdown with the ability to disable the repeaters regardless of which controller was operational.

Fig. 1 is the repeater system block diagram. It was constructed so that adding new features would cause only a few hours of downtime. New programming may be installed while the backup controller handles the repeater. Some of the new features include a tone decoder, a modem for RTTY I/O and control, and even a voice synthesis module.

We had defined the general system; features were chosen and the microprocessor would use TMS9900 family components. This left only the hardware details to design.

**build or buy?**

Texas Instruments makes several single-board microcomputers. The TM990/100 and TM990/180 boards have a small prototyping area where additional interface circuitry can be built. Each has plenty of onboard EPROM and RAM for program operation.

The final program would be burned in the EPROM, but I wanted to put the program in RAM first to do the final debugging and possible patching. The temporary RAM test-space would be free after program verification. The free RAM could then be used for other functions, perhaps as a message storage area for RTTY users. The only way to get enough check-out RAM with the TM990 boards is to add at least one additional board.

Designing and wire-wrapping a single board with enough memory and I/O components to meet the basic criteria seemed the best way to proceed. It would include enough circuitry to bring address, data, and control lines off the board for later additions. Later features could be added using separate boards.

**solidifying the design**

Figs. 3, 4, and 5 are the schematics for the controller board. Signal mnemonics connect the three main schematic groups. Two edge connectors, P1 and P2, connect the controller to the rest of the system. Details begin with fig. 3. The controller chassis is seen in photo 1.

The Central Processor Unit (CPU) is a TMS9980 with an 8-bit data bus and addressing to 16K (16,384) bytes, more than sufficient for this application. CPU clock frequency is 10 MHz, from the crystal-controlled inverter oscillator in U8. External device clocking is available at U20-22, marked Ø3.

The CPU resets by interacting with peripheral interfaces, shown in fig. 5. Power-on reset for these in-

*TIBUG is the Texas Instruments debugging utility.
fig. 4. Memory and expansion bus interface. Bus buffers and transceiver may be added later. U31 and U32 are minimum requirements for RAM, U25 and U26 minimum for ROM.
photo 1. Top view of controller chassis with power supply. New controller is long board in second slot. Stand-offs protect wire-wrap pins on IC sockets. First slot contains old controller, smaller board toward chassis rear. Small board in first slot toward front panel contains LED resistors and wire connections to front panel. Empty slots are for future expansion. Edge-connector socket pairs wired in parallel with PIIS1 toward front. interfaces is provided by Schmitt-input gate U9A, R1, C1 through U8A and U10B to the RSTI line. A normally open reset switch may be added for testing. RESET at P1-20 to reset future external circuits.

The failsafe timer one-shot at U21 is re-triggered by the program through FSSTRB every 16.7 milliseconds. As long as the controller is operational, RPTDIS at P1-41 remains low and disables the backup controller. Controller failure will make RPTDIS high and enable the backup; a TTL pull-up resistor is located in the backup controller.

Flip-flops U2 and U3 generate proper LOAD timing for the interface chips with the help of decoder U5 and gate U9B. The ready signal input to the CPU (U20-39) must be high for normal operation with memory; the low state causes a CPU wait mode, to allow for access with slow memory. AND gate U10C keeps the ready signal high via the failsafe one-shot and expansion signal EXTRDY.

RAM is organized in 1K banks, chip-pairs selected by U12. ROM is in 2K banks, selected by U13 and U14. ENDB is a fourth 2K bank select for expansion. U6 selects the interface chips and is wired for selecting one of the three 32-bit CRU I/O bit groups. Addressing is detailed in the last section.

memory and bus expansion

Fig. 4 is a simplified memory schematic. Static RAM uses 2114 devices having a 1K by 4-bit structure. Address lines A4 to A13 and write enable WE are common to all RAM chips, but data bus lines must be split as indicated. RAM chip select lines RAM0 to RAM7 must be common only to a pair of 2114s.

All ROM pins except chip selects ROM0 to ROM2 are common. Either a 2516 or 2716 EPROM may be used for ROM, but there is a slight programming difference between the two. Both RAM and ROM may use 450 nanosecond access time devices.

A minimum system must have U25, U26, U31, and U32 installed. All memory sockets are wired for ease of check-out. The board in photo 2 shows 4K RAM installed for program verification. The memory map is seen in fig. 4A.

Bus transceiver U24 and bus buffers U28 to U30 are needed only if expansion is considered. R21 must remain to hold EXTRDY high if U30 is removed.

talking to the rest of the system

The TMS9901 Programmable Systems Interface (PSI) is the key device in fig. 5. It provides interrupt masking, priority encoding, I/O ports, and an interval timer in one package. It also handles interrupts from the TMS9902 Universal Asynchronous Receiver/Transmitter (UART) at U17 and U18.

The 9901 communicates with the CPU through the CPU’s communications register unit (CRU), an internal serial interface within the 9980. (The CRU operation is covered briefly later in this article, but the reader is referred to the reference for detail.)

The open-collector buffers to the repeaters and

<table>
<thead>
<tr>
<th>HEXADECMAL ADDRESS</th>
<th>Required for repeater control firmware</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000</td>
<td></td>
</tr>
<tr>
<td>0800</td>
<td>Wired for future control firmware</td>
</tr>
<tr>
<td>1000</td>
<td>Wired for future memory-mapped I/O devices</td>
</tr>
<tr>
<td>1800</td>
<td>RAM used for initial program debugging. May be used by future enhancements.</td>
</tr>
<tr>
<td>2000</td>
<td>RAM 0</td>
</tr>
<tr>
<td>2100</td>
<td>RAM 1</td>
</tr>
<tr>
<td>3000</td>
<td>RAM 2</td>
</tr>
<tr>
<td>3100</td>
<td>RAM 3</td>
</tr>
<tr>
<td>3200</td>
<td>RAM 4</td>
</tr>
<tr>
<td>3300</td>
<td>RAM 5</td>
</tr>
<tr>
<td>30FF</td>
<td>RAM 6</td>
</tr>
<tr>
<td>3FF</td>
<td>RAM 7</td>
</tr>
</tbody>
</table>

fig. 4A. Memory map of controller. Monitor ROM located in $0000 to $07FF address. Minimum RAM in address location $3D00 to $3FFF ($ = hexadecimal).
fig. 5. Interface circuitry and power supply connections. UART in U18 used mainly for internal timer. RC filter for CW ID tone (IDOSC) should be isolated to minimize digital noise. A minimum of one 0.01 μF bypass per three ICs is recommended on entire board.
front panel controls are identical circuit groups to each repeater. Mnemonics for the signals have an A suffix for the 2-meter repeater, a B suffix for the 220-MHz repeater. Direct repeater controls are PTT (push to talk), IDOSC (ID tone or 'oscillator'), and SQOP (squelch open). Other signal lines in each group refer to the front panel controls and indicators shown in fig. 6A and in photo 3.

PTT is low to transmit. Pull-up for the open-collector buffers (U16E and U15D) is provided within the repeater chassis. The CW identification tone is provided by programming the first-level interrupt period of 512 microseconds for a square-wave frequency just under 1 kHz. RC filtering at the IDOSC output produces a triangular waveform with an amplitude of about 5 volts peak-peak.

Remote shutdown is common to both controllers, but the direct telephone interface is within the old controller. Two rings on the landline will cause SHUTDOWN to go low, disabling the main controller. SHUTDOWN is TTL-compatible but requires R18 to hold U19-20 high when the backup controller is removed.

The RS-232 terminal connections (completed in fig. 6C) use high-voltage buffers in U22 and U23 for an ASR-733 terminal. Other devices can be used to interface the UART at U18. The terminal is connected directly to the new controller, and not used in the backup.

The power demand of the single-board controller is 3 A at +5 Vdc, 2 mA at -5 Vdc, 0.2 A at +12 Vdc, and 0.1 A at -12 Vdc. The +5 Vdc supply demand is dependent on the amount and type of memory. A well-regulated supply should be used, but the current should be calculated for your own configuration.

**manual control and indication**

The front panel controls are not an absolute requirement, but do provide local control for testing and a quick indication of operation.* The 2-meter control and indication is shown in fig. 6A; the 220 MHz arrangement is identical except for interconnecting pins.

The condition of the ENABLE switch is periodically read by the program. Switch status, shutdown signal, and a flag in memory will determine if the particular transmitter should be turned on when requested. The ENABLE status is displayed by the program as a check of all conditions.

The XMIT display lights up whenever a repeater is transmitting. The TEST switch controls two methods of transmit: manual — without microprocessor control — if the switch is held to the left, or simulation of squelch-open with processor control if it is held to the right. The SQOP display indicates the latter simulation, or normal squelch-open condition, of the repeater.

The ID LED is driven from the same source as the audio tone. Since this signal is a fifty-percent duty cycle, the current limiting resistor is smaller, creating a more uniform brightness.

Four keyboard commands are recognized. An operator can type U on the terminal to update the time, T to print current program time, M to modify the clock, and S to print the current system status. Other entries are ignored. The time correction is the number of seconds to be added to the internal clock each day; there is no provision for tweaking the system clock frequency.

**construction**

The controller was wire-wrapped on a prototype board, as shown in fig. 7 and photo 2. Bypass capacitors for the +5 V supply line were soldered directly on the board, one for every three ICs and one

---

*User-friendly controls and terminal commands benefit the non-computerist in your repeater committee.
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Models to cover every practical rf if range to listen to SSB, FM, ATV, etc. NF = 2 dB or less.

Our traditional preamps, proven in years of service. Over 20,000 in use throughout the world. Tuneable over narrow range. Specify exact freq. band needed. Gain 16-20 dB. NF = 2 dB less. VHF units available 27 to 300 MHz. UHF models available 300 to 650 MHz.

P30K, VHF Kit less case $18.95 P30C, VHF Wired $25.95
P30Q, VHF Kit with case $20.95 P30W, VHF Wired/Tested $29.95
P432K, UHF Kit less case $25.95 P432Q, UHF Wired $33.95
P432C, UHF Kit with case $24.95 P432L, UHF Wired/Tested $31.95
P432L, UHF Wired $39.95

P432 also available in broadband version to cover 20-650 MHz without tuning. Same price as P432; add "B" to model #.

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<table>
<thead>
<tr>
<th>Model</th>
<th>Tuning Range</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>HRA-144</td>
<td>143-150 MHz</td>
<td>$49.95</td>
</tr>
<tr>
<td>HRA-220</td>
<td>213-233 MHz</td>
<td>$49.95</td>
</tr>
<tr>
<td>HRA-432</td>
<td>420-450 MHz</td>
<td>$59.95</td>
</tr>
</tbody>
</table>

While supply lasts, get $59.95 cabinet kit free when you buy an FM-5 Transceiver kit. Where else can you get a complete transceiver for only $159.95?

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- SELECTIVITY THAT CAN'T BE BEAT! BOTH 8 POLE CRYSTAL FILTER & CERAMIC FILTER FOR GREATER THAN 100 dB AT ±12KHz. HELICAL RESONATOR FRONT ENDS. SEE R144, R220, AND R451 SPECS IN RECEIVER AD BELOW.
- OTHER GREAT RECEIVER FEATURES: FLUTTER-PROOF SQUELCH, AFC TO COMPENSATE FOR OFF-FREQ TRANSMITTERS, SEPARATE LOCAL SPEAKER AMPLIFIER & CONTROL.
- CLEAN, EASY-TUNE TRANSMITTER; UP TO 20 WATTS OUT.

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- HRF-220 for 213-233 MHz $34.95
- HRF-432 for 420-450 MHz $44.95
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- CWID KITS 158 bits, field programmable, clean audio. Only $59.95.

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- T51 VHF FM EXCITER for 10M, 6M, 2M, 220 MHz or adjacent bands. Kits only $59.95

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More Details? CHECK OFF Page 129
for every two memory chips. All other discrete components mount on DIP plugs.

A $12 \times 17 \times 2$ inch ($30 \times 43 \times 5$ cm) Bud chassis is bracket-mounted to the rack panel. Two $7 \times 11$ inch ($18 \times 28$ cm) aluminum plates hold the power supply and four pairs of card edge connectors. All interface connectors, the line fuse, and switch are mounted on the rear face of the chassis.

**programming and checkout**

The program was coded in short routines, most containing less than fifty lines. The code is heavily commented to facilitate debugging and to provide good documentation. Documentation is essential if you want anyone, even the programmer, to understand the program at a later date.

The program was initially programmed into the EPROM and installed on the board. A short routine was executed to move the program from ROM into RAM. Execution from RAM was under control of the monitor, allowing correction and patching. The monitor used was TIBUG™.

The EPROMs are re-programmed after checkout so the program can execute from a ROM address area rather than RAM.

Hardware and system checkout procedure used the front panel TEST switch to simulate the receiver squelch-open signal until most of the program bugs were found. Later, the PTTA line was jumpered to SQOPB and PTTB was jumpered to SQOPA; with both channels enabled, the controller would alternately transmit on 2 meters and 220 MHz. We ran the controller only in this mode for several days in the presence of the club’s HF and repeater equipment to verify that the controller was rf compatible. No interference was observed. A typical printout is seen in fig. 8.

**history**

Total construction time for this project was approximately four months. Most of the board wiring and program design was completed during a two-week vacation. The most time-consuming task was packaging the controller.

