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The 2K Classic represents the culmination of fifteen years experience in developing, manufacturing and improving the 2K series. It remains as always a "workhorse", engineered and built to loaf along at full legal power for days or weeks without rest. A look inside shows why! No expense has been spared to make the 2K a truly "Classic" Amateur amplifier. Heavy duty, top quality components along with its rugged construction assures you of trouble free operation. The 2K Classic offers engineering and features second to none. It will put your signal on the air with greater strength and clarity than you ever dreamed possible. The 2K Classic operates on all amateur bands, 80 through 15 meters (export models include 10 meters).

Features:
- Two rugged Eimac 3-500Z grounded grid triodes
- Pi-L plate circuit with silver plated tank coil
- Resonant cathode pi input circuit
- Maximum legal input on all modes
- Price: $1195.00

The 1KD-5...Another fine member of the famous Henry Radio family of superior amplifiers. And we're still convinced that it's the world's finest linear in its class. The 1KD-5 was designed for the amateur who wants the quality and dependability of the 2KD-5 and 2K-4, who may prefer the smaller size, lighter weight and lower price and who will settle for a little less power. But make no mistake, the 1KD-5 is no slouch. Its 1200 watt PEP input (700 watt PEP nominal output) along with its superb operating characteristics will still punch out clean powerful signals...signals you'll be proud of. Compare its specifications, its features and its fine components and we're sure you will agree that the 1KD-5 is a superb value at only $695.

The 2KD-5...We have been suggesting that you look inside any amplifier before you buy it. We hope that you will. If you "lift the lid" on a 2KD-5 you will see only the highest quality, heavy duty components and careful workmanship...attributes that promise a long life of continuous operation in any mode at full legal power. The 2KD-5 is a 2000 watt PEP input (1200 watt PEP nominal output) RF linear amplifier, covering the 80, 40, 20, and 15 meter amateur bands. It operates with two Eimac 3-500Z glass envelope triodes and a Pi-L plate circuit with a rotary silver plated tank coil. Price $945.

And don't forget the rest of the Henry family of amateur amplifiers...the Tempo 2002 high power VHF amplifier and the broad line of top quality solid state amplifiers. Henry Radio also offers the 3K-A and 4K-Ultra superb high power H.F. amplifiers and a broad line of commercial FCC type accepted amplifiers for two way FM communications covering the range to 500 MHz.

Announcing!

A brand new "super" linear...the 3K Classic! Designed for the most critical Amateur Radio operator...the individual who wants and appreciates owning the finest. Available in spring 1981.

F.C.C. approval pending

53 years of service

Prices subject to change without notice.

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Butler, Missouri 64730 (816) 679-3127

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No matter what you are doing to your signal, Heath has the amateur gear to help you do it better... and to save you money, too. Heath is your one-stop headquarters for accessories, antennas and complete, build-it-yourself rigs. And they're all backed by the more than 200 hams at Heath.

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What other maximum legal power amplifier gives you...

(A) A full kw CCS power supply with a 45 pound, 1.5 KVA transformer that plugs in for easy handling...

(B) Tough EIMAC ceramic triodes, thoroughly cooled by ETO's exclusive full-cabinet ducted air system...

(C) Heavy silver plated tubing coil in a full pi-l network that extends to 160 meters and provides 10-15 dB better harmonic suppression than the pi networks commonly used...

(D) Centrifugal blower floating on a foam rubber "sandwich" that absorbs noise and vibration, permitting whisper quiet operation...

And who else but ETO rates linear for "a full kilowatt key-down forever?"

Alpha!

Every new Alpha carries a two year (limited) factory warranty—just one factor that makes Alpha such a sensible investment. Most Alpha's command resale prices close to what they sold for new five or even ten years earlier!

To prevent a sad case of linear buyer's remorse later on, your best move now is to investigate Alpha carefully before you buy any amplifier. Call or write your dealer or ETO today. Just ask for our full color brochure; it contains inside and outside photographs and detailed specifications for all the famous Alpha amplifiers.

Ehnhorn Technological Operations, Inc.
Box 708, Canon City, CO 81212
(303) 275-1613
March 1981

Volume 14, number 3

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Observation & Opinion

The January, 1981, issue of *ham radio*, which incorporated Ham Radio *Horizons*, resulted in a flood of mail. Responses were mixed, as expected. Readers who had never seen an issue of *ham radio* were surprised and pleased with the new magazine. Old-guard *ham radio* readers appreciated the new mix of articles. We also received complaints from *Horizons* readers, who expected all of their favorite features in the combined magazine.

A major change in a magazine format, such as was begun in the January, 1981, issue cannot be accomplished overnight. When the decision was made to discontinue Ham Radio *Horizons*, the January, 1981, issue of *ham radio* was almost “locked up” and ready to be sent to the printer. This state of affairs resulted in an intense scramble to include at least some of the Ham Radio *Horizons* articles. Production schedules are demanding and unforgiving in the magazine-publishing business, so it was impossible to include all the *Horizons* features in the January issue. Under the circumstances, we did the best we could.

We don’t intend to abandon our faithful *Horizons* readers, nor do we intend to compromise the technical integrity of the magazine. If *Horizons* readers will bear with us for a few months, they will find more and more articles and features that made the *Horizons* magazine so popular. *Ham radio* has enjoyed a reputation for technical excellence for many years. We plan to continue this tradition.

Suggestions for article subjects were many and varied. These and the constructive criticism we received are gratefully appreciated. All were carefully considered, and future issues, now in the planning stage, will include as many different subjects as space will allow.

We received requests ranging from “more antenna theory” to “more on operating practices, station accessories, DX, and elementary theory.” The demand for the continuation of “Ham Radio Techniques,” “DXer’s Diary,” “Equipment Owners’ Survey,” and “Q and A” came through loud and clear. We got the message. You will see these features as well as some great stories that we’ve been keeping on the back burner. For the advanced Amateur, we have some interesting construction articles — in short, something for everyone. You asked for it; you’ll get it.

caution

I’d like to direct your attention to a letter in this month’s “Comments” column taking us to task for a potential safety hazard in the modular amplifier article that appeared in the January issue on page 12. It’s a point very well taken, and I’d recommend that anyone planning to build this circuit take a close look at my reply to the letter.

That’s it for now. See you next month.

Alf Wilson, W6NIF
Editor
ICOM MOBILE! ICOM MOBILE!
TAKE ANOTHER LOOK AT THE POPULAR MOBILE TWINS... IC-260A AND IC-255A.

ICOM IC-260A. Enjoy VHF mobile at its best. Sideband, FM or CW, the ICOM IC-260A does it all. The ICOM IC-260A contains all the features a mobile operator would want in a compact 2 meter mobile package with FM, SSB, CW operation. Features customers ask for most including:

- Squelch on SSB. The 260A will automatically and silently scan the SSB portion of the band seeking out the SSB activity on 2.
- 3 memories built in.
- Memory scan.
- Programmable band scan.
- 600kc repeater offset built in.
- Variable repeater split — with the 2 built in in VFOs, it’s possible to work the odd splits.
- Multimode operation — USB, LSB, CW, and FM. Great for getting into OSCAR, plus enjoying SSB rag chewing as well as repeater operation.

ICOM IC-255A. Features that have made the field proven and tested IC-255A the most popular 2 meter FM rig on the air today.

- 25 W / 1 W battery saving output.
- Scanning (memory and programmable limit band scan), now with automatic scan resume.
- Programmable splits — Flexibility for new repeater offsets.
- Dual speed tuning — 15 KHz Steps, 5 KHz Steps with TS Switch depressed.
- 5 memory channels — For easy access to your favorite repeaters.
- Dual VFO's built in, lockable, mobile mount, dynamic mic standard, RIT fine tuning.
- Simple, easy to use single knob tuning system for mobile operation.

All stated specifications are approximate and subject to change without notice or obligations. All ICOM radios significantly exceed FCC regulations limiting spurious emissions.
Two Meter Boomers

Whether you have the space for the 3.2 λ, 32-19 or the compact 2.2 λ, 32-19 models, two meter Boomers are your best choice. They offer the maximum gain available for their boom length (See NBS no. 688). They feature trigon reflectors for additional front-to-back ratio and clearer patterns. All stainless steel hardware and heavy gauge heat treated aluminum are used throughout. Whatever your choice of two meter amateur activity, the Boomer will fill your needs. For FM use the 221AF or 214BF. For CW/SSB on the low end use 32-19 or 214B. In EME, DX or just reliable QSOs the Boomer will perform for you.

Six Meter Boomer

The new six meter Boomer offers more boom and more gain from its new element spacing. The six meter Boomer has Cushcraft's typical attention to detail, including T match feed with balun, and extra heavy duty mechanical construction. The key to this Boomer's super performance and relatively lightweight is the special element spacing and boom length.

Specifications

<table>
<thead>
<tr>
<th>Model No.</th>
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<th>214FB</th>
<th>221AF</th>
<th>6174B</th>
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<td>1.66</td>
<td>1.66</td>
<td>1.66</td>
</tr>
</tbody>
</table>

Stacking Kits

For stacking two Boomers, use the coax harness and power divider Kits: 32-19 = 32SK, 214B = 22SK, 6174B = 617SK.

When stacking four Boomers, use the following complete stacking kits. They include H frame, harness, hardware and complete instructions: 32-19 = 324OK, 214B = 224OK.

Specifications, Stacked Boomers

<table>
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<tr>
<th>Antenna</th>
<th>2x214B</th>
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<td>10</td>
</tr>
</tbody>
</table>

The Antenna Company
46 Perimeter Road, P.O. Box 4680
Manchester, NH 03108
Tell 'em you saw it in HAM RADIO!
Dear HR:

The otherwise excellent design of the modular linear amplifier by KBRA in the January, 1981, issue contains a potential safety hazard. In fig. 3, the amplifier control circuit, the two transformers are shown with one side of their primary windings connected to ground. If these primaries ever become disconnected from ground or were not properly soldered to the chassis, the entire chassis would be floating at 110 volts ac above ground. I sure wouldn’t want to be touching the chassis if that ever happened.

Dave Karpiel, K1THP
Plainville, Connecticut

Neither would I. An easy and inexpensive solution is to use two small filament transformers connected back-to-back as shown in the drawing. This circuit thus isolates the two transformers in the amplifier control circuit and provides a much-needed safety feature. Editor.

Dear HR:

The circuit in the September, 1980, issue of ham radio referred to by Mr. Nelson is used in several thousand commercial radio telephone transceivers in New Zealand, and the notes I made on it were as a result of my bench work following modifications to put it on 144 MHz. The shorting of the crystal was only during a test setup. (Surely Mr. Nelson does not think I employ a little green man to short out the crystal each time I switch it on!) It is still flying too, after a year’s operation.

True, there were other circuits in his article which probably would have been suitable, but this was the circuit built into the equipment so it had to be got going on its new frequency. It was satisfactory outside the Amateur band in its commercial use.

B.E. Graham Goodger, ZL2RP
Napier, New Zealand

Dear HR:

Author Mead, K4DE, did an excellent job of making a complex subject clear with his article, "How to Determine True North for Antenna Orientation." The only problem is that two years from now we will all have forgotten where that issue of ham radio is, along with its graph for the equation of time. There is another way to determine the time of meridian passage of the sun (local apparent noon), a way which does not require knowledge of the equation of time. It goes like this:

Look in your local newspaper and record the times of sunrise and sunset. Convert the sunset time to 24-hour time by adding 12 hours to it. Subtract the time of sunrise from the time of sunset. Add half the difference to the time of sunrise. You now have the time of meridian passage of the sun for the location for which the times of sunset and sunrise were computed. You will now have to determine what that location is (a call to the local U.S. Weather Service Office is probably your best bet) and make a correction for longitude difference between that location and your QTH, as explained in Mr. Mead’s article.

Since the times of sunrise and sunset as published in newspapers are accurate only to the nearest minute, this method may not be quite as accurate as the method explained by author Mead. However, even though the sun’s azimuth is changing more rapidly at meridian passage than at any other time of the day, 30 seconds’ error in time will result in only a fraction of a degree of error in the resulting orientation. As an example, at latitude 35 degrees the azimuth change in 4 minutes at meridian passage is 1.7 degrees when the sun’s declination is 0 degrees; it’s 1.1 degrees when the sun’s declination is 23 degrees south and 4.4 degrees when the sun’s declination is 23 degrees north. Happy hunting to all you seekers after true north!

Thurman Smithey, N6QX
Chula Vista, California

Dear HR:

In response to W6DLQ, I would like to say the following: there are a variety of ways of determining true north. W6DLQ has correctly pointed out one of the better-known methods. My article was intended to be both educational and practical, and, in particular, to introduce some little-known concepts that can be used in Amateur Radio practice.

The use of Polaris is limited to those regions of the globe where the star is visible. This rules out the entire Southern Hemisphere, as I’m sure Jim realizes. Azimuth by meridian transit of the sun, on the other hand, does not have this limitation. Further, because Polaris is a circumpolar star (sidereal hour angle 329°, declination 89° N), accurate work requires a the- odolite for taking azimuths at each elongation (not simply at dawn and dusk), afterwards splitting the difference. Alternatively, a time sight (at either upper or lower culmination) may be precomputed using the local hour angle of Aries and the Greenwich hour angle of Polaris. Tables for this method, along with latitude corrections, are included in the nautical almanac.

Donald C. Mead, K4DE
Greensboro, North Carolina
CABLE TV SYSTEMS, now expanding rapidly into many major urban areas, are posing a potential threat to Amateur Radio operations. Since they are supposed to be closed (non-radiating) systems, many utilize the VHF spectrum from 50 to above 225 MHz for their multi-channel content, providing subscribers with continuous tuning converters to permit them to tune in cable channels outside the standard 12-channel VHF TV band. This puts some cable-carried signals into the Amateur (as well as aircraft and public safety) bands, and when systems leak (an all-too-common occurrence due to corrosion, loose connectors, or cable damage) interference results. Cases of cable-system interference on Amateur repeater inputs have been documented.

Amateur Interference To Cable Reception is the other side of the coin. Cable subscribers who've paid to watch cable material being transmitted within an Amateur band aren't likely to be very sympathetic when poorly shielded converters pick up Amateur signals. The cable interference issue has come to a head in Richland, Washington, where Amateurs (and others) have thus far successfully opposed Teleprompter's efforts to open its transmissions across the VHF spectrum. Forty to fifty Amateurs were at the Richland City Council meeting January 19 to testify along with unhappy cable subscribers and an airline pilot about radiation and poor system performance. They convinced the council to vote against the expansion, and Teleprompter is required to improve its performance and report back March 3.

ARRL Has Been Watching the development of potential problems from cable TV, and would like to hear from any Amateur who has had difficulties with interference to or from cable TV systems. Because cable TV is a regulated utility, cable systems operators are required to take care of problems with their systems.

ARRL'S DXCC ETHICS RULE, Rule 12, has been strengthened considerably in a move directed primarily at DX stations who have allegedly been demanding payment before providing confirmation of a contact. The rule has now become as the additions to Rule 12, the first addition stating, "Credit for contacts with individuals who have displayed continued poor operating ethics may be disallowed by action of the ARRL Awards Committee," and the second including "confirmation procedures" as "operating ethics." Impetus For The New Rule tightening had come from the ARRL's DX Advisory Committee, which in turn had been under ongoing pressure from many DXers over the practices of "buying" QSLs. The issue had come to a head following a well-known Israeli Amateur's insistence that only QSLs accompanied by a dollar bill would be acknowledged for his recent operations from various rare Pacific locations. The specifics of the change have been worked out and approved unanimously by the League's Awards Committee, and circulated to the DXAC.

The Expanded Rule 12 will actually become effective with its publication in QST, possibly as early as March. There are no plans to enforce it retroactively.

AN AMATEUR HAS BEEN PUT OFF THE AIR in yet another court action that could have far-reaching implications for the Amateur Radio community. In early December, K2AHL of Springfield, New Jersey, was ordered by Judge Kentz of the New Jersey Superior Court in Elizabeth to cease operating his station, as a result of a suit filed in 1977 by neighbors over TVI and stereo interference.

The Problem Had Surfaced a year earlier, when, without previous warning, he received a letter from the neighbor's lawyer stating that he'd be sued if he didn't stay off the air. Since the suit began, technical experts for both sides have agreed that a proper antenna plus filters would solve the TVI, and a properly designed stereo system would eliminate the problem in that area. Although K2AHL offered them a new stereo, they refused to make any changes. The judge apparently agreed they shouldn't have to, and even told K2AHL's lawyer he would have the FCC suspend K2AHL's license!

The Suit Has Cost K2AHL and his family $7,000 thus far, and an appeal is estimated at another $10,000. Nonetheless, he's willing to continue the fight if there are indications the Amateur community is behind him.

K6EOA WAS SENTENCED TO THREE YEARS felony probation and fined $500 for his threats against FCC engineers who were investigating jamming charges against him in 1979. The sentence was handed down in January by the Superior Court In and For the County of Los Angeles, and his probation will hinge on the condition that he does not use any of his Amateur equipment during the probation period and that he does not threaten, call, or harass either FCC officials or certain specified area Amateurs during his three years on probation.

He Will Also Be Required to obtain psychiatric treatment from a qualified M.D. at least once a week, and must obey all instructions from his probation officer and all other laws during his probation. Failure to comply with any of these conditions could put him into prison for the balance of the three years. The judge said the provision that he not use his Amateur equipment was an appropriate one in this case, since Munson had used his Amateur station in committing his crime.
MFJ Super Keyboard

For $279.95 you get: CW, Baudot, ASCII, buffer, programmable and automatic messages. Morse code practice, full featured keyer, human engineering.

Sending CW has always been a task, especially when you get a little tired. Electronic keyers help, but it's still too much work.

Now MFJ has a Super Keyboard that makes sending perfect CW effortless. It also sends Baudot RTTY and ASCII.

"Big deal" you say. "That's so special about that. There are lots of keyboards." Yes, but this one is different.

HUMAN ENGINEERED

A lot of thought has gone into human engineering the MFJ-494 Super Keyboard.

For example, you press only a one or two key sequence to execute any command. All controls and keys are positioned logically and labeled clearly for instant recognition.

Pots are used for speed, volume, tone, and weight because they are more human oriented than keyboard sequences and they remember your settings.

A meter gives continuous readout of buffer memory and speed. Two characters before full, the meter lights up red and the sidetone changes pitch.

PROGRAMMABLE, AUTOMATIC MESSAGES

Four automatic messages and two programmable message memories (A and B) are provided. Messages A and B can be a total of 30 characters. B starts where A ends.

When recalled, each message takes only one character of the buffer. They may be chained and/or repeated via the buffer.

"Well," you say, "that sure is not much memory." But it's more than it seems because of the built-in automatic messages.

For example, type your call into message A. Then by pressing the CO button you send CO CO DE (message A). Press twice to send twice, etc.

The other automatic messages work the same way: CO TEST DE (message A), DE (message A), ORZ (message A).

Special keys for KN, SK, BT, AS, AA, and AR.

TEXT BUFFER

The 50 character text buffer sends smooth perfect code even if you "hunt and peck."

Since each automatic or programmable message takes only one buffer character, this gives a far larger effective buffer.

You can preload a message into the buffer. When ready to transmit press the control key.

You can hold the buffer by pressing the shift key and space bar.

With the buffer in hold, you can send a comment with an external paddle as a keyer. To resume sending buffer, press the control key.

Simply backspace to delete errors.

RTTY: BAUDOT, ASCII

5 level Baudot is transmitted at 60 WPM. RTTY and CW ID are provided via message A. Carriage return, line feed, and "LTRS" are sent automatically on the first space after 63 characters on a line. After 70 characters the function is initiated without a space. This gives unbroken words at the receiving end and frees you from sending the carriage return.

All up and down shift is done automatically. A downshift occurs on every space to quickly clear any garbles in reception.

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The ASCII mode includes all the features of baudot. Transmission speed is 110 baud. Both upper and lower case are generated.

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converting surplus AN/UPX-6 cavities

A little scrounging, a little work, and you’re on 1296 MHz with 40 watts output

In this day of microprocessor control, frequency synthesis and miniaturization, the thought of using surplus military equipment is almost an anachronism. Nevertheless, Amateur Radio can be served by tried and true methods — experiment! For example, if you’ve ever considered running more than a few watts output on 1296 MHz and have looked at the price of transistors capable of producing that power, you seek an alternative. One possibility is to obtain and convert the three-cavity assembly (described in this article) from the AN/UPX-6 transmitter. With 100 milliwatts of drive and a 600-volt power supply, you can obtain about 40 watts output on 1296 MHz.

According to MIL-HDBK-1628, "Radar Recognition Set AN/UPX-6 is part of the target identification equipment for a radar set in an IFF* system."

So much for background, and on to the important data. The main component of the AN/UPX-6 is Radio Receiver-Transmitter RT-264/I/UPX-6. The three-cavity assembly to be converted is part of that unit.

Each cavity houses a 2C39A, with the three cavities gang-tuned to cover a frequency range of 1080-1130 MHz. I’ve never seen the complete RT-264/I/UPX-6, but the cavity assemblies frequently show up at flea markets. (If any of this equipment is available from surplus dealers, I’m sure that it will be advertised shortly after this article is published.) At any rate, you can identify the complete receiver-transmitter from its nameplate or the cavity assembly alone from the pictorial presentation of fig. 1. There may be considerably more hardware attached to the cavities than shown, but only that part of the assembly shown in fig. 1 is used. Even if the interstage coaxial cables have been cut, don’t despair — they can be restored with a minimum of effort provided that the end ferrules are still attached to the cavities.

†The use of open parentheses in military nomenclature indicates that the basic number or a letter-suffixed version applies; for example, RT-264/UPX-6, RT-264A/UPX-6, etc.

By Robert S. Stein, W6NBI, 1849 Middleton Avenue, Los Altos, California 94022

*IFF: Military jargon for "Identification of Friend or Foe." Editor.
modifying the cavities

The mechanical modifications that must be made to raise the cavities' resonant frequency are relatively simple and require only standard hand tools. If you follow my instructions exactly as written, you should be able to complete the basic conversion in a couple of hours:

1. Remove all extraneous parts and material so that only the basic cavity assembly shown in fig. 1 remains. Then refer to fig. 1, as necessary, when performing the following steps.

2. Remove the heater inductor and all wiring between the bases of the cavities and inside the base of the third cavity. Also remove the 10-ohm resistor and solder lug in the base of the third cavity.

3. Remove the perforated cover from each cavity. Remove the three screws, nuts, and washers that secure the spring-loaded tube retainer to the inside of each cover. Save the perforated covers; everything else may be discarded.

4. Carefully withdraw the tubes from the cavities (if you were lucky enough to find tubes in place) and clean out the accumulated dust, cobwebs, and spiders.

5. Remove the square access plate on the side of each cavity opposite the view shown in fig. 1. This permits access to the rotors of the ganged tuning capacitors. Save the access plates and the attaching hardware.

6. Loosen the setscrews that secure all the capacitor rotors, bushings, couplings, and spacers to the tuning shaft.

7. Remove the tuning shafts from the first and third cavities by pulling on the end of the shaft with pliers. Don't worry about using whatever force is necessary — the shaft and all the parts that will fall off are discarded.

8. Loosen the hex nut, at the bottom of the second cavity, which secures the coax cable between the first and second cavities. Unsolder the center of the cable from the input coupling capacitor in the base of the second cavity and pull the coax out of the cavity.

9. Remove the first cavity from the baseplate.

10. Perform step 7 on the second cavity.

11. Loosen the hex nut at the input connection of the first cavity. Unsoon the wire from the center of the input coupling capacitor so that the input connection assembly can be removed and discarded.

12. Remove the hex plug from the base of the first cavity and save the plug.

13. Use a hacksaw to cut off the threaded portion of the input connection boss at the bottom of the first cavity. Then file down the remaining part of the boss so that it is flush with the flange at the base of the cavity.