The controller was installed in the K5OJI repeater in January, 1981. Up to the time of this writing,
about two years, we had only one failure due to bad memory chips. Since the backup controller picked up when the main unit failed, the repeater was never off the air. The bad chips were quickly located and replaced.

The controller is reliable, expandable, and relatively simple. It can be made on a prototype board or it may be an adaptation of commercially available microprocessor boards. Hardware and software is designed so other features may be added easily.

Based on observation of microprocessor loading, the controller should be able to control three repeaters simultaneously. The Level 1 interrupt is the heaviest CPU load and provides the ID tone; a separate hardware oscillator will relieve much of the first-level interrupt handling.

This project would not have been possible without the help of WB8CEB for most of the program editing and N5JS and AJ5L who maintained the RF portions of the repeaters.

A listing of the control program is available on an 8-inch CPM™ compatible disk available from the author for $15.00. This disk contains the program listing and an object file for programming EPROMs. The disk is single-sided, single-density and the program uses 26 sectors at 128 bytes per sector.

for the computer technician

Computer technology is a specialized area. Some explanations and technical arguments follow which will serve the needs of the computer specialist who undertakes this project. Ham radio cannot take sides in programming techniques, but a strong relationship between hardware and software is integral to the successful design of this system, and the computer technician should be aware of this before beginning the project. Editor.

Reentrant programming is sometimes confused with recursive programming; we offer the following abbreviated definition from Granino Korn's Microcomputers for Scientists and Engineers:

“A special case occurs where a subroutine is inter-

fig. 7. Location of ICs on controller board. Edge connections are double side, and pins etched in board. Letters and numbers used for construction reference. Two RAM chips in U31, U32 is the minimum requirement but photo indicates 4K RAM population up to U38 for development purposes.

fig. 8. Typical printout of part of one day’s operation.
table 2. TMS9901 PSi bit assignments.

<table>
<thead>
<tr>
<th>select bit</th>
<th>CRU read data</th>
<th>CRU write data</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Control bit (1)</td>
<td>Control bit</td>
</tr>
<tr>
<td>1</td>
<td>INT1/CLK1 (2)</td>
<td>MASK1/CLK1 (3)</td>
</tr>
<tr>
<td>2</td>
<td>INT2/CLK2</td>
<td>MASK2/CLK2</td>
</tr>
<tr>
<td>3</td>
<td>INT3/CLK3</td>
<td>MASK3/CLK3</td>
</tr>
<tr>
<td>4</td>
<td>INT4/CLK4</td>
<td>MASK4/CLK4</td>
</tr>
<tr>
<td>5</td>
<td>INT5/CLK5</td>
<td>MASK5/CLK5</td>
</tr>
<tr>
<td>6</td>
<td>INT6/CLK6</td>
<td>MASK6/CLK6</td>
</tr>
<tr>
<td>7</td>
<td>INT7/CLK7</td>
<td>MASK7/CLK7</td>
</tr>
<tr>
<td>8</td>
<td>INT8/CLK8</td>
<td>MASK8/CLK8</td>
</tr>
<tr>
<td>9</td>
<td>INT9/CLK9</td>
<td>MASK9/CLK9</td>
</tr>
<tr>
<td>10</td>
<td>INT10/CLK10</td>
<td>MASK10/CLK10</td>
</tr>
<tr>
<td>11</td>
<td>INT11/CLK11</td>
<td>MASK11/CLK11</td>
</tr>
<tr>
<td>12</td>
<td>INT12/CLK12</td>
<td>MASK12/CLK12</td>
</tr>
<tr>
<td>13</td>
<td>INT13/CLK13</td>
<td>MASK13/CLK13</td>
</tr>
<tr>
<td>14</td>
<td>INT14/CLK14</td>
<td>MASK14/CLK14</td>
</tr>
<tr>
<td>15</td>
<td>INT15/INTREQ</td>
<td>MASK15/RST2 (4)</td>
</tr>
<tr>
<td>16</td>
<td></td>
<td>Fall-safe strobe</td>
</tr>
<tr>
<td>17</td>
<td></td>
<td>LEVEL 1 INTERRUPT INDICATOR</td>
</tr>
<tr>
<td>18</td>
<td></td>
<td>LEVEL 2 INTERRUPT INDICATOR</td>
</tr>
<tr>
<td>19</td>
<td></td>
<td>LEVEL 3 INTERRUPT INDICATOR</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>LEVEL 4 INTERRUPT INDICATOR</td>
</tr>
<tr>
<td>21</td>
<td>Remote shutdown</td>
<td>ID Ch A</td>
</tr>
<tr>
<td>22</td>
<td>iD Ch A</td>
<td>ID Ch A</td>
</tr>
<tr>
<td>23</td>
<td></td>
<td>ENABLE Ind Ch A</td>
</tr>
<tr>
<td>24</td>
<td>SQ OP Ch A</td>
<td>XMIT Ch A</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>ID Ch B</td>
</tr>
<tr>
<td>26</td>
<td>ENABLE SW Ch B</td>
<td>ENABLE Ind Ch B</td>
</tr>
<tr>
<td>27</td>
<td>iD Ch B</td>
<td>XMIT Ch B</td>
</tr>
<tr>
<td>28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>SQ OP Ch B</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>ENABLE SW Ch B</td>
<td></td>
</tr>
</tbody>
</table>

(1) 0 = interrupt mode, 1 = clock mode
(2) Data present on INT pin for clock value will be read regardless of mask value.
(3) In interrupt mode writing a 1 into mask will enable interrupt; a 0 will disable the interrupt.
(4) Writing a zero to bit 15 while in the clock mode executes a software reset of the I/O pins.

rupted and the interrupt calls the same subroutine. A program may fail on return from interrupt. Subroutines designed to work properly on interrupt and restoration from interrupt are called 'reentrant.' A good way to obtain reentrant subroutines is to provide temporary storage of addresses and register contents in 'stack' storage. Real-time computation with many interrupt-driven segments make reentrant programming desirable."

When many repeaters need be controlled, the only additional software necessary should be new parameter tables and calls to the routines handling data in these tables. Not only should the data manipulation instructions be reentrant, but so should I/O instructions; controlled devices will not always have the same I/O addresses.

The I/O structure of the 8080 does not lend itself to reentrant programming. I/O routines must be programmed once for each channel, and you must decide which piece of code to execute, or the code must be written to be self-modifying: the program modifies the instruction set about to be executed before entering the set. The instruction must reside in RAM to be self-modifying. The I/O of the 8080 must transfer eight bits at once, which requires extra logical instructions. This means that the bits which control the repeater must be set, reset, and tested, or only one function can be assigned to each I/O port.

While you need subroutines to load and test an 8080 memory location, a single 9900 instruction performs the same function. The 9900 I/O structure lends itself to reentrant programming. The 9900, through its CRU, may transfer from one to sixteen bits with a single instruction. This makes it suitable for multiple-control applications.

The address bus I/O address is generated by add-

April 1983
ing the CRU bit address in the instruction to the contents of the CRU base register, one of the user-accessible registers. By setting base register contents differently for each channel, the same I/O instructions can be used to control the same function on different channels.

Since all general purpose registers are in memory, only the CPU program counter, status register, and workspace pointer need be saved during an interrupt. These are saved and restored automatically. The programmer does not have to keep track of which registers to save or restore.

The TMS9980 CPU is part of the 9900 family and uses the same instruction set. This class of processor differs from earlier designs and readers should refer to the reference material for exact details. The following will help you understand the CRU and how it is used in the KSOJI repeater.

understanding the CRU

The communications-register-unit uses a dedicated bit-addressable interface for I/O between the CPU and 9901, 9902 devices. The CRU interface in the system is the address bus and three signal lines: CRUCLK, CRUIN, and CRUOUT (multiplexed with address line A13 on the 9980). The 9901 and 9902s are enabled via U6 by address lines A0, A1, A5, A6, and A7 while address lines A8 through A12 select the single bit to be input or output. The CRU transfers data one bit at a time, serially, on the CRUIN and CRUOUT lines.

For output, the address lines are set to point to the desired output bit and that bit of data is put on the CRUOUT (A13) line. CRUCLK then clocks the data into the selected device. For input, the address lines are set to point at the desired input, then clocked into the CRU through the CRUIN line. There is no external signal to indicate when an input is read.

Table 1 lists the hardware and software addresses for the CRU. The 9901 occupies thirty-two bits of CRU input/output space and assignments are given in Table 2. Table 3 is a complete parts list for the controller.

Table 2 needs further explanation: bit 0 controls the mode of bits 1 to 15. If bit 0 is logic 0, the 9901 is in interrupt mode. Writing to bits 1 to 15 sets an internal mask for passing or ignoring an interrupt level.

The 9901 in clock mode (internal interval timer) if bit 0 is logic 1. Writing to bits 1 to 14 loads a value into the timer's count decrementer. As the timer counts down to zero, an interrupt is issued and the timer resets to decrement value. Reading bits 1 to 14 will read the current value of the decrementer. Reading bit 15 inputs the status of the interrupt request while writing to bit 15 initiates a reset of input/output pins.

| table 3. Controller parts list. |
| quantity | type |
| 1        | TMS9980  |
| 1        | TMS9901  |
| 2        | TMS9902  |
| 2 min., 16 max. | 2114 U31 to 2146 |
| 2 min., 3 max. | 2516 U25 to U27 |
| 1        | 74L500   |
| 1        | 74L504   |
| 1        | 7404     |
| 3        | 7407     |
| 2        | 74L08    |
| 2        | 74L74    |
| 1        | 74LS123  |
| 1        | 74LS132  |
| 4        | 74LS138  |
| 3        | 74LS244  |
| 1        | 74LS245  |
| 1        | 75188    |
| 1        | 75189    |

resistors

| (all resistors are 0.1 W, 10% unless otherwise specified) |
| 1        | 220 K    | R7       |
| 1        | 68 ohm   | R2       |
| 2        | 82 ohm   | front panel |
| 2        | 120 ohm  | front panel |
| 2        | 510 ohm (5%) | R4, R5  |
| 2        | 2.2 K    | R19, R20 |
| 6        | 4.7 K    | R1, R6, R8, R13, R18, R21 |
| 6        | 15 K     | R9, R10, R12, R14, R15, R17 |
| 2        | 1 K      | R11, R16 |
| 1        | DIP array | K |
| 1        | 220 K    | R7       |

capacitors

| (all capacitors are disk, 25 V min unless otherwise specified) |
| 24        | 0.01 μF  | C2, C7, C8, C9, C11 to C30 |
| 2         | 0.1 μF   | C5, C6   |
| 1         | 1.0 μF   | C4       |
| 1         | 10 pF mica | C3    |
| 1         | 33 μF    | C1 (electrolytic, 10 V min.) |
| 1         | 47 μF    | C10 (electrolytic, 10 V min.) |
| 1         | CY-18 crystal, 10 MHz | Y1 |
| 1         | 1N4001   | CR1      |
| 2         | LED, green | front panel |
| 2         | LED, red | front panel |
| 2         | LED, yellow | front panel |
| 2         | switch, SPDT, momentary-off-momentary | front panel |
| 2         | switch, SPST | front panel |

Bits 16 to 31 are for I/O, the majority directly interfacing with the repeaters. Writing a 0 and then a 1 to bit 16 will re-trigger failsafe one-shot U21. Re-triggering must occur at a 60 Hz rate.

Bits 17 to 20 are monitor output which indicates the level of interrupt processing. Entering an interrupt routine sets the appropriate bit for that interrupt level. Completing an interrupt resets the bit. Oscilloscope monitoring verifies the interrupt and indicates CPU loading for each interrupt time. The first three
interrupt levels are used here with the fourth level reserved for future use.

Bit 21 is an input for remote shutdown via telephone line through the old controller. The old controller will shut down through its own interface circuitry and a low state of SHUTDOWN will disable the new controller.

Bits 22 to 26 are I/O control for the 2-meter repeater ("A" suffix mnemonics) while bits 27 to 31 are identical in function for the 220 MHz repeater ("B" suffix).

Interrupt level 3 is internal to the 9901. Interrupt levels 4 and 5 are hardwired to the interrupt outputs on both 9902s. The 9901 will prioritize interrupts, outputting an interrupt code of 0 for highest priority and 15 for lowest priority. The 9980 CPU interprets levels 3, 4, and 5 as interrupt levels 1, 2, and 3, respectively.

Each 9902 UART is assigned thirty-two bits of CRU and each may cause an interrupt from four separate events. Repeater control uses only the interval timer interrupt. The second 9902 (U18) is used solely for the timer, but could be used for a second serial interface.

software

Author Warner claims that packaging the controller was the most time-consuming task and that software design was second. Judging from the 51 pages of program listing available, we might reverse that statement. The final excerpt contains some details on the program package.

The software design was to include as many features as possible and to break the program into small, easy-to-follow modules. These modules can be called by the appropriate interrupt processor module, depending on the desired frequency of execution. It would not be difficult to add modules for new features.

Modules communicate with each other (on the same and different interrupt levels) via semaphores, flags set in specific memory locations. Seven extended-operation (XOP) instructions are included for I/O with a keyboard/printer. The hardware will support a total of 16 XOPs, so users may add their own XOP routines.