14. Replace the hex plug that was removed in step 12.

15. Enlarge the input connection hole in the first cavity by drilling it out with a 3/8-inch (9.5-mm) drill.
Then ream or file the hole so that it will accept the threaded end of a UG-1094/U BNC connector. Be careful not to damage the input coupling capacitor inside the base of the cavity! Clean out all filings, especially on the faces of the input coupling capacitor.

16. Insert the UG-1094/U connector into the input connection hole to determine how much of its center contact must be trimmed so that it just touches the center contact of the input coupling capacitor. Cut and/or file the connector contact accordingly. **NOTE:** Be sure to use a UG-1094/U, not a UG-1094AlU; the latter is too long.

17. Install the UG-1094/U connector in the input connection hole, and solder its center contact to the center of the input coupling capacitor.

18. On the input sides of the first and second cavities only, locate a point directly below hole A which is 1/2 inch (12.7 mm) below the bottom of the top flange, or 7/32 inch (5.6 mm) below the bottom of hole A. At each of these points, drill and tap a 10-32 (M5) hole.

19. On the first cavity only, locate a point directly above the button-type heater feedthrough capacitor (not visible in fig. 1), which is 27/32 inch (21.4 mm) below the bottom of the top flange. At this point, drill and tap another 10-32 (M5) hole.

20. Use an ohmmeter to determine that there are no shorts to ground a) from the center contacts of the input coupling capacitors, b) from the heater feedthrough capacitors, and c) from the plate-voltage connectors of all three cavities.

21. In each of the three tapped holes, insert a 10-32 x 5/8 inch (M5 x 16 mm) brass screw so that it butts against the grid line inside the cavity. The screw must seat firmly to ensure a good rf short circuit between the grid line and the cavity wall. Be careful not to overtighten the screw and strip the threads in the thin cavity wall.

22. Reinstall the first cavity onto the baseplate, then resolder the center conductor of the coax to the input coupling capacitor in the base of the second cavity. Tighten the hex nut.

23. Fig. 2 is a view looking into the access hole from which the cover was removed in step 5. Use a heavy soldering iron to tin the tips of the crescent-shaped bosses on the grid line inside each cavity and to tin the top and bottom horizontal surfaces of the access hole flange. Solder a short length of 3/8-inch (1-cm) wide copper strap between the crescent tips and the flange of the access hole as shown.

24. Replace the access hole cover plate on each cavity.

25. If the inter-cavity coax cables are intact on your cavity assembly, you have completed the mechanical changes and can proceed directly to step 46. However, if you have to replace one or both of the cables, continue with step 26.

26. If not already done, cut the cable close to the end ferrules.

27. Remove and save the hex nut and washer used at the end of each cable.

28. At the ends of the old cable, unsolder the center conductor from the output coupling loop (physically, a grounded plate parallel to the cavity wall) and from the input coupling capacitor. Remove the remainder of the coax. Save the ends of the coax to recover the end ferrules.

29. Clean out the old solder from the holes in the output coupling loop and the center of the input coupling capacitor.

30. Extract the center conductor from the ferrules on the ends of the old coax, and trim off as much of the old coax as possible. Then, using a number 17 drill, enlarge the hole in each ferrule to 0.173 inch (4.4 mm).

31. Clean out the solder holes in the ferrules. Make sure that the inside bore of the ferrule is smooth.

32. Trim a length of RG-142 B/U coaxial cable to 6-1/2 inches (16.5 cm). (The instructions which follow, covering the assembly of the ferrule to the coax, apply to one end.)

33. Strip back the outer jacket 1-1/2 inches (3.8 cm). Take care not to nick the braid.

34. Push the braid back slightly, being careful not to unravel the braid. Cut 1/8 inch (3.2 mm) of dielectric and center conductor off the end.
35. Reform the braid so that it tapers over the cut end, which will make it easier to assemble the ferrule to the cable.

36. Slide the modified ferrule over the end of the coax so that the corrugated end butts against the jacket.

37. Solder the braid to the ferrule through the solder holes in the ferrule. Be sure that the solder is sweated around the entire periphery of the cable.

38. Trim the braid that extends through so that it’s flush with the end of the ferrule.

39. Trim the dielectric so that only 1/8-inch (3.2 mm) extends beyond the end of the ferrule. Do not cut off the center conductor.

40. Place one washer and hex nut, removed in step 27, over the end of the coax so that the washer is against the ferrule and the threaded end of the hex nut is against the washer.

41. Place a second washer and hex nut onto the cable so that they are a mirror image of the set already in place.

42. Repeat steps 33 through 39 for the other end.

43. Insert one end of the cable into the top of the applicable cavity so that the bared center conductor passes through the hole in the output coupling loop. Determine how much of the center conductor must be cut off so that it will extend through the coupling loop about 1/32 inch (1 mm). Remove the cable and cut off the excess center conductor.

44. Reinsert the cable center conductor into the hole in the plate coupling loop and tighten the hex nut.

Solder the center conductor to the coupling loop.

45. Insert the other end of the cable into the bottom of the succeeding cavity so that the center conductor passes through the hole in the center of the input coupling capacitor. Tighten the hex nut, solder the center conductor to the capacitor, and trim the excess center conductor.

46. Install a 2C39A tube in each cavity. Replace the perforated covers removed in step 3. Do not substitute a 7289 or 3CX100A5 tube for the 2C39A. Although they are similar, neither will work properly in the modified cavities.

**input matching**

The VSWR at the input of the first cavity will be between 40 and 50 (that’s right!) after it’s been modified. Therefore, to obtain a reasonable power transfer, especially from a solid-state driver, some form of input matching must be provided. A simple matching network, which should bring the VSWR down to better than 2:1, is shown in fig. 3. The configuration is that of a stub matching network in which a discrete variable capacitor is used instead of a shunt capacitive stub, thereby permitting the network to be tuned to compensate for variations in the input impedance of the cavity.

The matching network should be constructed *exactly* as shown in fig. 3. Use a crimp-type BNC connector, similar to a conventional UG-88/U, designed for RG-58/U cable; the crimping sleeve is not used. Before cutting the semi-rigid coax to length, solder the connector pin to one end, trimmed as shown. Insert the semi-rigid cable into the connector body to position the pin properly. Solder the coax to the connector cap.

Trim the outer conductor to the 2-3/8-inch (6.0-cm) length shown, allowing about 1/2 inch (13 mm) of additional bare center conductor for connection to the center contact of the UG-290/U receptacle. Solder the outer conductor of the coax to the body of the receptacle to minimize the length of the unshielded center conductor to be soldered to the receptacle contact. Trim the excess center conductor after soldering it to the connector.

Solder the trimmer capacitor on the UG-290/U as shown in fig. 3. The small angle bracket is not required electrically; it is used only to secure the connector to the chassis or mounting surface upon which the cavity assembly will ultimately be mounted.

**input VSWR**

The input VSWR can be checked at this point, before applying any power to the cavities, if a signal generator, slotted line, and SWR indicator are avail-
able. Otherwise, an alternative check can be performed under operating conditions.

Using the slotted-line technique, you should be able to reduce the input VSWR to 2:1 or less by adjusting the trimmer capacitor on the matching stub. If the measured minimum VSWR is greater than 2:1, add a 5.5-18 pF trimmer across the 2C39A input circuit inside the base of the first cavity. One side of the trimmer should be soldered to the solder lug in the center of the cathode structure (one of the heater rf chokes is connected to this lug). Add a solder lug and nut to one of the studs that support the ends of the cathode structure. Solder the other side of the trimmer to this lug. Adjustment of this capacitor, in conjunction with the matching-stub trimmer, will then result in better than a 2:1 VSWR.

**power supplies**

I'll not attempt to detail the heater and plate power supplies, since the choice of plate voltage and bias voltage usually depends on what each person has available and his preference as to control. Instead, I'll present some ideas, along with tube limitations, which may be helpful. I assume that all operation will be CW or SSB.

First let's consider the plate-voltage supply, since bias and control may depend on this voltage. My preference is to use as high a voltage as possible, but not over 1000 volts, on the output stage, and to use about 350 volts on the first two stages. This provides for maximum power output, yet allows the first two tubes to operate with zero bias so that only two heater supplies are required. (More about this under the discussion of heater requirements.)

If the plate voltage is limited to 350 volts, a 2C39A will draw 50 to 60 milliamperes static plate current when zero biased. The plate dissipation limits for the tube are 12 watts with convection cooling and 100 watts with forced-air cooling. Therefore, a small blower or fan is recommended, especially if 500 volts or more are used on the last stage. Placing the blower at the end of the cavity assembly, facing the third cavity, will afford maximum cooling for that stage while also dissipating heat from the first two cavities.

Plate voltage is applied to each cavity through the MHV connectors shown in fig. 1. The required mating MHV connector is an Amphenol 29100 for RG-58/U cable, or an Amphenol 28000 for RG-59/U. The latter is recommended, since the RG-59/U has a higher breakdown voltage rating than RG-58/U. If you can't obtain the mating MHV connectors, or if the receptacles on the cavities are damaged, the cavity receptacles can be replaced with more conventional UG-290/U BNC connectors. In that case, use UG-280/U cable connectors so that RG-59/U can be used.

**Biasing.** Because the 2C39As are used as grounded-grid amplifiers, with the grids at dc ground, a positive dc bias must be applied to the common heater-cathode connection when bias is required. This means that each tube must have its own heater supply unless the tubes are zero biased or operated at sufficiently low plate voltages so that a common bias source will keep the plate currents of two or three tubes reasonably close to a bogey value.

As the cavities exist (after the preceding modifications have been made), the heater-cathode leads of the first and second stages are returned to ground through rf chokes, while the rf choke in the other heater lead in each cavity is brought to a feedthrough capacitor in the cavity wall. In the output cavity, both heater rf chokes connect to feedthrough capacitors.

If the plate voltage for the first two stages is limited to about 350 volts, the heater and bias circuits shown in fig. 4A may be used. The values of R1 and R2 must be such that the heater voltage, measured at the heater ends of the rf chokes, is 5.5 volts. Crk provides cathode bias and is made of several silicon rectifiers (1N4001 or similar), so that the quiescent...
plate current of V207 is between 40 and 60 milliamperes; the number of diodes in series will depend on the plate voltage and the tube characteristics. With a plate supply of 600-700 volts, four diodes should provide the proper bias.

If higher plate voltages are used on the first two stages, or if either is not to be operated under zero-bias conditions, a separate heater transformer will be needed for each tube. The tubes may then be individually biased, in the manner shown for V207.

**Recommended circuit.** One of my phobias is to have transmitting tubes draw plate current during standby. Consequently, I use the biasing circuit shown in fig. 4B. Cutoff bias of about +20 volts is applied to the cathodes of all three tubes through the normally closed contacts of a relay. When the relay is energized for transmit, V205 and V206 cathodes and the low end of CR4 are grounded, allowing plate current to flow. This requires lifting the heater-cathode returns of V205 and V206 from ground as follows:

Cut the ground ends of the rf chokes in the bases of the first and second cavities. Remove the button plug at the bottom of each cavity (see fig. 1) and replace it with a button-type feedthrough capacitor, designated C1 and C2 in fig. 4B (similar to those used for the ungrounded heater connections). The capacitance value isn’t critical; anything between 100 and 1500 pF will do. Connect the ungrounded end of the rf choke to the new feedthrough capacitor.

**operation**

After the power supply smoke test has been made and the tube plate currents checked, connect the input matching network to the input connector on the first cavity, then connect your exciter to the matching network. If the matching network capacitor has not previously been adjusted for minimum VSWR, set it near minimum capacitance.

The trimmer capacitors on the cavities (see fig. 1) tune the cavities to resonance, the old ganged tuning capacitors having been removed. With rf drive applied, the cavity trimmers are tuned for maximum output, as is the matching network capacitor. If the additional trimmer capacitor has been added to the input of the first stage to minimize the input VSWR, it may also be adjusted for maximum output. Its effect will be slight, however, if it has been set for best VSWR.

**wrap-up**

That’s all there is to getting the modified cavities on the air. The output-stage plate current will be about 200 milliamperes at full output. However, don’t allow the tube to draw that much current for any extended length of time. Maximum plate current for a 2C39A is 125 milliamperes. Plate efficiency will be about 30 per cent, which is consistent with the tube specifications.