Hardware reset causes an entry into the initialization section of the program. This initializes certain memory locations, I/O interfaces (including all interval timers), and the interrupt mask register in the 9901. Once accomplished, the program enables interrupts and begins execution of the program's polling loop.

The following program names are those included in the program. The interrupt level routines handle all the repeater control functions. Three levels of interrupts are used. Level 1 is highest and occurs when the 9901 interval timer decrements to zero. Program segment C04 generates the CW ID tone on a Level 1 interrupt. This will generate a 1 kHz tone for each repeater.

Interrupt handlers are similar. First the appropriate CRU output bit is set to indicate initiation of processing at the particular interrupt. Register 1, used as an index register, is loaded with the address of the parameter table for one repeater. The proper routines for that repeater are then called to operate on the parameters. When processing for one repeater is complete, Register 1 is re-loaded with the address of the parameter table for the other repeater, and the same routines are called again. When all processing for the interrupt level is complete, interrupt hardware is enabled for the next interval timer decrement-through-zero. The CRU bit, indicating process in operation, is reset and control returns to the interrupted routine.

Level 2 interrupt is caused by the interval timer in the 9902 at U17. This timer is set to decrement through zero every 4.7 milliseconds. The routine labelled C01 is executed on a Level 2 interrupt and forms the ID tone length and beep.

Main repeater timing occurs at Level 3, generated every 16.7 milliseconds. Some system functions, such as time of day and checking for remote shutdown, are executed only once per interrupt. All other repeater routines must be executed once for each channel. Routines R00, R07, and R09 are called only once while repeater routines R01 through R05, R08 are called twice.

When no interrupts are being serviced, the polling loop at I03 is operating. This loop checks for keyboard inputs and checks flags that indicate printout of an hourly repeater status. Once each hour the interrupt level routines move the hourly status for each repeater to a print buffer, clear the next hour's status, and set a print request flag. The polling loop checks this flag and, if set, lists the status from the print buffer on the terminal. If both repeaters are enabled, 2-meter status is printed first.

Each status line printout includes the hour, the number of seconds of total transmission, the number of QSO periods, timeouts and IDs issued. For status purposes, a QSO is defined as a period of exchanges separated by no more than thirty seconds. The last printout column is the number of receptions too short to bring up the repeater.

reference


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6-meter amplifier

A companion unit to the 2-meter and 1 1/4-meter amplifiers

This six-meter amplifier is a companion unit to the 2-meter and 1-1/4-meter amplifiers previously described in *ham radio* articles. All three amplifiers are built using the same chassis configuration originally described by K2RIW for a stripline kilowatt for 432 MHz. The 50-MHz version uses a conventional pi-network output with inductive tuning, and a coil simulated half-wave line for its input section. Both the tetrode (fig. 1) and the triode (fig. 2) versions will be discussed. Like its predecessors, the 50-MHz amplifier uses parallel combinations of any of the 4CX250 type tetrodes, the 8930 tetrodes, or the 8874 triodes. Metering and power supply connections are identical to the 2-meter and 1-1/4-meter amplifiers. Using a standard design for VHF/UHF amplifiers, a single power supply can be switched from one amplifier to another. Remote operation with a separate metering unit at the operating position or built into the power supply is another adaptation, useful particularly at 432 MHz.

These four 12 x 6 x 8 inch (30.5 x 15.2 x 20.3 cm) power amplifiers for the four popular VHF/UHF

By Fred J. Merry, W2GN, 35 Highland Drive — P.O. Box 546, East Greenbush, New York 12061
Amateur bands have been successfully duplicated hundreds of times. They are rugged and offer a proven performance developed by thousands of hours of testing and use over the past eight years. They provide flexible and reliable high-power operation.

By initially drilling and punching a set of chassis boxes for all four models (432, 220, 144, and 50 MHz), an amplifier can be converted from one band to another. This might be achieved by using a quick-change mechanical procedure for the four separate frequency-sensitive circuit elements.

construction details

The essential dimensions for chassis drilling and punching are contained in the articles listed in reference 1. This article covers only construction details peculiar to the 50-MHz amplifier.

Referring to the schematic of the 50-MHz tetrode amplifier (fig. 1), notice that the two grids are connected by a copper strap between the sockets. The two anodes are paralleled by a brass or copper plate assembly which uses fingerstock for connection to the anodes, providing a mounting for the plate blocking capacitors and a connection point for the high-voltage RFC. The dc circuitry is similar to that found in the previously described amplifiers.

In the triode amplifier (fig. 2), the rf section is exactly the same as that shown in fig. 1 except that rf chokes are used in the filament leads and in the cathode bias lead. The cathode bias and metering circuitry is conventional for a grounded grid amplifier. Two meters are used with the grid current meter on a non-locking switch to read plate voltage.

control and safeguard options

The optional circuitry shown in fig. 2 provides examples of control and safeguard features which can be added to these amplifiers. The blower option provides 120 Vac on pins 2 and 4 of the cable connector. This permits powering the blower from a receptacle on the amplifier chassis, rather than running a lead...
back to the power supply. An air switch is mounted in the blower air stream and connected via the blower connector to two power switches (one locking and one non-locking) and to pin 7 of the amplifier connector. Pin 7 is the power relay operate lead in the power supply.

To turn the amplifier on, the locking-type power switch is switched to the on position and the non-locking (push-button type-momentary) switch is pressed to operate the power relay. The power relay energizes the power supply and provides 120 Vac on pins 2 and 4 to start the blower. With the blower up to speed, the air switch keeps the power relay actuated. Once the push button is released, the power supply relay is under the control of the air switch.
Should the blower fail or not come up to speed, the power supply will automatically shut down, an important safeguard considering the two hundred dollar price tag on 8874s.

If excitation is applied with no plate voltage on the tubes, damage to the grid structure may result. The high-voltage fail-safe option provides a safeguard by using a transistor and a relay to open the bias control circuit if high voltage is not present. A 12-volt power supply for this feature is provided by a voltage-doubling circuit from the filament line.

The remaining option, shown in fig. 2, is used to operate a DPDT coaxial relay which can be mounted (with a coaxial adapter) on the output connector of the amplifier. The coil of the relay and a set of auxiliary make-contacts are connected to the amplifier chassis via a four-contact connector. The 12-volt supply, auxiliary control relay circuitry, a power amplifier (PA) in/out switch, and a control jack complete this feature. Note that a ground on transmit to the amplifier control jack will apply operating bias to the amplifier only if the antenna relay is operated and the auxiliary relay (in this optional circuit) is released. In receive, 12 volts is applied through the winding of the antenna relay to the auxiliary relay winding. The auxiliary relay operates, but the antenna relay, which requires more current than the auxiliary relay, does not operate with the PA switched to the in position. A ground on transmit from the exciter causes the antenna relay to operate immediately and the auxiliary relay to release after a slight delay. This prevents the amplifier from being "hot switched" and provides additional protection for the rf amplifier in the receiver. A layer or two of cellophane tape on the pole piece of the antenna relay is usually required to guarantee release. More sophisticated antenna relay-control circuitry is desirable, however, for EME amplifier applications.

Construction and mounting arrangements for the various options are covered in the construction information.
of harmonic attenuation which no longer meets modern RFI design requirements. A suitable LP filter design for this 50-MHz amplifier is shown in the 1981 ARRL Handbook, pages 7-11 (fig. 3A). Harmonic trap circuit construction is shown in fig. 3B.

Information on the triode and tetrode amplifier power supplies has already been provided in the 220-MHz amplifier article.¹

construction — tetrode amplifier

If you do not intend to use the chassis for the 50-MHz amplifier on any of the other VHF/UHF bands, omit the following in its construction: five holes (11/64 inch or 4.4 mm) in the right side of the upper chassis used for mounting the 2-meter plate line, four holes (7/64 inch or 3 mm) and one hole (5/8 inch or 15.9 mm), on the rear of the upper chassis for mounting the rf output connector; two holes (7/64 inch or 3 mm), one hole (3/8-inch or 9.5 mm) for the plate load control in the top plate, and the hole in the front of the lower chassis for the plate tune control. The remaining holes not used for 50 MHz can be drilled and disregarded or filled with 6-32 (M3.5) hardware.

A lowpass filter or harmonic trap circuit is needed in the rf output to attenuate harmonics in the amplifier output. These amplifiers, even when operated in the linear mode, may have harmonic components no more than 40 dB down from the fundamental, a level

¹ Information for the triode amplifier. Which options are chosen, and whether they are mounted inside or outside the amplifier, is determined by the intended application and the builder's inclination. These options are also applicable to the 50-MHz tetrode amplifier version as well as to the other models of these amplifiers, already described.
Triode amplifier socket plate assembly — top view.

Fig. 4 shows the upper chassis drilling required for mounting the plate coil, variable load capacitor, rf choke, fixed load capacitor, and tune and load controls. Fig. 7 shows the drilling and punching for the rf output connector. This completes the chassis preparation.

Details of the inductive tuning ring are shown in fig. 5. Fig. 8 gives the dimensions for the plate line. Fig. 9 provides information on the plate rf choke.

The plate coil is wound with 1/4-inch (6.3-mm) copper tubing, four turns, 2 inches (50 mm) ID, 3-1/4 inches (8.3 cm) long. The ends of this coil are flattened, bent and drilled 11/64 inch (4.4 mm), to mount the coil on 1-1/2-inch (3.8-cm) Teflon pillars midway between the top and bottom of the upper chassis. When construction is completed, the spacing between the turns of the plate coil is adjusted to provide the required tuning range. The tuning range with the inductive ring is in excess of 1 MHz. An accurate grid dip meter is useful for preliminary adjustment of turns spacing for the desired frequency range. The final adjustment of coil size to the desired range is made during the final rf testing.

The assembly and wiring may be done in the same sequence used for the 144- and 220-MHz amplifier, by first assembling and wiring the lower chassis and then assembling the upper chassis and grid box. Mount the sockets and install the plate line parts. Finally, join the upper and lower chassis, make filament and grid bias connections, and install the grid box parts to complete the assembly.
construction — triode amplifier

Follow the directions for the tetrode amplifier construction for chassis drilling and punching, for the plate line and plate coil. The cathode tuned circuit for the triode amplifier is the same as that described for the grid circuit of the tetrode version. The holes in the grid box for the filament feed-through capacitors are relocated toward the bottom of the box to accommodate the toroid chokes (fig. 6). An additional meter hole is punched in the lower chassis front on the right side.

The tube sockets are mounted on a brass plate, as described for the 220-MHz triode amplifier. This assembly (fig. 10) lets you solder the grid collet (EIMAC part #882931) in position. Vent holes are provided around the base of the tube; it's a good idea to have this assembly silver plated. The assembly is bolted in place in the same position as the two 630A sockets used for the tetrode amplifier. A brass strip (fig. 11) may be used to connect the cathode pins of the two sockets together. This strap is soldered in place after the socket plate has been mounted. Its position is such that the cathode socket pins protrude through the holes about 1/8 inch (3 mm).

Alternatively, a small brass plate mounting a brass bushing (tapped 10-32) may be soldered to the cathode pins of each socket. This method of construction is more involved, but avoids soldering the grid strap in place after the socket plate is mounted. The grid strap is fastened by the 10-32 screws on each mounting plate.
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Metering and other circuitry is mounted in the lower chassis, as shown in the photos. The vitreous-type resistors are mounted to the chassis wall. Other resistors and parts are mounted on terminal boards secured to the chassis with mounting spacers.

The options shown on the triode amplifier schematic (fig. 2) are mounted as follows:

The antenna relay connector is located on the right side of the lower chassis (rear). The small relay associated with this option is located in any convenient spot in the lower chassis. The various resistors, capacitors, and other parts for the antenna relay control circuit, the 12-Vdc supply, and the high voltage fail-safe circuitry are on terminal strips which are located in the lower chassis.

The blower connector is located on the left (side) rear of the lower chassis.

The PA in/out switch, the power switch, and the non-locking switch to start the blower are located on the front of the lower chassis.

In assembling and wiring the triode amplifier, follow the same pattern described for the tetrode amplifier — lower chassis parts mounting and wiring first — upper chassis and cathode box, tube socket assembly, plate circuit parts, joining upper and lower chassis, cathode parts, and the final wiring steps.

**Automatic load control**

An ALC circuit (fig. 12) has been added as an option to the triode amplifier. The parts within the grid box are mounted close to the rf input connector. A bias winding is required on the high-voltage transformer, or a separate small transformer is required to provide the +56 volts threshold control voltage. The bias voltage parts can be mounted in the power supply chassis on a terminal board.

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<table>
<thead>
<tr>
<th>MODEL</th>
<th>Application</th>
<th>Bandwidth</th>
<th>Poles</th>
<th>Price</th>
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10.7 MHz CRYSTAL FILTERS

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LOW NOISE RECEIVE CONVERTERS

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LOW NOISE RECEIVING TRANSVERTERS

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LINEAR POWER AMPLIFIERS

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ANTENNAS

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<td>88 Element</td>
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STATE OF THE ART

by K.V.G.

SPECTRUM INTERNATIONAL, INC.
Post Office Box 1084 Concord, MA 01742, U.S.A.

April 1983

Mounting of double-pole coaxial relay on output connector.