A drive level of 100 milliwatts should be more than enough to obtain full output at any final-stage plate voltage up to 1000 volts.

If you don’t have an rf power meter, you can calculate the output power from the dc input power, assuming a plate efficiency of 30 per cent. (We can ignore the feedthrough power from the second stage, since we’re assuming the efficiency to arrive at only a rough estimate of the output.)

If you don’t obtain output power corresponding to about 26 dB of power gain in the cavity assembly, one or more of the tubes may be weak. However, if the input VSWR hasn’t been checked, it’s possible that the mismatch loss between exciter and first stage is the culprit. Add a trimmer capacitor across the first-stage input, as described earlier, then adjust this capacitor, along with the trimmer on the input matching network, for maximum output. This should solve the problem.

**postscripts**

At drive levels under 1 milliwatt, the over-all gain of the three cavities is 28-34 dB, depending on plate voltages. However, at the higher drive levels needed to produce power outputs of more than 20 watts, full gain can’t be realized. It’s likely that the over-all gain might be increased at these higher outputs, thereby reducing the drive levels required, by replacing the interstage connecting cables with matching networks.

Although I’ve not tried this, preferring to stay with the simpler brute-force approach, my rationale is based on the VSWR that the first stage presents after modification. There’s no reason not to believe that severe mismatches may occur between first and second and second and third stages.

It’s interesting to conjecture on the results that might be obtained by matching. If we assume a gain of 11 dB per stage and an output of 40 watts, only 20 milliwatts of drive should be required.

It should also be apparent that one, two, or three cavities can be used, depending on available drive power. I’ve run tests using only two cavities and obtained approximately 16 watts output with a drive level of 100 milliwatts — a power gain of 22 dB — indicating that the limiting occurs in the final stage when three cavities are used.

I’d be interested in hearing from anyone who attempts to improve the interstage matching. I’ll also answer all inquiries accompanied by a self-addressed, stamped envelope.

**ham radio**
It's Saturday at 1300Z; 7 AM in Chicago, a late winter’s morning. Considering the hour, I feel pretty good. An early retirement last night and a good sleep, and now I'm ready for DX.

The warm glow of the dial lamps, the smell of the fresh coffee, the warmth of my heavy bathrobe pulled tightly around me, the headphones nestled over my ears — I'm at peace with the world and ready to go.

There are a couple of stations I'd like to tie into this morning. That A51RT is high on my list; three times now I've heard him, with nothing to show for it. Not that he's being pursued all that widely; he's been listed in the DX bulletins only once, and that was for an evening path. Every time I've heard him was on a morning path. Of course, as soon as I QSO him, I'll report it to the DX bulletins, but with the luck I've been having with that one, the last thing I need is more competition.

But the A51 isn't the only DX station I'm after. The bands were full of talk and reports last night that ace DXpeditioner KP2A had managed to pull off both a ticket and a pass for Cocos-Keeling, VK9Y, and would be operational any moment now.

Cocos-Keeling has always been a tough one; not an easy shot for propagation to start with, and a location remote from anywhere. Add to that Australia's military making it a high-security area a couple of years ago, and you have the makings of a rare country, a very rare country.

Every one knows the difference between a rare country and a very rare country: A rare country is one that you have and your buddy doesn't. A very rare country is one that your buddy has and you don't. I don't have Cocos Keeling.

Let's see how the band sounds. Hmmm. A number of signals; that's certainly a good sign. Let's see where they are from. Haul the antenna around — let's start straight west. Watching for both the A51 and the Cocos-Keeling station poses certain difficulties — beam headings. The A51 has been coming through on long path, almost dead south, over the Antarctic. The Cocos-Keeling bearing, on the other hand, is more northwest, over Japan. The signal from the A51 is weak enough that I can copy it only when the antenna's on him; no way can I copy him on the side or back of my antenna. Perhaps I should leave my antenna on the long path for the A51?

On the other hand, I can develop a very good case for leaving the antenna on that VK9Y bearing. With any DXpedition, or for that matter, any new country, it is always desirable and advantageous to grab a QSO ASAP — As Soon As Possible!

I'll never forget my lesson of Serrana Bank some years ago. A DXpedition came on one evening from there, and seemingly half the world was in one pileup. I decided to wait a day, so that getting a QSO would be easier. Guess what? An approaching hurricane forced them off the island at dawn, and they never went back. I had to wait years for a Serrana Bank QSO from another DXpedition.

On top of that lesson, the path to Cocos-Keeling is a long one, and this time of year propagation can be a bit tenuous. We certainly will get openings, but the peak part of any opening won't be over half an hour, and perhaps less. Catching the peak is vital on a DXpedition like Cocos-Keeling; the competition can be so fierce from all over the world that in a really huge pileup you need all the help you can get from propagation.

Even so, the easiest way is to catch him calling CQ, and nail him before the ravening hordes get onto him.

KP2A is fairly predictable. He's a superb operator, cool under fire, which, God knows, he's going to need to be, and he controls pileups very well from DXpedition QTHs. From past observation, I know that he likes to work 5 to 10 kHz up from his own frequency. Also, he has a knack of getting a good signal out; he seems to know how to set up
decent temporary antennas, I guess.

Okay, enough wool gathering. Let's see here, it's 1314Z. Okay, I haven't yet heard the A51 before 1340Z, so I could start watching for him at 1330Z. That would give me fifteen more minutes to hunt for the VK9Y. Then, I think, if there's no action, I'll swing the antenna every five minutes to watch for both the A51 and the VK9Y. If I come across either of them, I'll devote all my attention to that one. So, let's go! I move the antenna into the northwest, the path for Cocos-Keeling, and start hunting.

KP2A seems to like to transmit around 020. I center my tuning around there. Let's see what we have here. Lots of W signals, some pretty loud. Phooey. The skip is a bit short today. It figures. If that VK9 shows, sure do hope that the traffic cops don't show up. There's a VK4.

Yes, VK4RF. Good signals. That's not the exact path for Cocos-Keeling, but there's hope.

There go four or five fellows chasing someone. Maybe it's my boy? No — there — one of the Ws gives the call of the fellow he's calling. It's P29ET; Papua/New Guinea. That's a nice catch, but I don't need it. But let's wait a bit and see what kind of signal the P29 has. There he is. Fine, a good S-7 and no flutter. Ohhhay — if Cocos is going to show up soon, I should be in tall clover, propagation-wise. That P29 isn't as far down the path as the VK9Y is, but it's pretty much the same path, and that's the tougher part of it. It's a pretty safe bet that we'll have at least adequate propagation to Cocos-Keeling.

Let's flip on 2 meters to see if anyone has any late information or hot tips.

"Hellooo out there. W9KNI here. Any late information on the VK9Y?"

"Yeah. W9KNI from K9QVB. Hello, Bob. I was just going to call you. He showed up a few minutes ago on 20 sideband. He's on fourteen-one-nine-two, listening up. Said he's going to CW on oh-twenty at fourteen hundred zulu. He's not real strong. Over."

"Okay, great, John, and thanks for the hot stuff. Who's he working?"

"He's mostly on W4s. He's getting a few threes and W92RX with that super stacked system got him too. But I think the W4s have a long-path opening to him, and they're working it to death. The guy's a pretty good op, for sure."

"Roger, he's that. What path are you copying him on?"

"Definitely short path. I can't hear a whisper on long path. But he's pretty weak. I think he's starting to get stronger, though."

"Okay, fine, John. Appreciate the info. You need him too, I think?"

"Yeah, sure do, Bob. I thought I worked that VK9YK a couple of years ago, but I got my card back with a 'Not In Log,' so I guess I didn't make it. Yeah, I need this one. But I'm not even calling him right now; he's four and four here, and the W4s are all giving him five-eights and five-nines. Hope we get a better shot on CW."

"Okay, I'm going to run and get a cup of coffee, John. I'll be back in five minutes or less. Good hunting. K9QVB from W9KNI."

"Okay, Bob. I'll squawk if anything changes. W9KNI from K9QVB."

I run up the stairs and turn on the water for my coffee. The juices are starting to flow — a shot at a new one — with a good operator, too. And, on a Saturday. Incredible! It's been a bit dry of late for new ones in the log. Oh, I heard a few — the A6X, the A51, the VK9 on Norfolk. But I'm not chasing SWL awards; I'm looking for QSLs that say, "RST 599" on them, or whatever report. And lately, I'm not getting any of them into the log book. Maybe today's my day.

In minutes I'm back at the rig. Let's see here... I adjust the headset a bit to seat it comfortably, and move the gleaming Bencher paddle to where it is most comfortably placed. KP2A is a pretty sharp operator — I ease the keyer speed up a bit, and dry fire a few letters to get my timing down. My fingers respond almost instantly to the higher speed.

"Hellooooo out there. W9KNI here. Any late information on the VK9Y?"

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"Okay, fine, John. Appreciate the info. You need him too, I think?"

"Okay, I'm going to run and get a cup of coffee, John. I'II be back in fourteen-oh-twenty. You ready?"

"W9KNI from K9QVB. Okay, Bob, he just said that he's going to take a two-minute break, and then be on fourteen-oh-twenty. You ready?"

"Yeah. K9QVB from W9KNI. Great, John, thanks. Yeah, I'm as ready as I'll ever be. Hope we get him."

I reach for my cup of coffee — and leave it — I've got butterflies enough.
I am the knight in armor at the end of the lists, awaiting the trumpet call. I am the Spitfire pilot revving up the engine at the end of the runway, just before takeoff to certain battle. I listen to all the carriers tuning up as I set my receiver on 14,025—they are all out there, waiting. It’s me against the wolfpack.

"Hey Bob?"
"Yeah, John, go ahead."
"Hey, don’t forget, it’s only a hobby."

That breaks the tension, and my wild flights of fancy. I laugh.

"Naw, you got it all wrong, John. It’s not a matter of life and death. It’s more important than that."

"Haw, Haw. Okay, he should be on any second now. W9KNI from K9QVB."

"Roger, K9QVB from W9KNI. Hey John, what call is he signing?"

"Oh, Yeah, he’s VK9YR—Yankee Radio."

"Thanks."

Oohkayy! Let’s go. Lemme see here. KP2A likes to set up a little lower than the usual 025; he’ll probably transmit on 14,021 or 022, and listen up around 030.

Huh, what’s that? There, on 020, maybe 569, 569, “5NN W4QM, K.”

4QM — yeah, he’s one of the South Florida aces. I give the receiver a quick turn up a few kHz. “5NN TU VK9YR DE W4QM E E.”

Yup, there he is, as I pick up the VK9 again.

“R73 QRZ NA NA UP5 DE VK9YR K.”

I blindly set my VFO on 025, and stroke the paddle.

“DE W9KNI K.”

“4QN 5NN K.” Hmm. Another four, I check my transmit frequency. There’s QON. Okay, I’m half a kHz low. Move it up. There, a hair above QON. The VK9 clears. Call. Keep it short, this fellow’s good. Okay, N4OW got him. He’s in Florida too. He clears. Call now. Huh? He’s back to N4WW this time, Florida again. There’s K9QVB calling too. Okay, I don’t need to alert him on 2. The VK9 clears; call now! There. He’s back to W4FLA — and Florida again. Let’s cool it for a moment and consider all this.

I’ve been calling at about the right frequency every time, almost, but it sure looks like the W4s are milking the long path for all it’s worth. But it’s getting later in the morning, and that path can’t hold up very much longer. Also, our peak time should be coming fairly soon; with any luck we Midwesterners should get a good shot within the next half hour. The fellows that are going to get stung are the boys on the upper East Coast. Their short path peak is being overridden by the Florida long path shot, and by the time that path is gone, so will the East Coast short path. Oh well, they leave us for dead on the short path into the “middle east,” so I guess it will all come out in the wash.

But, while the fours still have it in such convincing fashion, I’d be smart to quit transmitting and study his techniques. That way, when he does start working W9s, I’ll be ready for him. Okay, he’s back to W4MLP. Find MLP. There he is; note the frequency — yes, 026.3, plus or minus. He clears. Now — KB4CH has him. Okay, 026.6. He clears. Listen to that pileup! Back to the VK9. Yes, he’s got KT4X. There’s the KT4, 026.9. All right! The VK9 is working up through the pile. Fast, too. One call seems to get him. None of your 1x3s for this boy. Great!

4BW — 027.1. W9QN — huh? No, he’s in Florida too, 027.3. Thought for a moment we nines had broken the stranglehold. Oh well, our turn will come.

Hey, this boy IS good. I notice with admiration how he’s picking up only the stations that give him an X1 call — in other words only sign their own call, and only once. That’s the mark of a very good DXpedition operator. There are two ways to do that, and both are tough. One is copy several signals simultaneously and choose the one that meets the X1 rule. The other is to copy the call a QSO ahead and pick it up one QSO later. But either is tough to do. However, a skilled operator can get a QSO rate that is 50 per cent higher than he can without that selection. And at the rate the VK9’s going he might be good for a 150-QSO-per-hour rate. That’s really great for us: it
means our chance of a QSO in a brief opening is greatly enhanced.

Okay, KG4TH — where’s he? Oh, yes, 027.6. Now it’s N4BKU; yup, 028.0. KB4AJ 028.3. Okay, he’s moving up 300 to 350 hertz every QSO, apparently always moving after each. Now, is he going to keep moving up, or will he stop and start tuning down, or will he suddenly move down and start tuning up?

W4TO — where’s he? He ought to be about 028.6. But no. Back to the VK9’s frequency. He clears. Maybe he’s moved. There, he’s got N4AR. Wait a minute! That isn’t Florida, that’s Bill in Kentucky. Maybe the path has shifted. Quick, go ahead and look for him. He’s probably a back-scatter signal.

Yes! There he is, 024.2. All right! Let’s try 024.5. Call; just one. The paddle dances under my fingers, “DE W9KNI.”

“WB8EUN 5NN K.” Darn! Okay; there’s EUN, right on the same frequency I was. He clears. “DE W9KNI K.”

“W9BW DE VK9YR 5NN K.” Where’s BW? There, above me about 200 hertz. Up 300 for me above BW.

“DE W9KNI K.”

“K9QVB 5NN K.” Good for QVB. There he is, just about zero with me. Okay, up 200 again.

“DE W9KNI K.”

“W8SR 5NN K.” Yup, the fours have lost the path. Hope I get one. There’s 0SR on backscatter. He’s about 200 above me. Okay, my steps up seem to be a little too small now; he seems to be jumping about 400 at a time. Move the VFO.

“DE W9KNI K.”

“K9RF 5NN DE VK9YR K.” Well, the nines seem to have a lock on him. It would be nice if I could be one of them. Up another 400 hertz.

“DE W9KNI K.”

“K9DX 5NN K.” Where’s DX? He’s nowhere near my frequency. Quick, look down. Yes! 023 and a hair. The VK9 shifted back down. Quick, about 300 above DX. Call!

“DE W9KNI K.”

“W9KNI 5NN DE VK9YR.”

“VK9YR 5NN TNX DE W9KNI.”

“R TU E E.”

Wow! Just like that. The actual QSO took under ten seconds. But he’s all mine. I’m in the log. I notice that I’m breathing fast. Ah, it feels good to inscribe the rest of the details into the log.

I turn 2 meters back up; I must have turned it down earlier in the fray, but I don’t remember.

“Twenty-eight. Twenty-eight.”

“DWQ’s got him. Way to go Ed!”

“Twenty-eight point five, eight point five.” I recognize K9DX’s voice.

“It’s W0VX.” There’s K9RF giving the call signs.

“Twenty nine oh. Watch it, he’s going to move back down.”

“K5LM.”

“He moved. Oh twenty three two. Call up a little.”

“K9AJ, good work, Mike.”

“Twenty three five.”

Ah, the 2-meter net is having one of its finest hours spotting frequencies for the rest of the club. It was a free-for-all at first, but as soon as a few members made it through, they started coaching the rest. But I’m glad I figured it by myself. Not that I’m against help, but it is nice the other way.

“W9OA — way to go, George.”

The basement lights blink; my signal to lift up my headset a moment.

“Bob, breakfast’s ready.” A wave of sausage aroma follows my wife’s voice. They don’t need me here on 2 meters — and I’m hungry!
Collins Owners’ Reports:

KWM-2
KWM-2A

A survey of owners’ opinions on these two popular transceivers

The April, 1980, issues of *ham radio* and *Ham Radio Horizons* carried questionnaires directed at the owners of Collins equipment: 32S-line transmitters, 75S-line receivers, and the KWM-2 and KWM-2A transceiver. In this issue, we will present our readers’ opinions on the KWM-2/2A transceiver. Next month, we’ll give you a rundown on what our readers had to say about their S-line gear.

the good features

By far and away the single most commonly mentioned feature of the Collins KWM-2/2A transceiver is its great reliability. More than any other characteristic, reliability seems to be the hallmark of these radios. In a way, that’s not too surprising: many of these rigs (27,000 have been built since 1958) have seen continual use for more than 20 years. Virtually every owner of a KWM-2 or KWM-2A included praise for its reliability among his comments.

Running just behind reliability on the list of best features were stability and audio quality. Take a look at the table of Best Features and you’ll get a feel for just how many owners of these Collins radios were happy about the superior stability and audio of their transceivers. Also well represented among the Best Features were wide frequency coverage (making it possible to operate the new frequencies opened to Amateurs as a result of the 1979 WARC), ease of operation, solid construction, and dial accuracy. Below are some representative comments by our respondents to the question, What is the rig’s best feature?

‘The KWM-2A has excellent stability, accurate readout, and good audio quality both transmit and receive. It has large knobs that are easy to use, and

By Martin Hanft, WB1CHQ, Production Editor, *ham radio* magazine
it's built like a battleship. Long life expectancy and very neat looking design of front panel.” — WØRJ

"Wide frequency coverage, good reliability, easy to operate, good human engineering, good frequency readout and stability, no TVI problems.” — W3PE

"The VFO. It is low-drift and calibrated accurately enough to be precisely resettable.” — KH6S

"Absolutely superb audio quality. Addition of a speech processor increases average audio, but disturbs pureness of the audio signal as originally designed by Collins. Collins Field Service Engineering department very helpful, considerate, and prompt.” — WD4CWF

"Dial accuracy and dependability. Stability. Every bit as accurate as the digital (readout), and certainly the dial is easier to turn with the thumb hole.” — WA6UZL

"Reliability, ease of operation, and solid construction.” — VE3RO

"High resale value. The radio has good audio and is easy to maintain. There's a very good instruction and service book that comes with the equipment.” — K5NG

"The design of the receiver circuits. The permeability tuned rf circuits plus the careful design of the whole receive chain are, to me, the hallmarks of this rig. There is a combination of sensitivity and rejection of unwanted signals that is as good as anything manufactured today. There is still nothing that will outperform this KWM-2.” — K5RSG

"Superb audio quality combined with sharp selec-
tivity inherent in the mechanical filter. Truly accurate frequency readout without having to resort to digital displays. Beautiful appearance.”

“It's a well-engineered tube-type rig, which leads to unusually good frequency stability, matchless audio, tolerance for SWR, and relatively easy owner servicing.” — W0RHW

“Faults with the Collins are few and far between.” — WA6PSG

“Dependability.” — K9LKA

“Durability: This rig is over 20 years old and has needed only minor servicing.” — WD5CKA

“This rig with its external VFO, crystal pack, and speech processor is exactly what I need for Navy MARS activities. It will hit all the oddball frequencies and give me all of the output I need without a linear.” — W9NZF

“I like the 1-kHz readout on the dial. It has the best sounding audio of any rig I have used, and it is super reliable. A real easy rig to operate.” — K9BQL

“Selectivity, sensitivity, and calibration. I would buy another, if I could convince my XYL!” — WB2VXY

“Frequency coverage. Plug in a crystal and operate anywhere.” — WA1PEL

“Reliability. I inadvertently left it on FULL TUNE (key down) position for almost two hours with no bad effects. In fact, I am still using the same finals.” — WB4KCO

“Easy to tune and operate. It will cover any 200-kHz band between 3 and 30 MHz. Very good receiver front end. Excellent frequency stability, and rear skirt allows easy interface to other station equipment, such as RTTY.” — WA9VYB

“I can always count on this rig to do what it is capable of without fail, without eccentricity or deviation — and do it rather well.” — K50CS

“Excellent engineering, very stable, good filter, and repairable. All parts can be worked on and replaced easily. It is only unfortunate that tube technology is phasing out so fast.” — VE7AFJ

“Ability to withstand abuse. I have driven all over the U.S.A., including the desert Southwest, gotten dust and sand in it mobiling, accidentally overloaded it, mistreated it in almost any way you can think of short of dropping it out the window. It never has failed to operate.” — W0RKU

“Solid investment — especially with today’s stock market.” — KA6ACD

“Longevity! This rig (serial #42) was purchased by my dad in 1959. It gave him 20 years’ service until his becoming a silent key last year. The KWM-2, now in my possession, has since motivated me into earning my Novice ticket and I’m now struggling toward my General. I plan another 20 years’ service from the rig.” — KA6IYH

“The use of good components makes this the best unit I have ever owned since my first license in 1937. I’d say it’s the best rig ever made for Amateur use.” — K4FXP

“Maintaining this rig myself sure beats waiting for new solid state modules to arrive — or for factory servicing.” — KH6BZF

the other side of the coin

Some of the very qualities that make the Collins KWM-2/2A so attractive to so many Amateurs are cited by other Amateurs as the radios’ faults. The fact that the KWM-2/2A is solid and dependable also means that it’s big and heavy in comparison with more modern, solid-state rigs. The fact that it uses tube circuits, which the Amateur can service himself, often without the help of professional service technicians, also means that those tubes will have to be replaced and the radio may put out a lot of heat. Because the radio was designed over 20 years ago, primarily for SSB use, it is less than ideal for CW: there is no CW filter position, and there is no R.I.T. And, hand in hand with its good resale value and the fact that the Collins name is widely respected, this transceiver is not inexpensive.

The worst feature most commonly cited in the KWM-2/2A was the relays. In earlier models, these relays were open (unsealed) and not of the plug-in variety. Dirty contacts were referred to by many of the respondents to this questionnaire. Several of the owners of the KWM-2/2A who wrote to us had replaced the original relays with plug-ins; in later models, Collins began using sealed relays, which

**table 2. Worst features**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>relays</td>
<td>27</td>
</tr>
<tr>
<td>no CW filter</td>
<td>16</td>
</tr>
<tr>
<td>position</td>
<td></td>
</tr>
<tr>
<td>bad CW rig because of frequency offset</td>
<td>11</td>
</tr>
<tr>
<td>heat</td>
<td>11</td>
</tr>
<tr>
<td>no R.I.T.</td>
<td>9</td>
</tr>
<tr>
<td>200 kHz per segment</td>
<td>8</td>
</tr>
<tr>
<td>high cost</td>
<td>7</td>
</tr>
<tr>
<td>faulty switches</td>
<td>5</td>
</tr>
<tr>
<td>RCA phono plug for antenna</td>
<td></td>
</tr>
<tr>
<td>no noise blanker</td>
<td>5</td>
</tr>
<tr>
<td>no internal supply</td>
<td>4</td>
</tr>
<tr>
<td>problems with bandpass switch</td>
<td>3</td>
</tr>
<tr>
<td>weight and size</td>
<td>2</td>
</tr>
<tr>
<td>microphone</td>
<td>1</td>
</tr>
<tr>
<td>delay in getting parts</td>
<td>1</td>
</tr>
<tr>
<td>broad signal</td>
<td>1</td>
</tr>
</tbody>
</table>

24 March 1981
considerably cut down on the number of these problems. In most instances, a simple cleaning of the relay contacts and regular use are all that’s necessary to get the rig working properly again. Another common complaint was that the KWM-2/2A is not a good radio for working CW, because of the frequency offset.

See table 2 for the percentages. Below are some sample replies to the question, What is the rig’s worst feature?