Table 1. Typical operation tetrode amplifier.

<table>
<thead>
<tr>
<th>Power</th>
<th>Drive</th>
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<th>Screen</th>
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<td>2.5</td>
<td>0</td>
<td>0</td>
<td>-0.003</td>
<td>0.430</td>
<td>2000</td>
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<tr>
<td>5.0</td>
<td>0.002</td>
<td>0.027</td>
<td>0.600</td>
<td>2000</td>
<td>800</td>
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Table 2. Typical operation triode amplifier.

<table>
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<tr>
<th>Power</th>
<th>Drive</th>
<th>Grid</th>
<th>Plate</th>
<th>Voltage</th>
<th>Output</th>
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<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0.04</td>
<td>0.30</td>
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<td>285</td>
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<tr>
<td>2.5</td>
<td>0.002</td>
<td>0.210</td>
<td>2100</td>
<td>140</td>
<td></td>
</tr>
<tr>
<td>5.0</td>
<td>0.004</td>
<td>0.30</td>
<td>2060</td>
<td>285</td>
<td></td>
</tr>
<tr>
<td>10.0</td>
<td>0.025</td>
<td>0.380</td>
<td>2056</td>
<td>540</td>
<td></td>
</tr>
</tbody>
</table>

Operation

The 50-MHz amplifiers tune and load in a conventional manner. Make initial adjustments with low drive power. Final adjustment of the grid (or cathode) tuning is made for lowest SWR toward the drive source. Final adjustment of the plate tuning must be done at full power output in order that the load control may be set at its optimum position.

Tables 1 and 2 show typical operation of the tetrode and triode amplifiers.

References


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ICOM has always been the amateur communications equipment industry's leader in 2 meter solid state digital technology. ICOM continues its established leadership with the all new IC-251A 2 meter multi-mode base transceiver. ICOM's advanced engineering incorporated a multi-memory system, 2 programmable scanning systems, 2 internal VFOs, and built in repeater offsets.

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<th>$49.95</th>
<th>SAVE $10.00</th>
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<tr>
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</tr>
<tr>
<td>CIGAR ANTENNA</td>
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<tr>
<td>HIGH GAIN TRANSISTOR</td>
<td>$6.95</td>
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<tr>
<td>KD44 DISH ANTENNA</td>
<td>$47.95</td>
<td></td>
</tr>
</tbody>
</table>

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Typical Specs:

<table>
<thead>
<tr>
<th>MODEL</th>
<th>INPUT FREQ</th>
<th>OUTPUT FREQ</th>
<th>PRICE</th>
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<tr>
<td>RCK 6/10</td>
<td>50</td>
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<td>6/2</td>
<td>50</td>
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<tr>
<td>ATV P</td>
<td>63</td>
<td>60</td>
<td>$39.95</td>
</tr>
</tbody>
</table>

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April 1983
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- Low impedance, low distortion, adjustable sinewave output, 5v peak-to-peak.
- Instant start-up.
- Off position for no tone output.
- Reverse polarity protection built-in.

<table>
<thead>
<tr>
<th>Group A</th>
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<tr>
<td>67 0 XZ</td>
</tr>
<tr>
<td>71.9 XA</td>
</tr>
<tr>
<td>118.8 2B</td>
</tr>
<tr>
<td>156.7 5A</td>
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</tbody>
</table>

- Frequency accuracy, ± 1 Hz maximum - 40°C to + 85°C
- Frequencies to 250 Hz available on special order
- Continuous tone

<table>
<thead>
<tr>
<th>Group B</th>
</tr>
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<tbody>
<tr>
<td>TEST-TONES:</td>
</tr>
<tr>
<td>600</td>
</tr>
<tr>
<td>1000</td>
</tr>
<tr>
<td>1500</td>
</tr>
<tr>
<td>2175</td>
</tr>
<tr>
<td>2805</td>
</tr>
</tbody>
</table>

- Frequency accuracy, ± 1 Hz maximum - 40°C to + 85°C
- Tone length approximately 300 ms. May be lengthened, shortened or eliminated by changing value of resistor

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FSK tone generator
using an integrated tone dialer

Have you ever thought about redesigning or building an FSK (frequency shift keying) tone generator? If so, you are not alone. How many FSK

**fig. 1. Schematic for the FSK tone generator.**

Except as indicated, decimal values of capacitance are in microfarads (μF); others are in picofarads (pF); resistances are in ohms.  

$k = 1,000$  
$m = 1,000,000$
generators have you seen that use an integrated circuit? To my knowledge there aren’t very many.

Here is an easy way to build a circuit using a TouchTone™ chip which generates the frequencies needed for FSK. This circuit is connected between the teleprinter and transmitter. There are four main areas in constructing this circuit: the integrated tone dialer chip, switching circuit, filter, and amplifier. See fig. 1.

frequencies
Both frequencies are generated by a Mostek MK 5086N IC chip. Pin 9 is used for space at 1.633 kHz, and pin 5 as mark at 1.47 kHz. A 3.579545 MHz television color-burst crystal is the frequency-determining element for the chip. To simulate keyboard operation, tie pins 14 and 13 to pin 5 and pins 12 and 11 to pin 9. This makes the Mostek think it is being switched by a keyboard.

Transistors in a switching circuit determine if a space or a mark is sent.

filter and amplifier
An op amp provides a small amount of needed gain. A lowpass filter is used to reduce the harmonic content generated by the Mostek IC chip. This filter can be made by placing a capacitor across pins 2 and 6 of the op amp.

This circuit was constructed by Charles Aron, Ney Vew, and David Nagel at Northern Montana College in Havre, Montana. Special thanks are also given to Lee Barrett; without his time and advice this project would not have been possible.

David Nagel
Havre, Montana

capacitive-reactance meter multiplier
Recently I saw a large commercial type 0-150 Vac voltmeter in mint condition — just what I needed for my station control panel to monitor line voltage. However, the external series resistance was missing. Well, the owner sold it to me for $2.50, as he admitted it didn’t have too much value as it was. I discovered it would need an external 15-watt series resistance of about 1500 ohms. I decided to use a capacitor of the same reactance instead of using a resistance; reactances do not dissipate power and I would save energy.

The calculation for finding the required reactance is:

\[
C = \frac{1,000,000}{(6.28)(f)(Xc)}
\]

where \( f \) is the line frequency, in this case 60 Hz, \( Xc \) is the desired reactance in ohms equal to 1500 ohms, and \( C \) is the required capacity in \( \mu \)F:

\[
C = \frac{1,000,000}{(6.28)(60)(1500)} = 1.77 \mu \text{F}
\]

The theory and application worked fine. I used a good accurate ac voltmeter as my calibration standard. By paralleling a few small non-electrolytic fixed condensers from my junk box, it was easy to make my meter read the same. The real advantage of using condensers is that the power drain on the line is practically negligible. Naturally, the calibration is good only for the 60 Hz line voltage you are monitoring.

William Vissers, K4KI

fig. 2. The capacitor changes to the N6RY diplexer mods.

diplexer mods
You can diplex high frequency to go above 28 MHz (refer to N6RY's article on page 71 in the December, 1980, issue of Ham Radio). By building up the VHF part of the two boxes and changing a couple of the capacitors in the high frequency side of the boxes, you can operate 10 and 2 or 10 and 220, or 6 and 2 or 6 and 220 meters at the same time. You can also add 6 or 10 meters to your 2 or 220 repeater by adding a box and an antenna on top and a box and a repeater or remote base on the bottom. All additions use the same feed line. The capacitor changes are shown in fig. 2.

If you have a 6-meter rig and want to go mobile, but can’t find a spot to mount another antenna, try a 5/8 wave 2-meter antenna and check the SWR. If it is low on 6, just add the box between the 6 and 2-meter rigs and connect it to the same antenna.

Robert McWhorter, K5PFE
simple diode tester

I recently had to check the peak inverse voltage of some surplus diode units. Searching for a suitable device, I decided to use a high-resistance transformer acquired at a flea market sale. This particular unit had a high resistance secondary (over 600 ohms) which precluded its use for service in a power supply unit supplying more than minimal power. This was hooked up as shown (fig. 3), in a simple full-wave doubler circuit, and provides over 1,000 volts dc from a secondary rated 400 volts ac.

There are two methods for checking diodes for PIV. One method is to increase the test voltage until there is 10 μA of reverse current (for a 1-ampere diode) and then to rate the diode at a safe peak inverse voltage of 20 percent lower. The method I prefer is to calibrate for a PIV of that value attained when 5 μA of reverse current flows. Either way gives a satisfactory rating for diode breakdown voltage, see fig. 4.

Any multimeter with a basic sensitivity of at least 5,000 ohms per volt can provide the needed test current, since the basic limiting resistance is present in the meter's multiplier resistance. A convenient method of checking voltage at the same setting is to simply short out — with an insulated screwdriver — the terminals across the diode being tested. The high-resistance secondary precluded the need for any limiting resistors in the circuit, and the low-capacity filter capacitors cause the output voltage to drop sharply under load, tremendously reducing the hazard of testing with high voltage sources.

Neil Johnson, W2OLU

fig. 3. Simple tester for checking silicon diodes. To test diode, insert in circuit at x, and then raise input voltage from zero. Meter M is any sensitive voltmeter on 1,000 volt scale, having sensitivity of 5,000 ohms per volt or more. Alternate method is to utilize a 0-200 microammeter and 5 megohms of resistance.

fig. 4. Sample rating chart. Safety is enhanced by limiting current by high impedance supply.
improved logic probe

I was considering buying or building a logic probe to complement my dual channel scope when troubleshooting my homemade microcomputer. The August, 1980, issue of Ham Radio finally convinced me to build my own version.

The following specs were essential: indication of high-low-open conditions; capture-stretching short-positive or negative pulses; operation at TTL (5V) and at CMOS (5-15V) levels; high and low should be indicated at the specified levels for each logic family and every voltage, that is, 0.8 and 2.5V for TTL and 1/3 Vcc and 2/3 Vcc for CMOS.

I took two ideas from N6UE's article in the August issue on page 38: using the 555 timer and voltage regulation for the display LEDs. I met the requirements of the first, third, and last specs by using National Semiconductors' 339 quad, single supply comparator. I obtained the required reference levels from a voltage dividing network and a switch, which modifies the resistor values to suit TTL-CMOS levels. See fig. 5.

Comparators a and b serve as a window detector, both being high inside the forbidden voltage region, while going low at a high or low input. A low from comparators a and b is used to drive the high (red), and the low (green) LEDs. The negative transitions are differentiated and ORed by the remaining two comparators, and applied to the 555 for stretching. The timer drives the pulse (orange) LED. An LM309 TO-5 voltage regulator provides protection for the LEDs against voltage rise.

I wired the prototype on a piece of Veroboard. As I lack a PC board production capability at home, I decided to stay with the prototype.

Tests indicate that the probe operates as required up to about 250 kHz square wave input. The minimum captured pulse width is about 4 µs. These results are close enough to the specified delay through the comparators to indicate that speed-pulse width limitations could be reduced by using faster comparators.

references
2. Signetics NE555 data sheet.

J. Rozenthal

fig. 5. The improved logic probe.
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by Phil Anderson, W8X1

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More Details? CHECK — OFF Page 129

April 1983 93
spring DX

The powerful DX months (around the equinox) are here for us to try again. Over the years March and April have provided excellent 6-meter openings on transequatorial (TE) paths. Using 6-meter openings as a criterion for the higher-frequency-band DX, last year didn’t have as many openings as 1981, but the opening on March 4 was acclaimed the best in years in Westlink Report. The March 4 opening was a period of high solar flux and geomagnetic disturbance, which probably influenced the TE (one-long-hop) propagation. April was also roaring with TE openings from the southern U.S. to South Africa, South America, New Zealand, and Australia. The other openings in April were not so pronounced, as the solar flux was lower. However, four large disturbances (April 2, 11, 25, and 29) and two smaller disturbances (April 17 and 21) increased the ionization near the geomagnetic equator for high maximum-usable frequencies for TE.

This year’s 6-meter openings may be fewer in number since we are already near the half-way point on the down-side of cycle 21. The sunspot number should be about 75 (123 flux units). The second maximum 1981-82-83) period of geomagnetic-ionospheric disturbance in cycle 21 is expected to be the dominating factor for openings this year. These disturbed periods during April are expected around the 5th, 15th, and 23rd. The latter is the longer recurrent type (see February, 1982 DX Forecaster).

last minute forecast

The higher segment of the h-f bands (6-30 meters) will probably be best during the middle of the month. Watch for the high radio flux and disturbance numbers from WWV at 18 minutes after the hour. On the lower bands (30-160 meters)*, night DX will be best during the first and last weeks of the month, particularly in-between the springtime frontal thunderstorms when QRN should be low. Your favorite TV weather forecaster will show these fronts moving across your QTH.

The perigee of the moon’s orbit (for moon-bounce DX) is on the 21st at 2100 hours; the moon will be at full phase on the 27th at 0631 hours. There will be a short meteor shower, the Lyrid, on April 20-22. The rate is five per hour, hardly a real help for meteor-scatter DX. But a bigger shower, the Aquarid, starts before the end of the month, peaks on May 5, and ends by mid-May. Its rate is 10 to 30 per hour.

band-by-band forecast

Six meters may provide occasional band openings with a peak during the late afternoon hours. Transequatorial north/south paths will be the best. Your guide to good conditions are strong openings on 10 meters with high values of solar flux and A and K geomagnetic indices.