"Does not have a noise blanker built in. It should have a cooling fan for the 6146s (I added one on mine). Transceiver is a bit slow on recovery from transmit to receive. Also, the transceiver has no R.I.T." — W0RJ

"No supplied noise blanker. No CW filter position." — W3PE

"Only 200 kHz tuning capability per switch position (crystal)." — W4FDJ

"No good on CW because of 1.5 kHz shift in transmitted signal." — W3US

"The bandpass. There are no selectable options for the bandpass besides the 2.1-kHz installed. This situation becomes a problem when it is desired to copy 850-Hz shift RTTY signals. The high tone is then eliminated. Other than this, the narrow and steep sided bandpass characteristics are superb." — KH6S

"Requirement for external power supply and very long production lead time for parts." — WD4CWF

"Band switch was corroded and had to be cleaned. Even when it came back from Rockwell-Collins, the switch was corroded and had to be cleaned. Not easy if you have it on a rack." — WA6UZL

"It’s no good on CW, and it needs a noise blanker. Only 200 kHz per segment, and it’s hardly portable." — K6RK

"Initial high cost and factory cost for repairs." — K5NG

"I don’t like being able to tune only 200 kHz at a time. And they use a phono plug connector for the antenna." — WA7ZPQ

"Not solid state. I hope the tubes for this rig do not become obsolete. The open relays in the VOX circuit collect dust. No notch filter or noise eliminator." — W3TFTF

"The worst feature is the heat given off by the tubes — and the tubes’ having to be replaced." — WB4PVT

"Difficult to troubleshoot and repair, and factory work is very expensive." — WB6ZYE

"There is no designed-in way to get narrower selectivity for CW reception, although Collins did point out that the transceiver was intended only for occasional, not serious, CW." — W0RH

"Noisy VOX relays." — WB1FYV

"Band switch problems." — WB4NTM

"Weight and size. In the summer, it requires a small fan for cooling during extended periods of use: that is, over 30 minutes." — W2HBC

"RCA phone plug for antenna connection (should be BNC-type)." — K2QDE

"The fact that in this period the relays were not plug-in." — N7AA

"Poor CW break-in capability. Not too fast on recovery." — WB2VXY

"Not easily adaptable for mobile use." — WA1PEL

"If judged during its heyday, I can think of none. Now, of course, it lacks some of the little conveniences of the newer rigs: R.I.T., digital readout, power requirements, etc." — K50CS

"VOX controls mounted inside chassis. Key jack is behind the rig and also covered by the power supply. And this radio is very expensive, even used." — KA6ACD

problems

The most common problem encountered with this rig was having to replace tubes. Take a look at table 3 and you’ll see that tube failures were by far and away the biggest problem. Several owners reported problems with shorted capacitors; and once more, relay problems show up as a main source of trouble for KWM-2/2A owners.

Nevertheless, the fact remains that most of the KWM-2/2A owners who responded to this survey were happy with their rigs and considered the problems to be minor. Many reported no problems. Here are some of their replies to the question, Have you had any problems?

"PTT relay contacts dirty." — WB6AWU

"Changed telephone-type relays to plug-in type." — K7GEX

"C187 shorted and the unit blew fuses. It required removing the band switch housing and band switch

<table>
<thead>
<tr>
<th>table 3. Problems</th>
<th>percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>tubes</td>
<td>42</td>
</tr>
<tr>
<td>relays</td>
<td>23</td>
</tr>
<tr>
<td>shorted capacitor</td>
<td>11</td>
</tr>
<tr>
<td>long wait for parts</td>
<td>11</td>
</tr>
<tr>
<td>also high cost</td>
<td>6</td>
</tr>
<tr>
<td>band switch</td>
<td>5</td>
</tr>
<tr>
<td>VFO dial</td>
<td>4</td>
</tr>
<tr>
<td>VOX circuit</td>
<td>4</td>
</tr>
<tr>
<td>alignment</td>
<td>2</td>
</tr>
<tr>
<td>difficult to change</td>
<td>2</td>
</tr>
<tr>
<td>components</td>
<td>2</td>
</tr>
<tr>
<td>AGC</td>
<td>1</td>
</tr>
</tbody>
</table>
shaft to replace. I occasionally have to replace, tubes.” — AH6U

“Just worn tubes.” — HI3HEG

“I have a KWM-2 which has been almost fully modified to the "A" version. Occasionally (about once a year) the old wired-in relays give me trouble. I remove the M2 from its case, clean the relays, and it’s good for another year. I do have the plug-in relay kit and plan to install it the next time the old relays give me trouble.” — W3US

“Tubes and alignment.” — WA6UZL

“VOX circuit erratic — had to change many components.” — K6RK

“In over 20 years of use, I’ve replaced a few weak and shorted tubes. Original 6146s lasted nine years. Haven’t had to change them since. Replaced one capacitor and one resistor!” — K5NC

“Tubes and heat.” — K20B

“Minor problems easily corrected by replacing a soft tube or tightening a loose screw. The equipment is so well made and logically constructed that it almost repairs itself.” — KB9IY

“Mica capacitor in the i-f failed. Loose screw in the power supply shorted B+.” — K9LKA

“The usual tube replacements.” — K9LKA

“An intermittent receiver problem that has been hard to locate.” — WD5CKA

“Had to replace the power transformer after ten years.”

“Severe audio feedback when mic button released; corrected by cleaning all relay contacts with emery cloth — a very difficult job because my rig does not have plug-in relays.” — WA1PEL

“VFO dial slippage.” — WA2CBA

**accessories**

Table 4 shows the accessories purchased for the KWM-2/2A. A noise blanker was the most frequently mentioned item, followed by speech processors and amplifiers. It certainly does seem as though finding the wanted accessories is not much of a problem: 98.7 percent of the respondents who had purchased accessories had been able to find all the accessories they’d wanted. And 97.8 percent were satisfied with the accessories they purchased.

**related findings**

The beam antenna is by far the most popular antenna with KWM-2/2A owners, accounting for 55 percent of the tally. Next came wire antennas, with 34 percent, followed by all others, 11 percent. As for license class, there were a large percentage of Advanced-class hams represented, 57 percent, followed by 39 percent for Extras. Technicians, Generals, and Novices made up the remaining 4 percent. More than half of the hams who responded did their own servicing, and the majority of those who shipped the rig out for factory service were satisfied with the service they received. A few complained about a minimum parts order of $50 and delays in service or delivery.

The following twelve categories were scored from 1 to 10 (with 1 being poorest, 4 to 6 average, and 10 perfect): Ease of Operation, Reliability, Durability, Instruction Book, Factory/Dealer Service, Quality of Workmanship, Performance, Maintenance, Parts Availability, Accessories (ease of connection), Price, and Flexibility. The scores are reported in fig. 1.

**would you buy one again?**

This is the big question, and for the KWM-2 and KWM-2A the answer was that 73 percent said yes versus 27 percent who said no. That’s a very good showing for a radio that was designed and built before the days of integrated circuits and modern “conveniences.” Yet the KWM-2/2A continues to hold its own — and remains very popular. Of those who answered that they would not buy this rig again, the most common reason was the price, followed by the lack of modern, solid-state construction or “extras” found only on newer rigs. Not a single respondent faulted the Collins KWM-2/2A for lack of quality or workmanship. These transceivers were built to be solid and dependable — and they still are today.

Next month, *ham radio* will present the results of its survey of owners of the 325-line transmitter and 755-line receiver. Watch for it. And don’t forget to return the questionnaire on the ICOM 701, Drake TR7, and Kenwood 520 series that appeared on page 22 of the February issue. If you own, or have owned, one of these rigs, now is your chance to tell the world what you think of it.

---

**Table 4. Accessories**

<table>
<thead>
<tr>
<th>Accessory</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise blanker</td>
<td>13</td>
</tr>
<tr>
<td>Speech processor</td>
<td>10</td>
</tr>
<tr>
<td>Amplifier</td>
<td>10</td>
</tr>
<tr>
<td>External VFO</td>
<td>8</td>
</tr>
<tr>
<td>Rejection tuning</td>
<td>8</td>
</tr>
<tr>
<td>Microphone</td>
<td>5</td>
</tr>
<tr>
<td>Crystal pack</td>
<td>5</td>
</tr>
<tr>
<td>Q multiplier</td>
<td>4</td>
</tr>
<tr>
<td>Digital display</td>
<td>4</td>
</tr>
<tr>
<td>Dummy load</td>
<td>3</td>
</tr>
<tr>
<td>Wattmeter</td>
<td>3</td>
</tr>
<tr>
<td>Antenna tuner</td>
<td>1</td>
</tr>
<tr>
<td>Transverter</td>
<td>1</td>
</tr>
<tr>
<td>SWR bridge</td>
<td>1</td>
</tr>
</tbody>
</table>
# More Keyer Features for Less Cost

AEA Invites You to Compare the AEA Keyer Features to Other Popular Keyers on the Market.

## Important Keyer and/or Trainer Features

<table>
<thead>
<tr>
<th>Feature</th>
<th>AEA MM-1</th>
<th>AEA KT-1</th>
<th>AEA MT-1</th>
<th>AEA CK-1</th>
<th>AEA MK-1</th>
<th>COMPETITOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed Range (WPM)</td>
<td>2-99</td>
<td>1-99</td>
<td>1-99</td>
<td>1-99</td>
<td>2-99</td>
<td>8-50</td>
</tr>
<tr>
<td>Memory Capacity (Total Characters)</td>
<td>500</td>
<td>500</td>
<td>400</td>
<td>100/400</td>
<td>400</td>
<td>8-50</td>
</tr>
<tr>
<td>Message Partitioning</td>
<td>Soft</td>
<td>Soft</td>
<td>Soft</td>
<td>Hard</td>
<td>Hard</td>
<td></td>
</tr>
<tr>
<td>Automatic Contest Serial Number</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Selectable Dot and Dash Memory</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Independent Dot &amp; Dash (Full) Weighting</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Calibrated Speed, 1 WPM Resolution</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td></td>
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<tr>
<td>Calibrated Beacon Mode</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Repeat Message Mode</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td></td>
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<tr>
<td>Front Panel Variable Monitor Frequency</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Message Resume After Paddle Interrupt</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Semi-Automatic (Bug) Mode</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Real-Time Memory Loading Mode</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Automatic Word Space Memory Load</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Instant Start From Memory</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Message Editing</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Automatic Stepped Variable Speed</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>2 Presettable Speeds, Instant Recall</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Automatic Trainer Speed Increase</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Five Letter or Random Word Length</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Test Mode With Answers</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Random Practice Mode</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Standard Letters, Numbers, Punctuation</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>All Morse Characters</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Advertised Price</td>
<td>$199.95</td>
<td>$129.95</td>
<td>$99.95</td>
<td>$129.95</td>
<td>$79.95</td>
<td>$139.95</td>
</tr>
</tbody>
</table>

## Options:

- **MT-1P** (portable version of MT-1) with batteries, charger, earphone: **$139.95**
- **ME-1** 2000 character plug-in memory expansion for MM-1: **$59.95**
- **AC-1** 600 Ma. 12 Volt wall adaptor for MM-1 with ME-1: **$14.95**
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- **DC-1** Cigarette lighter cord for all AEA keyers and trainers except MT-1P: **$5.95**
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All our keyers (except the MT-1) will operate with any popular single lever or lambic squeeze paddle and will key any type of modern amateur transmitter with no external circuitry required. AEA keyers are as easy to operate as a four function calculator. The internal AEA computers are all pre-programmed for the features shown above. Each AEA product is fully RF protected and receives a complete elevated temperature burn-in and test before it is shipped from the factory.

Ask a friend how he likes his AEA keyer compared to anything else he has ever tried, then JUDGE FOR YOURSELF. See the AEA keyer and trainer family at your favorite dealer.

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AEA Brings you the Breakthrough!
Digital frequency displays are becoming commonplace in new transceiver designs. Older but still useful rigs lack this refinement. A digital display may be added easily to single-conversion transceivers such as those made by Swan and Atlas. The display described here will enhance operation of these rigs.

Frequency counters are in wide use, and it is quite easy to measure a CW transmitter's frequency. Single sideband is difficult, since a steady tone is required and you must find the carrier by adding or subtracting the tone frequency. Received-signal frequency measurement requires connection to the local oscillator plus mathematical operation on adding or subtracting the intermediate frequency.

common display methods

Nearly all transceivers use a single master oscillator or VFO for tuning both receive and transmit frequencies. A display can use this variable oscillator output, compensating for the i-f and any other fixed oscillators.