Ten and fifteen meters will be open to many areas of the world from morning until early evening hours most days. Times of geomagnetic disturbances will limit the number of signals heard, but listen carefully — they can be from very unusual places. Fifteen meters should stay open later in the day than 10 meters. Operate 10 first and move down to 15. More hours of daylight means earlier band openings and longer periods of operation.

Twenty meters will be the main daytime DX bands, as it is almost always open to some part of the world. It opens to the east as the sun rises and extends into the late evening hours to the west. Geomagnetic disturbances do not affect this band as much as the higher ones, but look for unusual transequatorial DX propagation once in a while. One-hop transequatorial DX of 5,000 to 7,000 miles (8,000 to 11,200 km) may be possible in the late evening hours during some of these unusual conditions.

Thirty meters is a day and night band. The day portion should be like 20 meters except the signal strengths may decrease during midday on some days. Days of decreasing strength should be those with high solar flux values. This band will also work well into the night, often through the night. Nights this doesn’t hold true will most likely follow a day with a very high solar flux value. The problem time is usually the hour or so before dawn. The workable distance may be expected to be greater than 80 DX at night and less than 20 during the day.

Forty and eighty meters will exhibit short skip conditions during daylight hours and lengthen after dark. The bands will open to the east just before your sunset, swing more to the south toward Latin America about midnight, and end up in Pacific areas during the hour or so before dawn. On some nights these bands will be as good as during the winter DX season. The coastal regions usually have the edge for working rare DX on these bands.

One-sixty meters will probably bring many nights that will remind you of last summer’s noise. However, many good nights are left for working DX before this summer’s noise comes to stay. Propagation on 160 meters will approximate a shortened 80-meter condition.

*Editor’s note: 30 meters because of its unique place in the h-f spectrum and characteristics is discussed in both sections (higher/lower segments) of the h-f band forecast.
* Look at next higher band for possible openings.
Speaker projects to help you choose and build the best type for your listening room. Comprehensive and a mix of both simple and advanced design. Speaker Builder, a new quarterly from the publishers of Audio Amateur, has all the design answers you novice-to-experts need to dramatically improve the quality of sound you're getting from your stereo system. The drivers are relatively cheap and the sources for them are all listed in Speaker Builder’s pages. As an experienced ham, you probably know your way around your audio system already. Here’s an easy way to make what you have sound a whole lot better at minimum cost. Speaker Builder can save up to two thirds of the cost of the speakers—which translates to almost one third of your outlay for your stereo system. Over 110,000 Americans will build their own enclosures this year—and you can too! Your dream speaker is probably well within reach if you build it yourself. There will be reports on building the many kit speakers and enclosures now available, and a roundup of suppliers for drivers, parts, and kits. Articles range from the ultimate (650 lbs. each) to tiny plastic pipe extension stock designs. There will be help around already and now, Speaker Builder brings it all together in an assortment of articles that are comprehensive and a mix of both simple and advanced projects to help you choose and build the best type for your listening room.

**SPEAKER QUALITY IS THE PRIMARY KEY TO YOUR STEREO SYSTEM’S SOUND**

And speakers are easy to make—and very difficult to design. Speaker Builder, a new quarterly from the publishers of Audio Amateur, has all the design answers you novice-to-experts need to dramatically improve the quality of sound you’re getting from your stereo system. The drivers are relatively cheap and the sources for them are all listed in Speaker Builder’s pages. As an experienced ham, you probably know your way around your audio system already. Here’s an easy way to make what you have sound a whole lot better at minimum cost. Speaker Builder can save up to two thirds of the cost of the speakers—which translates to almost one third of your outlay for your stereo system. Over 110,000 Americans will build their own enclosures this year—and you can too! Your dream speaker is probably well within reach if you build it yourself. There’s a lot of help around already and now, Speaker Builder brings it all together in an assortment of articles that are comprehensive and a mix of both simple and advanced projects to help you choose and build the best type for your listening room.

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RADIO SCHOOL, INC. 2414 College Drive, Costa Mesa, CA 92625. (714) 549-5000
NEW products

REVIEW: Daiwa CN520 SWR and power meter

About the only time we had a chance to use a dual needle SWR meter was when we used the TMC transmitter at W1AW. That was, until MCM (distributors for selected Daiwa products) sent us their CN520 SWR and power meter.

The Daiwa meter comes in four different models: the CN150 for 1.8-60 MHz 20/200 watts, the CN520 for 1.8-60 MHz 200/2 kW, the CN530 for 50-150 MHz 20/200 watts, and the CN540 for 140-250 MHz 20/200 watts. Each of these units measures just 2.83 x 2.83 x 3.62 inches (72 x 72 x 96 mm) and weighs less than a pound. RF connectors on each are SO-239 and accuracy is listed at ± 10 percent.

Installing the SWR bridge is a matter of connecting it in-line between your transmitter and load. Setting the meter to the correct power position ensures that you will get an accurate SWR reading. Two needles are used to measure SWR: the left needle measures forward power, the right needle measures reflected power. The point at which the two needles cross is the SWR reading. SWR is clearly visible on the meter.

PhotoCaster includes a circuit board to interface an Apple to a TV camera and a receiver/transmitter, plus a two-disk software package.

PhotoCaster can also add titles and graphics, create video special effects, enhance images, retrieve and store pictures on disk, and print high resolution pictures with an MX-80 printer.

Black and white pictures are processed with a resolution of 128 by 128 pixels and sixteen levels of gray. In the color mode, eight colors are available with sixteen saturation levels. Color pictures are taken with an unmodified black and white TV camera using a three-frame RGB sequence. Standard RGB transmission formats are available in addition to a unique Apple-to-Apple single-frame color mode which takes eight instead of the usual twenty-four (or more) seconds to transmit a color picture.

PhotoCaster requires an Apple II or Apple II Plus computer with 48K RAM and one disk drive. The price of the PhotoCaster is $499.95 for the basic system, including an assembled and tested circuit board and software. A complete system, consisting of a Panasonic WV/1400 camera, board and software, is available for $749.95.

For more information, contact Commsoft, Inc., 665 Maybell Avenue, Palo Alto, California 94306. Reader Service Number 302.

radio teletype and CW

With the Super-Ratt radio teletype and CW program for the Apple II, you can have your own Radio Bulletin Board System (RBBS) station on-line quickly and easily.

The program will operate in ASCII as well as Baudot at any speed from 40 to 300 baud. CW speeds range from 5 to 100 WPM, with an automatic speed adjust on receive.

The program may be run in either manual or RBBS modes. Extensive use of disk files permits storage of canned material for manual operation. In the RBBS mode, the system automatically saves nearly one hundred user messages to the disk. There are thirty-five different, simple English word commands on the RBBS.

Almost any modern terminal unit or convertor can be used with Super-Ratt, as well as devices such as the RADCOM card by AF6W. The program is not protected against copying. The BASIC portion may be listed and modified to suit your tastes. (The registered owner’s call is installed in the machine code by the factory.)

A free one-year subscription to the user newsletter, The Ratt’s Nest, is included in the purchase price of $54.95. For more information, contact Universal Software Systems, Inc., 9 Shields Lane, Ridgefield, Connecticut 06877. Reader Service Number 303.

helical resonator amplifiers

Hamtronics, Inc., has developed a new line of low-noise receiver preamps with helical resonator filters built in. The HRA-144, HRA-220, and HRA-432 units cover the three major VHF and UHF ham bands. The combination of a low-noise amplifier and the sharp selectivity of a three or four section helical resonator increases receiver sensitivity and reduces cross-band interference. The unit has a low 0.6 to 0.95 dB noise figure and 50 to 60 dB rejection of any signals out of the ham band.

The amplifier circuit uses some of the new microwave transistors developed for satellite TV service. Nominal gain is 26 dB on 2 meters, 22 dB on 220 MHz, and 16 dB on 420-450 MHz. A three-section helical resonator is used in the output circuit of the VHF units, a four-section resonator is used in the UHF unit. The VHF unit is only 1 ½ x 3 inches, and the UHF unit is only 2 ½ x 3 inches.

The HRA-144 or HRA-220 costs $49.95, and the HRA-432 is $54.95. For further information contact Hamtronics, Inc., 65 Moul Road, Hilton, New York 14468-9535. Reader Service Number 304.

Ameco multimeters

Ameco Equipment Company announces preliminary specifications of its new line of Ameco multimeters. Multimeter Model M-300 (available immediately) features highly sensitive 20K ohms/Vdc and 10K ohms/Vac; gold-
plated switching contacts; overload protection by diodes and fuse; and carrying handle that can be used as adjustable stand.

Ranges for dc voltage: 0-0.25, 1, 2.5, 10, 25, 100, 250, 1000 V; ac voltage: 0-10, 25, 100, 250, 1000 V; dc current: 0-50, 500 μA, 5, 50, 500 mA; resistance: 0-6K ohms, 60K ohms, 600K ohms, 6M ohms. Volume level: ±22 dB to ±22 dB in five ranges. Size and weight: 5.5 inches high x 4.3 inches wide x 1.6 inches deep.

Model M-300 is a high quality, highly sensitive, laboratory-type instrument. Its large, easy-to-read scale and excellent damping are usually found only in expensive meters. Parallax errors are eliminated by a mirror arc. This meter comes complete with battery, spare fuse, test leads, and instruction manual. Model M-300, completely wired and tested, $528.95.

Ameco LCD digital multimeter, Model D-200, features high-contrast, large 1/2 inch, 3-1/2 digit LCD display; automatic polarity; automatic zero adjustment; over-range indication on all ranges; low-battery indication; full overload protection; 10-megohm input impedance; rugged anti-slip case with stand.

Ranges for dc voltage: 0-200 mV, 2V, 20V, 200V, and 1,000V; ac voltage: 0-200V, and 750V; dc current: 0-200 μA, 2 mA, 20 mA, 200 mA, and 10 A; resistance: 0-200 ohms, 2K ohms, 20K ohms, 200K ohms, 2000K ohms, and 20M ohms. Size and weight: 7 inches high x 2.7 inches wide x 1.6 inches deep.

The latest IC and display technology insure reliability, accuracy, and stability. Dual slope integration provides fast, accurate, noise-free measurements. The same two jacks are used for all functions and ranges (except 10A dc). Model D-200 comes complete with battery, spare fuse, test probes, instruction manual, and an optional carrying case. Model D-200, completely wired and tested, $69.95; optional carrying case, $3.75.

For further information, contact Ameco Equipment Company, 275 Hillside Avenue, Williston Park, Long Island, New York 11596. Reader Service Number 305.

RT-1100 receive terminal

DGM Electronics has just introduced the RT-1100 Receive Terminal for Baudot, ASCII, and Morse. The RT-1100 converts the audio from your receiver, decodes it, and displays the words on a video monitor or TV set (using rf modulator). The RT-1100 incorporates an active filter demodulator with scope tuning outputs. It will copy 170, 425, 850 Hz shift RTTY signals at speeds of 60, 66, 75, and 100 WPM on Baudot and 110 baud on ASCII. The unit will copy 6-60 wpm Morse signals using automatic or manual speed tracking.

The RT-1100 has a parallel ASCII printer output for hard copy. The video output provides sixteen lines of thirty-two characters per line with two pages. The second page is stored in memory and can be recalled by using the page 1-2 switch on the front panel. The unit has a built-in 110 Vac power supply and is housed in an attractive 3 x 10 x 10-inch case with brushed, anodized front and rear panels. The cover is a grey wrinkle finish. The unit comes with a one-year warranty on parts and labor.

For more information, contact DGM Electronics, Inc., 787 Briar Lane, Beloit, Wisconsin 53511. Reader Service Number 306.

encoder with ultra thin keyboard

Midian Electronics, Inc., has introduced the TTE-1 TouchTone™ encoder with ultra-thin keyboard. The unit features the thinnest available keyboard/DTMF encoder assembly with automatic PTT and side tone. The keyboard mounts virtually flush on a flat surface. DTMF encoder on the back of the keyboard fits into a 1 x 1-1/2 inch hole for flush mounting. It produces digitally synthesized tones for accuracy and stability with adjustable audio output level and generates twelve standard Bell System TouchTones. Options include keyboard only, without encoder, and LED indicating when automatic PTT is activated.

For more information, contact Midian Electronics, Inc., 5907 East Pima Street, Tucson, Arizona 85712. Reader Service Number 307.

interchangeable antennas

Antenna Incorporated has recently introduced a complete line of interchangeable antennas for use on hand held transceivers and scanners. The Portasuader antennas let the user replace only the radiator section of the antenna while continually reusing the mounting-adaptor fitting for the transceiver. The radiator are all internal threaded (No. 10-32) to accept the male thread of the interchangeable mounting adapter. The outer portion of the

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socket is etched with the frequency range for that particular radiator. Ten mounts are available to be used with the five different radiator styles.

The short 8-inch whips for 25-54 MHz incorporate a wire-wound base-loading coil and helical-style radiator in six different frequency steps. Tuning has been eliminated and fragile temperature-sensitive ferrite cores have also been eliminated. A distinct feature is the antenna length which is less than 8-inches long, measured from mount to tip. In the 115-174 MHz frequencies, Portasuaders are available in standard tuned helical units, extra-fat helical units and 1/4-wavelength stainless steel whips incorporating a spring section. The advantage of the fat Portasuader is its shorter length (about 2 inches shorter than helical). A secondary benefit in using the fat antenna is its lower Q, broadening the resonance curve and thus achieving a better match over the frequency range.

Also available is a 1/4-wavelength 0.046 inch diameter 17-7PH stainless steel whip incorporating a novel spring construction above the base fitting. This spring allows the whip assembly to bend when the user sits down with his radio attached to his belt. The 1/4-wavelength Portasuader was designed to replace the telescopic antennas, which bend or break or simply do not telescope properly. As a further advantage, the 1/4-wavelength Portasuader exhibits a practical 10 dB gain over the helical or fat helical antennas.

The frequency range is covered in seven frequency steps, thus again removing the need for field tuning. UHF stubby helical whips and 1/4-wavelength speedometer cable antennas are available as radiators in five frequency ranges between 406-512 MHz. An 800 MHz 1/4-wavelength speedometer cable antenna is currently available.

These Portasuaders are constructed from heavy copper-plated springsteel that is screwed onto the base fitting and then soldered to ensure electrical contact. Both helical and speedometer styles are insulated by coating in a multi-stage process. The special process guarantees a solid section of material with minimum voids and high finish gloss. The coating is designed to remain flexible, retain its resilience at ~40 degrees F and not to soften at 200 degrees F.

For further information, contact Randy Friedberg, Vice President, Antenna Incorporated, 26301 Richmond Road, Cleveland, Ohio 44146. Reader Service Number 308.
**high resolution SSTV converter**

High resolution slow scan television (SSTV) is available with the Videoscan 1000 by Microcraft Corporation. The unit is completely compatible with Amateur-standard SSTV and first-generation equipment. Videoscan can convey high-resolution eight-second, 128-line SSTV pictures to first generation scan converters using current standards. In two separate high resolution modes, the TV picture uses the full 256 TV lines and 256 picture elements (pixels) per line, resulting in pictures that rival commercial TV quality. The pixels are quantized to 64 levels of gray, four times better than first generation units. No contouring (false edges) is introduced to detract from the picture.

Some features of Videoscan are: Split-mode, a special mode that enables viewing four regular 8.5-second SSTV pictures at one time on the TV monitor as they are received; Stop motion, a single frame of video may be grabbed into memory from a TV camera manually or automatically, thus stopping motion; Cursor, a cursor dot appears on the screen to indicate the current line being transmitted; Gray scale, Call Sign, mode selector activates a gray scale and optional call sign which are superimposed on the picture in memory; Station switching, all necessary switching between transmitter, microphone, and tape recorder is included in Videoscan.

Microcraft is presently working on a computer input/output port and a color conversion of the Videoscan 1000.

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- ATC, DTH, KOS, autostart, and antispace features.
- Operate 120/220 VAC, 50/60 Hz; table or rack mount.
- Solid state design with proven field-tested dependability.

Write or call for more information on the HAL ST6000.

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**Doppler Systems**

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The VideoScan 1000 is available as a complete kit for $595.00 or wired and tested for $795.00 plus $6.00 for shipping.

For more information, contact Microcraft Corporation, P.O. Box 513, Thiensville, Wisconsin 53092. Reader Service Number 309.

improved 225-400 MHz scanner converter

The CVR-1B Scanverter includes a built-in preamplifier for increased sensitivity. It allows complete coverage of the 225-400 MHz military/federal government aircraft band when used with a standard aircraft band scanner. "Bandstacking" allows the entire 175-MHz-wide UHF aircraft band to be compressed into the 118-136 MHz range tunable on any scanner capable of standard aircraft reception. No tuning or adjustments are necessary with the fully automatic converter.

Reception for hundreds of miles is possible when an outside antenna is used. Additional features include high sensitivity, low noise microstripline circuitry; all-metal cabinet for superior shielding; double-balanced mixer to reduce images; nine-pole filter to suppress out-of-band interference; crystal oscillator to provide high stability; and Zener diode voltage regulation to limit drift. The scanner is powered by convenient 12 Vdc.

The Scanverter, CVR-1B, costs $89.00 plus $2.00 for shipping. Contact Grove Enterprises, 140 Dog Branch Road, Brastown, North Carolina 28802. Reader Service Number 310.
Amateur data display, DTU-12

Get a clean, crisp computer quality display for your next ham project with a DTU-12 from Dotronix, Inc., available in kit, chassis, or chassis/ac power versions, either P4 (white) or P31 (green) phosphor. It requires only 12 volts at 1.5 amperes, and standard TTL horizontal and vertical control signals with 2.5 volts video drive. The scan rate is 15,750 Hz. Interface is made through ten-pin edge card connector.

The kit costs $85.00 (CRT/circuit only); chassis $95.00; ac supply $35.00 (for chassis version).

For additional information, contact Dotronix, Inc., 160 First Street S.E., New Brighton, Minnesota 55112. Reader Service Number 312.

programmable CTCSS encoder

A miniature encoder has been introduced by Ferritronics, Inc., featuring quartz-accurate stability and all thirty-seven EIA tones. Two variations are available: the FT303A, which is programmed by cutting wire loops; and the FT303B, which uses a dipswitch for programming. The encoder measures 0.9 x 1 x 0.4 inch and draws less than 7 mA. Mounting holes and color-coded lead set make installation simple.

For further information, contact Tom Whitney at Ferritronics, Inc., 222 Newkirk Road, Richmond Hill, Ontario L4C 3G7, Canada. Reader Service Number 313.

two-meter mobile transceiver

The TR-7950 and TR-7930 are identical in features except for rf output: 45 watts for the TR-7950, and 25 watts for the TR-7930. Their

the Z-Dubber

The Sinclair ZX81/Timex 1000 is a popular personal computer. One drawback is the difficulty experienced in loading cassette programs. Bytesize Computer Products has introduced the Z-Dubber, an interface between the Sinclair computer and its cassette recorder, which helps even the most difficult cassette program to load easily. Additionally, the Z-Dubber allows you to connect two cassette recorders together to create perfect back-up copies of your Sinclair programs. The Z-Dubber operates on two AAA cells, and is packaged in an attractive black case. It is available for $29.95 plus 3 percent for shipping.

For more information, contact Bytesize Computer Products, P.O. Box 21123, Seattle, Washington 98111. Reader Service Number 311.

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Installation and dismantling of towers is dangerous and temporary guys of sufficient strength and size should be used at all times when individuals are climbing towers during all types of installations or dismantlings. Temporary guys should be used on the first 10' tower during erection or dismantling. Dismantling can even be more dangerous since the condition of the tower, guys, anchors, and/or roof in many cases is unknown.

The dismantling of some towers should be done with the use of a crane in order to minimize the possibility of member, guy wire, anchor, or base failures. Used towers in many cases are not as expensive as you may think if you are injured or killed.

Get professional, experienced help and read your Rohn catalog or other tower manufacturers’ catalogs before erecting or dismantling any tower. A consultation with your local, professional tower erector would be very inexpensive insurance.

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</table>

- Gain (ref: 1/4 wave helical) ....... 6dB min.
- Bandwidth VHF (1.5:1 VSWR) ......... 3.5MHz min.
- Bandwidth UHF (1.5:1 VSWR) ......... 10MHz min.
- Maximum power .................. 5 watts
- Connector type .................. BNC

**LENGTH W/BNC CONNECTOR**

<table>
<thead>
<tr>
<th>Band</th>
<th>Extended</th>
<th>Collapsed</th>
</tr>
</thead>
<tbody>
<tr>
<td>34M</td>
<td>44&quot; (1124mm)</td>
<td>8&quot; (207mm)</td>
</tr>
<tr>
<td>14M</td>
<td>32&quot; (815mm)</td>
<td>7&quot; (197mm)</td>
</tr>
<tr>
<td>34M</td>
<td>17.3&quot; (435mm)</td>
<td>6.5&quot; (160mm)</td>
</tr>
</tbody>
</table>

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GEORGIA: Kennebec Episcopal Hamfest, Sunday, April 17, 10 AM to 4 PM, Civic Center, Marietta, GA.

ILLINOIS: The 17th annual Rock River ARC Hamfest, Sunday, April 10, Lee County 4-H Center, one mile east of jct. 52 and 30, south of Dixon. Doors open 6:30 for dealers. 90 general public, tables available $5.00. Advance ticket donation $2, at gate $2.50. Food. Camping available at nominal charge. Talk in on 37797 repeater. For information and advance tickets: Ed TD9CJB, 618 Orchard St., Dixon, IL 61021. (815) 284-3811.

LOUISIANA: The Baton Rouge Amateur Radio Club's annual Hamfest, Saturday, May 7 and Sunday, May 8, Catholic High School, 105 Heathstone Drive, Baton Rouge. Swap tables, dealers, tech forums and activities for non-hams and children. Talk in on 1879 and 52 simplex. For further information: BRARC, PO Box 4004, Baton Rouge, LA 70821.

MASSACHUSETTS: The Framingham Amateur Radio Association's 8th annual Spring Flea Market, Sunday, April 10, the largest indoor Ham Flea Market in New England. Framingham Civic League Building, 214 Concord St. (Route 126) in downtown Framingham. Doors open at 10 AM, sellers setup starting at 8:30. Admission $2, Tables $10 (pre-registration required). Talk in on 29551 and 52 direct. Radio equipment, computer gear, bargains galore. For information, tables: Ron Egalka, K1YHM, 3 Discroll Drive, Framingham, MA 01701.

MASSACHUSETTS: The Wellesley Amateur Radio Society's annual auction, Saturday, April 16. First Congregational Church of Wellesley Hills, 207 Washington Street, Wellesley Hills, intersection of Routes 9 and 16. Doors open 9 AM; auction starts at 10 AM (15% commission; $1.00 minimum, $30.00 maximum). Talk in on 0464, 0503, and 52. Contact: Kevin P. Kelly, W1AYV, 7 Lawnwood Place, Charlestown, MA 02129.

MICHIGAN: S.E.M.A.R.A., The Southeastern Michigan Amateur Radio Association's 25th annual Hamfest Swap and Shop, April 10, 8 AM to 3 PM, Grosse Point North High School, Venner Road between Mack and Lakeshore. Admission $1.00 advance, $2.00 at door. Good food, free parking. Talk in on 147.75 simplex. For information: SEMARA Swap, PO Box 546, Clair Shores, MI 48603 or phone Ray Ninnis, W8DNX (313) 777-0119.

MINNESOTA: The Arrowhead Radio Amateur Club's annual swapfest, Saturday, May 7, 19 AM to 3 PM, Holiday Inn, 207 West Superior St., downtown Duluth. Admission $2.50 advance, $3.00 at door. Reserved 4 ft. tables $3.50 advance, $4.00 at door. Food, free parking, enclosed shopping mall. Talk in on 3494. For information, reservations SASE to Jerry Frederick, KB9RCPF, 1112-1104th Avenue West, Duluth, MN 55808.

NEBRASKA: The 1983 Midwest ARRL Convention, April 15, 16 and 17, Marina Inn, South Sioux City. Seminars, displays, exhibits and large flea market all indoors. Fine entertainment during Saturday night banquet. QVQA breakfast, 3900 Club luncheon and an outstanding ladies' program Saturday convention. Saturday convention costs $6.00 for 3 days. Saturday night banquet $12.00 advance, $15.00 at door. To reserve flea market table contact Al Smith, W9PXE, 3529 Douglas St., Sioux City, IA 51104. Exhibitors contact Jim Bose, K0XZVY, 22 LaSalle St., Sioux City, IA 51104. For general information contact Dick Porter, W6FBQ, General Chairman, 2931 Pierce St., Sioux City, IA 51104. For advance banquet tables, banquet floors and rental reservations contact Jerry Smith, WD9VU, Akron, IA 51001.

NEW ENGLAND: The Hoosiers will hold their tenth annual Tailgate Swapfest, Saturday, May 7, sunrise to sunset, at Deerfield, NH, Fairgrounds. Admission $1.00, including tailgaters and commercial. Friday night camping for self-contained rigs at nominal fee. None admitted before 4 PM Friday. Profits benefit Boston Burns Unit of Shriners' Hospital. Last year's donation $2622.75. Questions or maps to northeast's biggest ham flea market? SASE to NARRC, W7AEW, 504 53rd St., West Bellevue, NE 68005 or Joe, K1ROG, 2101 SW 105th, Kansas City, MO 64114. For further information, call 816/941-2244.

NEW JERSEY: The 8th Trenton Computer Festival, Saturday and Sunday, April 16 and 17, 10 AM to 5 PM, Trenton State College, Trenton. Exhibits, electronics flea market, technical sessions, free short courses on Sunday. Admission $5. (3 students). For further information, TCFS, 83-85 Trenton State College, Hillswood Lakes CN550, Trenton, NJ 08625. (609) 721-2487.