Digital display compensation can be made by heterodyning the VFO pickoff before counting, multiple gating and counting the VFO and fixed transceiver oscillator outputs, or presetting the display counter before a count. The last is the easiest to implement and is easily accomplished with single-conversion transceivers such as the Swan 350, 500C or the Atlas 180, 210, or 215X.

Any of the three methods require some form of bandswitching. Both the Atlas and Swan units add the i-f and VFO on 10, 15, and 20 meters and subtract the i-f and VFO on lower bands. The preset-counter method takes a bit of study.

preset and complement

Counter ICs such as the 74176 and 74196 can load a specific number into the counter before counting is done. This is presetting a state and is the same as addition: final count is the sum of the preset value and number of regular count pulses. An equivalent subtraction is possible by borrowing a computer technique called complementing.

When added to a number, a complement will yield a sum value equal to a difference. The highest carry is ignored. Since a count is desired in decimal, subtraction requires the tens complement. The minuend value remains the same; the subtrahend value is replaced by its complement, addition is done, and the resultant value (ignoring the last carry) is the same as the difference.

If you're confused, assume a subtraction that re-

By Everett L. Beall, K6YHK, 715 East Cook Street, Santa Maria, California 93454
results in zero. The subtrahend will be the tens complement of the minuend. For example, the complement of 35 is 65, since \(35 + 65 = 100\) (ignore the highest carry). The complement of 850 is 150 since \(850 + 150 = 1000\) (again, ignore the highest carry).

Ignoring the highest carry is easy to implement. It is either unconnected, or the most-significant digit (MSD) of the display is blanked.

**some examples**

Setting up a Swan transceiver display counter on 20 meters requires addition. The preset, or load, will be 5500 kHz. For a six-digit display, the counter will accomplish:

| load i-f  | 05500.0   |
| add VFO   | 8502.2    |
| display sum | 14002.2   |

A 40-meter display requires subtraction of the i-f from the VFO. Conventional subtraction would be:

| input VFO | 12505.3 |
| subtract i-f | 5500.0  |
| difference | 7005.3  |

A preset counter can't subtract, so the complement of the i-f, 4500.0, is loaded first:

| load i-f complement         | 4500.0 |
| add VFO                    | 12505.3 |
| display sum                | 7005.3* |

The asterisk indicates a blanked display digit. The actual sum is 17005.3 with a preset of 04500.0. The preset value could have any MSD value, since the display MSD is blanked (the counter's most-significant digit operation is ignored on low bands).

Atlas transceivers have i-f of 5520 kHz, so the low-band complement is 4480 (5520 + 4480 = 0000)*. Addition and subtraction by complements is the same as in the Swan example.

**digital dial and display for the Atlas transceiver**

Fig. 1 is the schematic. U5 through U9 provide the counter time base. Count gating and display control are generated by U1-U4. The counter chain uses 74176 TTL presettable BCD counters. The 74196 and 74LS196 are pin-for-pin compatible and may be sub-

![Schematic diagram](image)

**fig. 1.** Schematic of Atlas transceiver digital display. Points marked A and B are 5 Vdc, regulated, from supplies in either fig. 3 or 6.
stified. The 74176 consumes less current, and the 35 MHz maximum count frequency is well above any expected frequency.

Counter preset data pin connections are:

<table>
<thead>
<tr>
<th>decimal preset</th>
<th>preset pin levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>1 0 0 1</td>
</tr>
<tr>
<td>8</td>
<td>1 0 0 0</td>
</tr>
<tr>
<td>7</td>
<td>0 1 1 1</td>
</tr>
<tr>
<td>4</td>
<td>0 1 0 1</td>
</tr>
<tr>
<td>5</td>
<td>0 1 0 0</td>
</tr>
<tr>
<td>3</td>
<td>0 0 1 1</td>
</tr>
<tr>
<td>2</td>
<td>0 0 1 0</td>
</tr>
<tr>
<td>1</td>
<td>0 0 0 1</td>
</tr>
<tr>
<td>0</td>
<td>0 0 0 0</td>
</tr>
</tbody>
</table>

A 0 indicates ground, or less than 0.4 volt. A 1 indicates any voltage between 2.4 volts and the 5-volt

fig. 2. Bus and jumper wiring diagram, wiring side of main and display boards.
supply. The high, or 1, state may be obtained by leaving the pin unconnected.*

The 7475 quad latches hold the counter state for display. Conversion to seven-segment LED display is through the 7447s. Grounding pin 1 of any 7447 will blank that digit display.

Monsanto MAN 64A common-anode, seven-segment LED displays were used, since they were in the junk box. Any common-anode LED with decimal point will work as well. The 150-ohm series resistors may have to be changed for different displays. Check manufacturer's specifications for proper value, allowing 0.4 volt at the 7447 driver output pins when a segment is illuminated.

**internal sequencing and display**

The time base counts down from a 1-MHz crystal oscillator, U9. The crystal is a Jameco CY-1A but may be any general-purpose crystal. The trimmer capacitor allows adjustment to WWV; a 5-50 pF range should be sufficient.

The 7490 dividers in U5-U8 are connected for symmetrical output. The divide-by-five output is connected to the divide-by-two input. Final output is 100 Hz or 10 millisecond period.

U1 through U4 must be wired directly as shown. This count and display control circuit is similar to the Atlas digital dial and provides a 100-ms count gate, count latch, and preset load in a non-overlapping sequence.

The 100-ms count gate allows 10-Hz counter resolution. Display is limited to 100 Hz resolution by omitting the latch, decode, and display packages for first-stage counter U16.

Counter preset data is always present but is not loaded until pin 1 of the 74176s goes low. A front-panel switch selects the proper preset. The HIGH position is for 10, 15, and 20 meters; LOW is for 40, 80, and 160 meters. This switch also controls MSD blanking of decoder U28.

**layout and construction**

Layout is not critical. The bus wiring diagram of fig. 2 follows the schematic and signal-flow sequence. Perforated board with one-tenth-inch (2.5-mm) hole spacing is used throughout. Board wiring is by wire wrap, with sockets for all ICs and displays.

I've found that wire wrap is easiest for a single project. It permits easy changes. Adhesive-backed copper tape is used for power, ground, latch, and preset bus lines. Socket wiring is wrapped, then soldered to the bus strips. This technique eliminates the usual rat's nest of conventional wire wrapping.

The main board is 5 inches (127 mm) by 8 inches (203 mm).

The six-digit display board is 5-1/2 by 1-1/4 inches, (13.8 cm by 3.2 cm) attached to the main board with small brackets and No. 2 machine screws and nuts at holes marked D in fig. 2. Holes marked M are for mounting the main board in the enclosure.

Usual socket layout orients pin 1 in the same direction. Signal flow and bus strips required some modification of this rule. Use care in identification during construction. The 0.1-µF disc ceramic bypass capacitors should be mounted where shown.†

**connection to the Atlas**

Power requirements are 5 Vdc at 1.2 amperes. My display used 12 volts from the Atlas external oscillator socket (fig. 3). Two National LM309K three-ter-

---

*An unconnected TTL input will float to a high level but is susceptible to noise pickup; direct connection to +5 volts minimizes noise pickup.

†If possible, use several 0.01-µF bypasses, distributed evenly along power and ground buses, which reduces the possibility of digital noise entering the receiver.
which is 9-1/2 inches (24 cm) wide and 6-3/4 inches (17.1 cm) deep, fits nicely on top of an Atlas cabinet. Shown in fig. 4, this homemade enclosure uses aluminum sheet plus angle stock for strength and joining the cover.

Metal spacers and No. 4 screws hold the main board to the bottom section. Since I used 1/2-inch (12.7-mm) spacers, the wire-wrap posts had to be trimmed after wiring to prevent shorts. Height may be increased to eliminate trimming or to include a power supply.

Power regulators and the dropping resistor are mounted on the back surface. The resistor cover prevents possible burns. Wiring from the Atlas is made directly into the display.

modification for the Swan transceiver

Preset connections must be changed for the Swan’s 5600 kHz i-f, and this information is given in fig. 5. Pins 4, 10, 2, and 11 of U14 through U16 remain grounded. External oscillator connection and power-supply arrangements are shown in fig. 6.

The ac-input supply may be used with any transceiver and installed within a larger display cabinet. Only one series regulator is required with the ac supply; LED display power is taken unregulated from the transformer center tap.

A Swan display could use the power supply from either fig. 3 or fig. 6; choice depends on primary power at installation.

preset options

The tens complement method is limited to single-conversion and certain VFO ranges. Some situations may use the nines complement for the MSD preset. The nines complement is equal to the tens complement minus one. One situation is indicating 12 MHz with a 15-MHz VFO.

The tens complement method would display 22000.0 or 2000.0* with MSD blanked. The added

---

fig. 4. Enclosure as seen in the photographs. Aluminum sheet 0.06 inch (0.060 cm) used for bottom and top. L-angle stiffeners are 1/2 inch (1.3 cm) which are available at hardware stores.

fig. 5. Swan transceiver preset connections. U14, U15, U16 connections are the same as in fig. 7.

fig. 6. Swan transceiver connections and optional ac power supply. Part numbers indicated are available in Radio Shack stores.

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complement would be 07000.0 and obviously wrong. Changing the MSD to nines complement, or 97000.0, would correct this:

<table>
<thead>
<tr>
<th>Operation</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>load mixed complement</td>
<td>97000.0</td>
</tr>
<tr>
<td>add VFO frequency</td>
<td>15000.0</td>
</tr>
<tr>
<td>display sum</td>
<td>12000.00</td>
</tr>
</tbody>
</table>

**Modifications of the preset can be included to correct slight frequency errors in a VFO. Grounding all presets allows direct frequency measurement subject to the accuracy of the time-base crystal oscillator.**

**Summary**

In this day of synthesizers, built-in digital displays, and other refinements, it's still possible to update good equipment. This isn't a beginner's project, but it can be built by an experienced homebrewer. Options are possible. An added incentive is low cost.

**Appendix**

This material is included for clarification of the only complex part of the digital display — the count and display control. This circuit has been breadboarded as well as analyzed. It works up to 1 MHz input without trouble.

The digital display operation depends heavily on proper operation of U1 through U4 (fig. A-1). Operation of this circuit is detailed as an aid to trouble-shooting and to illustrate variations in digital circuit designs. This section controls the counting gate, latch, and preset sequencing automatically.

The timing diagram begins with decade counter U3 in a decimal 9 state. U2-12 is low, inhibiting the U4 VFO count gate and holding the counter chain and display idle. The first negative edge from U4-3 will toggle U3 from 9 to zero. U3-11 will go low and toggle U2-12 high; counting begins.

After ten negative edges of U4-3, or 100 milliseconds, U3-11 will go low again. U2-12 will toggle low, inhibiting the U4 VFO count gate and holding the counter chain and display idle. The first negative edge from U4-3 will toggle U3 from 9 to zero. U3-11 will go low and toggle U2-12 high; counting begins.

The timing diagram begins with decade counter U3 in a decimal 9 state. U2-12 is low, inhibiting the U4 VFO count gate and holding the counter chain and display idle. The first negative edge from U4-3 will toggle U3 from 9 to zero. U3-11 will go low and toggle U2-12 high; counting begins.

After ten negative edges of U4-3, or 100 milliseconds, U3-11 will go low again. U2-12 will toggle low, inhibiting the VFO gate and toggling U2-9 high. Both U1-9 and U1-12 have remained low due to the low J input at U1-7 from U2-9; both sections of flip-flop U1 are connected as a shift register.

The next negative edge from U4-3 will toggle the first stage of U3 high and toggle U1-9 high, U1-8 low. U1-12 is ready to toggle on the next clock pulse from U3-4, but more significantly, U2-9 is cleared low by the low state of U1-8 into the direct-clear input, U2-6. The LATCH bus goes high through the inverter connection of U4-5,6 and all of the 7475 latches store the full counter state.