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AMATEUR TELEVISION MAGAZINE

Sample Issue Issue 181

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More Details? CHECK — OFF Page 129

April 1983

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NEW JERSEY: Annual Flemington Hamfest, Saturday, April 9 from 8 AM to 4 PM at the Hunterdon Central High School Field House, 20,000 square feet of heated indoor and outdoor facilities. Talk in on C99ABT, 146.167.6. For information and reservations write M.A.H.A., PO Box 3401, Madison, WI 53704.

WISCONSIN: The 3F ARC Swapfest, May 7, 8 AM to 3 PM, Neenah Labor Temple. 4 fl. tabs $1.50 advance, $2.00 door. Talk in on 146.115.21 and 146.52. For advanced registration: Mark Michel, W99P, 339 Nymay St., Menasha, WI 54952.

WISCONSIN: The Ozaukee Radio Club’s 5th annual Swapmeet, Saturday, April 10, 8 AM to 3 PM, Civic Recreation Center, Highway 60, Cedarburg, 20 miles north of Milwaukee. Admission $2.00 advance, $3.00 door. 8 fl. tabs $1.00 each. Tickets will be admit- ted at 7 AM for swaps. For tickets, tabs, maps or information SASE to Ozaukee Radio Club Swapfest, PO Box 13, Port Washington, WI 53074.

OPERATING EVENTS
“Things to do...”

APRIL 6, 7 AND 13, 14: DX YL to Northern American YL Con- test: CW, Wednesday, April 6, 1800 UTC to Thursday, April 7, 1800 UTC: Phone, Wednesday, April 13, 1800 UTC to Thursday, April 14, 1800 UTC. Sponsored by the licensed women operators throughout the world are invited to participate. DX YL call “CO Northern American YL”, N.A. YL call “CO Northern American DX YL”, and other states call “DX YL”. Inter- nally, even “DX YL” should be worked only for a score. For tickets and information, send SASE to: A. B. Davies, W9AD, 2105 S. State St., Madison, WI 53704.

APRIL 8, 9, 10: Cascade Amateur Radio Club’s 2nd annual Antique Weekend Hamfest, Friday, Saturday, and Sunday, 8 AM to 5 PM, Cascade High School, Dayton, WA. There will be demonstrations, displays, ARRL booth, refreshments and more. For tickets, maps or information SASE to: Cascade Amateur Radio Club, PO Box 271, Modesto, CA 95356.
incelcountry and QRP ARCI membership number. Non-

members give RS(T), state/province/country and power 

output. QSO points (total all bands) times total number 
of states/provinces/countries (may be worked on more 
than one band) times power multiplier times bonus mul-
tiplier (if any) equals claimed score. Send large SASE or 

IRCs to contest chair for scoring summary sheet in 

advance of contest. Send full log data plus separate 

worksheet showing details and time off air. No logs re-
turned. For results and score send large SASE with one 

ounce of U.S. postage or IRCs. Logs must be received by 

May 21, 1983. QRP ARCI Contest Chair, William 

Dickerson, WAS1OC, 230 Mill St., Danville, PA 17012.

APRIL 23 AND 24: The Missouri Valley Amateur Radio 

Club’s fourth annual Pony Express Day, 1000 CST to 

1900 CST (Saturday) and 0900 CST to 1200 CST (Sunday). 

This event commemorates the original running of the 
Pony Express from St. Joseph, Missouri to Sacramento, 

Calif. Operating frequencies: 10 kHz from bottom of 

the general phone bands on 15, 20, 40 and 75 meters. 

On 40 meters — 28.575 CW; 10 meters — 28.150; 15 meters 

— 21.150; 40 meters — 7.125. Anyone contacting Club sta-

tion WBVH is eligible for a special Pony Express certifi-
cate. Just send two-class postage stamps and a 

QSL card to: Missouri Valley Amateur Radio Club, 401 N. 

12th Street, St. Joseph, MO 64501.

APRIL 29-MAY 1: The first International VHFI/UDH Con-
ferece to be held as part of the Dayton Hamvention. 

Activities span all three days and include tech talks and 

forums; noise figure and antenna gain measuring con-
tests; a hospitality suite get-together with refreshments; 

all this along with the rest of the Hamvention features. 

For further information and to advise of participation in 

contests contact Jim Stilt, WABON, 311 N. Marshall 

Road, Middletown, OH 45402. (513) 475-4444 business or 

(513) 863-0820 home.

MAY 7: Harry’s Haydays. The Southside Amateur Radio 

Club will operate K2KHX to commemorate President 

Harry Truman’s 99th birthday. The station will operate 
at or near the old Truman farm home in Grandview, MO 

from 15002 to 24002 on 21.355; 14.139 and 7.230. Com-

memorative QSL’s will be sent via the bureau unless 

otherwise requested. For information: Southside ARC, 

PO Box 412, Grandview, MO 64030.

WORKSHOP: Personal Computer Interfacing and Scien-
tific Instrument Automation: $395.00. Charlotte, NC; 

June 24; Reston, VA; June 16-18; Charleston, SC, July 

14-16; Williamsburg, VA; Aug. 11-13; and Greensboro, 

NC, Sept. 8-10. These hands-on workshops work with each 

participant writing and testing interfaces. For more infor-

mation, call or write Dr. Linda Leffel, C.E.G., Virginia 

Tech, Blacksburg, VA 24061; (703) 961-4646.

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MONSTER JR. 500 $34.95 each. 

MONSTER JR. C-1000 $27.95 each. 

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**SPECIFICATIONS**

- **Print speed** up to 60ch.s.
- **Char. spacing** 2.54mm/1/10" 80ch/line
- **Char. Code** 1.55mm/0.06" 132ch/line
- **Char. Set** ECMA-6 7-bit coded char. set
- **Feed mechanism** 63 Char. various national versions
- **Sprocket feed.**

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**HEWLETT PACKARD MICROWAVE DIODES**

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| Projected Peak Pt. Voltage mv. Vpp Vf=Ip | 480min. 550Typ. 630max. |
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| Projected Peak Pt. Voltage mv. Vpp Vf=Ip | 480min. 550Typ. 630max. |
| Series Res. Ohms | Rs | 2.5Typ. 4max. |
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| Peak Pt. Current ma. | Ip | 9min. 10Typ. 11max. |
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**RF TRANSISTORS, MICROWAVE DIODES**

Toll Free Number 800-528-0180 (For orders only)

"All parts may be new or surplus, and parts may be substituted with comparable parts if we are out of stock of an item."

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MHZ electronics

Tell 'em you saw it in HAM RADIO!
### GaAs, TUNNEL DIODES, ETC.

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COAXIAL RELAY SWITCHES SPDT

Electronic Specialty Co./Raven Electronics FSN 5985-556-9683 $49.00
Part # 2SN28 Part # SU-01
26Vdc Type N Connector, DC to 1 GHz.

Amphenol
Part # 316-10102-8
115Vac Type BNC DC to 3 GHz.
$29.99

FXR
Part # 300-11182
120Vac Type BNC DC to 4 GHz.
FSN 5985-543-1225

FXR
Part # 300-11173
120Vac Type BNC Same
FSN 5985-543-1850

BNC To Banana Plug Coax Cable RG-58 36 inch or BNC to N Coax Cable RG-58 36 inch.
$7.99 or 2 For $13.99 or 10 For $50.00 $8.99 or 2 For $15.99 or 10 For $60.00

SOLID STATE RELAYS

P&B Model ECT1D872 5vdc turn on 120vac contact at 7amps or 20amps on a
PRICE EACH $5.00 10"x 10"x .124 aluminum. Heatsink with
Digisig, Inc. Model ECS-215 5vdc turn on 240vac contact 14amps or 40amps on a
PRICE EACH $7.50 10"x 10"x .124 aluminum. Heatsink with
Grigsby/Barton Model G87400 5vdc turn on 240vac contact at 15amps or 40amps on a
PRICE EACH $7.50 10"x 10"x .124 aluminum. Heatsink with

NOTE: *** Items may be substituted with other brands or equivalent model numbers. ***

MHz electronics 

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April 1983

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RECALL PHONE MEMORY TELEPHONE WITH 24 NUMBER AUTO DIALER

The Recall Phone Telephone employs the latest state of art communications technology. It is a combination telephone and automatic dialer that uses premium-quality, solid-state circuitry to assure high-reliability performance in personal or business applications. $49.99

ARON ALPHA RAPID BONDING GLUE

Super Glue 4CF-486 high strength rapid bonding adhesive. Alpha Cyanoacrylate. Set-Time 20 to 40 sec., 0.7 fl. oz. (20 gm.) $2.00

TOUCH TONE PAD

This pad contains all the electronics to produce standard touch-tone tones. New with data. $9.99 or 10/$89.99

MITSUMI UHF/VHF VARACTOR TUNER MODEL UVE1A

Perfect for those unscrambler projects. New with data. $19.99 or 10/$149.99

INTEGRATED CIRCUIT

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FERRANTI ELECTRONICS AM RADIO RECEIVER MODEL ZN414 INTEGRATED CIRCUIT.

Features:
- 1.2 to 1.6 volt operating range, less than 0.5mA current consumption.
- 150kHz to 3MHz Frequency range.
- Easy to assemble, no alignment necessary. Effective and variable AGC action.
- Will drive an earphone direct. Excellent audio quality, typical power gain of 72dB.
- TO-18 package. With data. $2.99 or 10 for $24.99

NI CAD RECHARGEABLE BATTERIES

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<td>12vdc at 5Amp/Hr.</td>
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We will be closed April 27th through May 2nd...

See you at the Dayton Hamvention!

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April 1983
“SOCKETS AND CHIMNEYS”

FINMAC TUBE SOCKETS AND CHIMNEYS

SK110  Socket
SK300A Socket For 4CX5000A, R, J, 4CX10,000D, 4CX15,000A, J
SK400  Socket For 4-125A, 250A, 400A, 400C, 4PR125A, 400A, 4-500A, 5-500A
SK406  Chimney For 4-250A, 400A, 400C, 4PR400A
SK416  Chimney For 3-400Z
SK500  Socket For 4-1000A/4PR1000A/J
SK500A Socket For 4CX5015B, BC, FG, R, 4CX350A, F, FJ
SK602  Socket For 4CX250B, BC, FG, R, 4CX350A, F, FJ
SK605  Chimney For 4CX250B, BC, FG, R, 4CX350A, F, FJ
SK607  Socket For 4CX6001, JA
SK610  Socket For 4CX6011, JA
SK620  Socket For 4CX6001, JA
SK626  Chimney For 4CX6001, JA
SK630  Socket For 4CX6001, JA
SK636B Chimney For 4CX6001, JA
SK640  Socket For 4CX6001, JA
SK646  Chimney For 4CX6001, JA
SK700  Socket For 4CX300A, Y, 4CX125C, F
SK711A Socket For 4CX300A, Y, 4CX125C, F
SK740  Socket For 4CX300A, Y, 4CX125C, F
SK770  Socket For 4CX300A, Y, 4CX125C, F
SK800A Socket For 4CX1000A, GCX1500B
SK806  Chimney For 4CX1000A, GCX1500B
SK810  Socket For 4CX1000A, GCX1500B
SK900  Socket For 4CX500A
SK906  Chimney For 4CX500A
SK1420 Socket For 5CX3000A
SK1490 Socket For 4CV8000A

JOHNSON TUBE SOCKETS AND CHIMNEYS

124-027/001 Socket For 4CX502, 4-125A, 250A, 400A, 4-500A, 5-500A
124-0113/00 Capacitor Ring (pair) $10.00
124-115/2/7/5620A Socket For 4CX250B, BC, FG, R, 4CX350A, F, FJ
813 Tube Socket

CHIP CAPACITORS

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PRICES: 1 to 10 $.99 101 to 1000 $.60 K IS A SPECIAL PRICE: 10 for $7.50

TUBE CAPS (Plate)

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<th>Tube Cap</th>
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WATKINS JOHNSON WJ-V907: Voltage Controlled Microwave Oscillator $110.00

Frequency range 3.6 to 4.2GHz, Power output, Min. 10dBm typical, 8dBm Guaranteed. Spurious output suppression Harmonic (mfn), min. 20dB typical, In-Band Non-Harmonic, min. 60dB typical, Residual FM, pk to pk, Max. 5KHz, pushing factor, Max. 8KHz/V, Pulling figure 1.5:1 VSWR. Max. 60MHz, Tuning voltage range +1 to +5Volts, Tuning current, Max. -0.1mA, modulation sensitivity range, Max. 120 to 30MHz/V, Input capacitance, Max. 100pf, Oscillator bias +15 +0.05 volts @ 55mA, Max.

MHZ electronics

Toll Free Number
800-528-0180
(For orders only)

"All parts may be new or surplus, and parts may be substituted with comparable parts if we are out of stock of an item."

Tell 'em you saw it in HAM RADIO!

122 April 1983
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NOTICE ALL PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE

TUBES MAY EITHER BE NEW OR SURPLUS CONDITION

"All parts may be new or surplus, and parts may be substituted with comparable parts if we are out of stock of an item."

MH z electronics

PRICES SUBJECT TO CHANGE WITHOUT NOTICE
“FILTERS”

COLLINS Mechanical Filter #526-9724-010 MODEL F455Z32F

455KHz at 3.2KHz wide. May be other models but equivalent. May be used or new, $15.99

ATLAS Crystal Filters

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<td>8 pole 2.7KHz wide Upper sideband. Impedance 800ohms 15pf In/800ohms 0pf out.</td>
<td>19.99</td>
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<td>5.595-2.7/8/AU, 5.595-2.7/USB</td>
<td>8 pole 2.7KHz wide Upper sideband. Impedance 800ohms 15pf In/800ohms 0pf out.</td>
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<tr>
<td>5.595-500/4, 5.595-500/4/CW</td>
<td>4 pole 500 cycles wide CW. Impedance 800ohms 15pf In/800ohms 0pf out.</td>
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<td>9.0USB/CW</td>
<td>6 pole 2.7KHz wide at 6dB. Impedance 6800ohms 7pf In/300ohms 8pf out. CW-1599Hz</td>
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KOKUSA ELECTRIC Co., Mechanical Filter #MF-455-ZL/ZU-21H

455KHz at Center Frequency of 453.5KC. Carrier Frequency of 455KHz 2.36KC Bandwidth. Upper sideband. (ZU) 19.99

CRYSTAL FILTERS

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<td>TEW</td>
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<td>SOG-113A</td>
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CERAMIC FILTERS

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<td>TO-01A</td>
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<td>SFE10.7MA</td>
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<td>CEF455A/BFU455K</td>
<td>455KHz +2KHz</td>
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SPECTRA PHYSICS INC. Model 088 HeNe LASER TUBES

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<th>Beam DLR</th>
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<td>68K OAH 1KWATT BALAST</td>
<td>1000VDC +100VDC</td>
<td>At 3.7MA</td>
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ROTRON MUFFIN FANS Model MARK4/MU2A1

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<td>115 VAC</td>
<td>1440</td>
<td>IMPEDANCE PROTECTED-F</td>
</tr>
<tr>
<td>105CFM at 60CFS</td>
<td>THESE ARE NEW</td>
<td>Toll Free Number 800-528-0180 (For orders only)</td>
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MHz electronics

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<td>11C19DC</td>
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<td>11C01FC</td>
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GENERAL ELECTRIC CO. GUNN DIODE MODEL Y-2187

Freq. Gap (GHz) 2 10, Output (min.) 100mW, Duty (%)

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VARIAN GALLIUM ARSENIDE GUNN DIODE MODEL VXS-920155

Freq. Coverage 8 to 12 4GHz, Output (min.) 100mW, Bias Voltage (Max.) 14Vdc, Bias Current (mADC) Operating 500 Typ.

<table>
<thead>
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<tr>
<td>1000Max.</td>
<td>$39.99</td>
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VAR-L Co. Inc. MODEL SS-43 AM MODULATOR

Freq. Range 60 150MC, Insertion Loss 13dB Nominal, Signal Port Imp. 500hms Nominal, Signal Port RF Power +10dBm Max., Modulation Port BW DC to 1KHz, Modulation Port Bias 1mA Nominal

<table>
<thead>
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AVANTEK CASCADABLE MODULAR AMPLIFIERS

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<td>5 to 500 MHz</td>
<td>15dB</td>
<td>2.3dB</td>
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HEWLETT PACKARD MIXERS MODELS

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FREQUENCY SOURCES, INC MODEL MS-74X MICROWAVE SIGNAL SOURCE

MS-74X: Mechanically Tunable Frequency Range (MHz) 100-1000 to 11200 10.63 to 11.23GHz Minimum Output Power (mW) 10, Overall Power Ratio 108, Internal Crystal Oscillator Frequency Range (MHz) 98.4 to 104.0, Maximum Input Current (mA) 400.

The signal source is designed for applications where high stability and low noise are of prime concern. These sources utilize fundamental transistor oscillators with high Q coaxial cavities, followed by broadband stable step recovery diode multipliers. This design allows single screw mechanical adjustment of frequency over standard communications bands. Broadband sampling circuits are used to phase lock the oscillator to a high stability reference which may be either an internal self-contained crystal oscillator, external primary standard or VHF synthesizer. This unique technique allows for both FM noise and low term stability. List Price is $1150.00 (These Are NEW)

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HEWLETT PACKARD 135712 MICROVACUUM DIODE

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MOTOROLA MH1172R LOW DISTORTION WIDEBAND AMPLIFIER MODULE

Frequency Range 40 to 300MHz, Power Gain at 50MHz 16.6mW / 17.4mW, Gain Flatness +0.1 Typ. +0.2 Max. DB, DC Supply Voltage — 28vdc RF Voltage Input +70dBmV

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<tr>
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<tr>
<td>#140579D1</td>
<td>$29.99</td>
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GENERAL ELECTRIC AA NICADS

Model #140579D1

Pack of 6 for $54.00

These may be broken down to individual cells.

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“CHIPS” electronics

More Details? CHECK — OFF Page 129

April 1983
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Find its resonant frequency.
Adjust it to your operating frequency quickly and easily.

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THE STAMP COLLECTOR ($31) Inventory and store up to 800 STAMP numbers in a single listing, quantity on hand, major classification, and provide full want list support.

STATES AND CAPITOLS ($32) Test yourself on the fifty states and their capitals. Three levels. Some of the levels include the state where each capital is located. (1) Name, you provide state; (2) name, you provide capital; (3) name, state, and capital.

PINBALL ($35) Plays like real pinball complete with flippers, bumpers, "nudge," bonus points and more. Uses fast efficient machine code to choose its moves.

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VULCALC (111) This program constructs, generates, and calculates large tables for financial analysis, budget sheets, and projections. An immensely powerful analysis chart.

THE FLIGHT SIMULATOR ($6) Take control of highly maneuverable light aircraft. With full controls, instrument and navigational aids to avoid hazards in landing.

STOCK MARKET GAME ($27) Bull or bear? This realistic simulation lets you analyze information, buy and sell stocks, take out and pay off loans, and win. If you can accumulate $50,000 in "The Market."

SUPERMAZE ($34) Navigate your way through a three-dimensional maze with traps, goals, master stones, and compass. Ten separate mazes. Three-dimensional graphics.

CHESS AND CHESS CLOCK (17) Six levels. All the legal moves including castling and en passant. Keeps a separate record of plays made for easy reference. Play another opponent or match with the computer.

FORTRESS OF ZORLAC ($36) A super fast game in which you are the commander of a fleet of spaceships. Your mission is to rid the galaxy of the dreaded alien, ZORLAC.

PERSONAL FINANCE PLANNER ($28) Permits calculations, finances a house, a car, keep savings accounts, repay loans and calculate an amortization schedule which can be generated to any of the financial programs.

BACKGAMMON AND DICE ($8) A perfect blend of chance and skill. Uses machine code to choose its moves. Full game including graphics board, rolling dice, and double six. Play the computer or another opponent.

ATOR THE ABC GATOR ($33) Designed to teach children the sequence of the alphabet. Combines computer instruction, music and video games.

THE HOME IMPROVEMENT PLANNER ($29) Stores up to 20 room measurements (length, width, height), compute total area in each (wall, floor), estimate costs of painting, wallpapering and carpets and draw house blueprints.

REAL ESTATE INVESTMENT ANALYSIS ($30) Analysis of different investment strategies. The first selection allows the user to choose between renting or buying. The second selection consists of a detailed analysis of the rental investment property.

SPACE RAIDERS, BOMBER ($3) Time/Sinclair version of the popular arcade game of full of bombs and rockets and collisions with skyscrapers.

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*Sinclair technology is the heart of both the ZX81 and the Times/Sinclair 3000.

 tearsheet of Sinclair Research, Ltd., 2 Sinclair Plaza, Nashua, NH 03061.
Answering the call for an HF rig that goes everywhere, sounds great, and is cost-effective, Yaesu proudly introduces the FT-77 Compact HF Transceiver System.

Computerized Design and Manufacture
The FT-77 design engineers utilized the latest computerized circuit board layout methods, resulting in a compact, reliable transceiver with maximum utilization of available space. Automated insertion techniques are used in assembly, providing improved reliability and quality control over earlier designs.

Operating Versatility
The FT-77 is equipped for operation on all amateur bands between 3.5 and 29.7 MHz, including the three new WARC bands. Fully operational on SSB and CW, the FT-77 includes a dual width noise blanker (designed to minimize the "Woodpecker" or ignition noise), full SWR metering, R.I.T., and optional CW filter with wide/narrow selection. The optional FM-77 permits operation on the FM mode, with front panel squelch sensitivity control.

Expandable Station Concept
Ideal for mobile operation because of its compact size and light weight, the FT-77 forms the nucleus of a versatile base station. Available as options for the FT-77 are the FP-700 AC Power Supply, FV-700DM Synthesized External VFO and Memory System, FTV-707 VHF/UHF Transverter, and FC-700 Antenna Coupler, providing top performance at an extraordinarily low price.

Best of All, It's a Yaesu!
With most experience in transceiver design and manufacture, the Yaesu trademark is your guarantee of quality and durability. We've got all-new technology and an all-new warranty policy to back it up.

See the FT-77 and the all new line of Yaesu HF, VHF, and UHF transceivers, receivers and accessories at your Yaesu Dealer today! It's time you tried a Yaesu!
Digital DX-terity...

General coverage, Superior dynamic range, 2 VFO’s, 8 memories, Scan, Notch...COMPACT!

TS-430S

The TS-430S combines the ultimate in compact styling with advanced circuit design and performance. An all solid-state SSB, CW, and AM transceiver, with FM optional, covering the 160-10 meter Amateur bands, it also incorporates a 150 kHz-30 MHz general coverage receiver with superior dynamic range, dual digital VFO’s, 8 memories, memory scan, programmable band scan, IF shift, notch filter, all-mode squelch, and built-in speech processor.

TS-430S FEATURES:

- 160-10 meter operation, with general coverage receiver
  With 160-10 meter Amateur band coverage, including WARC 30, 17, and 12 meter bands, it also features a 150 kHz-30 MHz general coverage receiver. Innovative UP-conversion digital PLL circuit, for superior frequency stability and accuracy. UP/DOWN band switches for Amateur bands or 1-MHz steps across entire 150 kHz-30 MHz range. Two digital VFO’s continuously tuneable from band to band. Band information output on rear panel.

- USB, LSB, CW, AM, with optional FM
  Operates on USB, LSB, CW, and AM, with optional FM, internally installed. AGC time constant automatically selected by mode.

- Compact, lightweight design
  Measures only 10-5/8 (270) W x 3-3/4 (96) H x 10-7/8 (275) D, inches (mm), weighs only 14.3 lbs (6.5 kg.).

- Superior receiver dynamic range
  Use of 2SK125 junction-type FET’s in the Dyna-Mix high sensitivity, balanced, direct mixer circuit provides superior dynamic range.

- 10-Hz step digital VFO’s
  10-Hz step digital VFO’s operate independently, including band and mode information. Different band and mode cross-operation possible. Dial torque adjustable. STEP switch for tuning in 10-Hz or 100-Hz steps. A-B switch quickly shifts “B” VFO to the same frequency and mode as “A” VFO, or vice-versa. VFO LOCK switch provided. RIT control states VFO or memory. UP/DOWN manual scan possible using optional microphone.

- Eight memories store frequency, mode, and band data
  Memories store frequency, mode, and band data. Eight memory stores receive and transmit frequencies independently. M.CH switch for operation of memory as independent VFO, or fixed frequency.

- Lithium battery memory back-up
  Estimated five-year life.

- Memory scan
  Scans memories in which data is stored.

- Programmable automatic band scan
  Scans programmed band width. Scan speed adjustable. HOLD switch interrupts band or memory scan.

- IF shift circuit for minimum QRM
  IF passband may be moved to place interfering signals outside the passband, for best interference rejection.

- Tunable notch filter built-in
  Deep, sharp, tunable, audio notch filter.

- Narrow-wide filter selection
  NAR-WIDE switch for IF filter selection on SSB, CW, or AM, when optional filters are installed. (24 kHz IF filter built-in.)

- Speech processor built-in
  Improves intelligibility, increases average “talk-power.”

- Fluorescent tube digital display
  Indicates frequency to 100 Hz (10 Hz modifiable).

- All solid-state technology
  Input rated 250 W PEP on SSB, 200 W on CW, 120 W on FM (optional), 60 V on AM. Built-in cooling fan, multi-circuit final protection. Operates on 12 VDC, or 220/240 VAC with optional FS-140 AC power supply.

- All-mode squelch circuit, built-in
- Noise blanker, built-in
- RF attenuator (20 dB)
- Vox circuit, plus semi-break-in with side-tone

Optional accessories:
- FS-430 compact AC power supply
- PS-30 or KPS-21 AC power supplies
- SP-430 external speaker
- MB-430 mobile mounting bracket
- AT-130 compact antenna tuner
- 80-10 m in. WARC
- AT-230 base antenna tuner
- 80-10 m incl. WARC
- FM-430 FM unit
- YK-88C (500 Hz) or YK-88CN (270 Hz) CW filters
- YK-88SN (1.8 kHz) narrow SSB filter
- YK-88A (6 kHz) AM filter
- MC-42S UP/DOWN hand microphone
- MC-60A deluxe desk microphone, UP/DOWN switch

More information on the TS-430S is available from all authorized dealers of Trio-Kenwood Communications, 111 W. Walnut Street, Compton, California 90220.