The following negative edge from U4-3 will toggle U1-12 high and force U3 into a decimal 9 state through the R8 control pins. The 7490 used for U3 will be held in the decimal 9 state until pins 6 and 7 go low. The first stage of U3 will toggle low and remain for 15 to 20 ns until forced high; flip-flop delays account for the negative spike.

If U1-12 is high, then U1-13 will be low and counter PRESET is enabled. Counters assume the preset connections, but the latches hold the previous count due to U4-6 dropping to a low state. U1-9 is now low and sets up U1-14 J input for the next clock edge.

The last clock will toggle U1-12 low and remove the forced 9 state of U3. U3 does not toggle, since the forced condition will have been still present at the clock edge arrival time. U3 remains in a 9 state, and all flip-flop Q outputs are low. The counter and display are idle.

The cycle will start again on the next clock edge. Display update occurs every 140 milliseconds, about seven per second.

Take care not to confuse pins 8 or 9; 12 or 13 of both flip-flop packages. An improper connection will cause a short cycle and false display; possibly no display at all.

**Fig. A-1. Counter gate and display timing circuit.**

**Fig. A-2. Counter gate and display timing diagram.**

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*ham radio*
more about moonbounce

My last column was an introduction to "moonbounce" (earth-moon-earth) communications — the past history of it and the way Radio Amateurs use this exciting means of communicating. One important point I stressed is that EME is totally unlike the more common modes of communications in that the parameters required for moonbounce work are well known and the beginning moonbounce enthusiast can make the larger, more well-equipped stations work for him, thus taking a portion of the communications burden off his back!

The Amateur bands between 6 meters and 1296 MHz have been used for moonbounce work. The most popular bands for this up-and-coming mode are 144 MHz and 432 MHz. There seems to be more activity on the 2-meter band, and the station requirements for this band are well established. This column limits discussion to 144 MHz moonbounce operation.

A representative EME path is shown in fig. 1. If two operators can see the moon at the same time, the path is available for contact. For general operation, EME operators aim for a "window in the sky" called the universal window, an area in the sky in the path of the moon through which most operators can see the moon. Most moonbounce activity occurs when the moon traverses the window.

The round-trip antenna gain required under ideal conditions on 144 MHz is very close to 41 dB. This means that a moonbounce operator having an antenna with a power gain of 21 dB over a dipole should be able to hear his own moon echos and should hear other moonbounce stations having 21 dB of antenna gain, or more.

Since the round-trip gain is supposedly constant, stations having an antenna gain less than 21 dB can't hear their own echos but can hear other...
stations having more than 21 dB of antenna gain. A station having an 18- dB gain antenna, for instance, should be able to hear and work moonbounce stations having an antenna gain of 24 dB. Exceptions to this rule make moonbounce very exciting.

Several commercially available 2-meter Yagi beams have a claimed signal gain of over 16 dB. Taking this as par, then, how does the beginning moonbounce builder up a practical EME array? Well, the 16-dB antenna can hear other moonbouncers having an antenna gain of 24 dB. Enough moonbouncers have arrays of this size to make a 16-dB antenna marginally acceptable for a moonbounce contact. The biggest moonbounce arrays that I know of in everyday use run about 26 dB over a dipole. Once in a while hams in research establishments obtain permission to put a “big dish” (parabolic) antenna on the air for moonbounce work. And that provides a moon-reflected signal that will knock your ear off!

how to achieve moonbounce antenna capability

How big must the moonbounce array be to provide practical EME work? A 16-dB antenna will permit contact with a few stations. If two 16-dB antennas are combined properly to form a larger array, the overall gain will be increased by about 2.5 dB. If four arrays are combined, the gain will go up another 2.5 dB. Two arrays, then, provide 18.5 dB and four provide 21 dB. Suitable antenna combinations are shown in fig. 2.

Many moonbouncers settle for four arrays as this configuration is not too bulky and the feed system is not complicated. Some of the ardent DXers use many as 24 antennas in a four-by-six arrangement — yet many enthusiasts use only one or two arrays.

Some of the factors to be considered when building a moonbounce array are as follows.

Distance to the moon. The distance to the moon varies because the moon’s orbit is an ellipse. At perigee (the closest point) the moon is about 221,400 miles (354,240 km) from the earth and at apogee (the farthest point) the moon is 252,700 miles (404,320 km) away. The path difference is about equal to 2 dB, so it pays big dividends to use the moon when it is closest to the earth.

Sky noise. This phenomenon refers to background noise that may limit reception. There are a lot of radio noise sources in space. The sun, for example, is a prolific radio-noise generator. Certain stars are radio-noise sources, too. A noisy star in line with the moon can override weak moonbounce signals. Wise moonbounce operators operate when the moon is in a quiet portion of the sky to reduce competition from unwanted noise.

Faraday rotation. A puzzlement to early EME experimenters was the mysterious loss of signal caused by polarization rotation of the signal as it passed through the earth’s atmosphere. Many simple moonbounce antennas are fixed as far as polarization goes, and the operators must patiently wait until polarization aligns itself with their antennas before contact can be established.

In addition, atmospheric effects can blur the signal (scintillation) and the rough surface of the moon causes libration fading. All of this means that sometimes moonbounce communication is almost impossible, and at other times signal strength is so great it cannot be explained.

But to plan a moonbounce station, a certain set of normal conditions must be taken, and the overall situation is not as gloomy as it might sound. To begin with, a single 16-dBd Yagi antenna will suffice if the beginner wishes to listen for some of the more well-equipped EME stations. Two 16-dBd Yagis will provide improved capability and allow two-way communication with the better moonbounce stations. Four Yagis will provide good EME capability. And from this point, the moon’s the limit!

moonbounce station equipment

Before leaving the discussion of the antenna it should be pointed out that feedline loss plays an important part in EME work, and it should be held to as low a value as possible. The length of the line should be short and the antenna mounted near the equipment. Contrary to what is required for ionospheric-reflected DX work, height is not important for EME work as long as the antenna can clearly “see” the moon. Many moonbouncers place their antenna right outside the operating room. In some cases a good grade of RG-213/U or RG-8B/U cable is used, or else the larger, more expensive RG-17/U cable. The better-equipped stations use air-dielectric coaxial line for minimum loss.

Some deluxe moonbounce stations locate the receiver preamplifier and transmitter power amplifier directly at the antenna to eliminate feedline loss. I don’t recommend the beginner attempt this, but it illustrates the attention to detail that makes a successful moonbounce station.

Progressing down the feedline, the antenna relay is a critical item. The relay must provide adequate isolation of the receiver during periods of transmission. The very sensitive devices used in EME preamplifiers cannot stand seepage of rf from the transmitter around the relay contacts. Many moonbouncers use two separate antenna relays, one to switch the feedline and the second to ground the input terminals of the receiver preamplifier for protection.

Next item to consider is the station receiver. A good, low-noise preamplifier is required. The receiver may consist of an hf receiver with a 2-meter converter in front of it. The receiver should be equipped with a narrowband filter such as used for CW reception. This will provide the best signal-to-noise ratio and enhance the operator’s ability to hear weak signals. A passband of about 500 Hz is a good compromise.
Finally, the transmitter must be considered. While moonbounce contacts have been made on rare occasions by stations using as little as 200 watts output, a practical moonbounce station calls for 1 kW input, with about 700 watts going into the antenna system. Maximum power, of course, provides the greatest margin for success.

In addition to the transmitting and receiving equipment, the practical EME station requires an accurate clock. A tape recorder is very handy for recording received signals. And finally, if the moonbounce antenna is steerable, the operator requires alignment information to aid in finding and tracking the moon.

With a tracking antenna and lunar orbital information, the moonbounce operator is able to plan his operation into the future and arrange schedules with other enthusiasts. The Nautical Almanac provides lunar information in terms of the Greenwich Hour Angle (GHA) and, unless the operator lives in Greenwich, England, he requires a second publication which converts this information into usable data. And, finally, the longitude and latitude of the station must be known.

A helpful handbook which discusses all of this information in detail is VHF Radio Propagation, by J.D. Stewart, WA4MVI (book number 21575) published by Howard W. Sams & Co. and available at many Amateur Radio distributors and from Ham Radio's Bookstore, Greenville, NH 03048 ($4.95 plus $1.00 shipping).

A day in the life of a moonbouncer — K1WHS

This is the story of Dave Olean, K1WHS, an active moonbouncer. Dave uses an array of twenty-four large Yagis to provide a power gain of over 26 dBi on 2 meters. This is an actual account of Moonbounce DX using this super-big antenna.

![One of the “Boomer” antenna arrays of the type used by K1WHS in his moonbounce antenna.](image)

The alarm clock sounds like Big Ben. I awake with a start in the blackness and fumble around to silence the noisemaker. Ah, yes. Tonight is the Universal Window. Saturday morning, 2 A.M. on the east coast. A lot of Europeans will be on 2 meters looking for moonbounce contacts.

Up and at ‘em. Wringing the sleep from my eyes, I head toward the shack. I flip on the lamp, view my schedule list and check the clock. The big antenna array of twenty-four Yagis rotates around to intercept the moon at the touch of the controls. The equipment has been running and warm all night in anticipation of this moment.

With a yawn I slip on the earphones, key the 2-meter transmitter, and adjust the drive level for 100 watts output. The SWR on the transmission looks good. All seems to be in order. I send a few dots and switch to receive. Yes! I am greeted by a nice moon-reflected echo of my signals that have just made the 450,000 mile (720,000 km) round trip.

The moon is at perigee, or the closest point to the earth. I know this can make a big difference when a small, marginal moonbounce antenna is being used on one end of the EME circuit. Path loss can increase by 2 dB between perigee and apogee, and this can spell success or failure with a marginal antenna.

All right. I scan the 2-meter band between 144.000 and 144.015 MHz and hear a few signals. They are coming back at me from the moon. WA1IJKN/7 is calling CQ on 144.007 MHz. Lance is about two and one-half S units above the background noise and very steady. Good copy. That’s a good sign.

Some days the lunar-reflected signals are very “watery” and subject to severe, rapid fading. Such conditions tend to frustrate avid moonbouncers. Stations with small antennas may have a hard time making any contacts at all during a period of disturbed conditions. Not so this evening. Tonight the band sounds perfect! Even the galactic background noise is cooperating. Very little excess noise means signals will be strong and clear.

By this time my first schedule with DL8GP in Germany is about to begin. I tune the receiver to 144.030 MHz and zero-beat my transmitter frequency as close as possible. Wow! I’m hearing his signal!

“K1WHS DE DL8GP...K1WHS DE DL8GP...” He’s there. Over and over I hear the two calls, clearly. After two minutes he signs over to listen for me. I transmit calls back for a minute and a half, then in the last 30 seconds I send the letter O several times, to signify that full call sets have been received. That’s moonbounce shorthand many stations use.

I stand by and DL8GP answers with more moonbounce shorthand: “R-O-R-O” meaning OK, call sets received. Another moonbounce DX
schedule logged. His signals have been quite steady the whole time. I let him go to work other moonbounce stations looking for a European contact.

The moon at this point is about one hour away from setting in central Europe. I touch up the antenna rotors to peak the array on the moon. A beamwidth of less than 6 degrees means a lot of antenna tweaking to stay on the moon. I generally update my headings every six or eight minutes.

What else is going on? I think 144.004 is clear for a CQ. I am "looking" toward the east and, by convention, should transmit during the even two-minute periods of the hour. As I reach for the key, VE7BQH and WB0QMN both come on calling CQ, about a kilohertz apart. Both signals are of unbelievable strength, considering they are coming at me from the moon. It is hard for a moonbouncer to comprehend the signal levels as received on such a large antenna array. Both Tom and Lionel are S6 on peaks, the receiver meter bouncing with a little libration fading. I quickly drop the idea of sending a CQ and decide to call WB0QMN. To my surprise he doesn't come back! This occurrence, I say to myself, is a perfect example of the K1WHS moonbounce theorem: Namely, that if a signal is loud enough to roll your socks up and down on 2-meter moonbounce, the operator will not even detect your signal! Sort of a vhf version of Murphy's Law.

Back to the idea of a CQ. I move up the band a few kHz and send a short call. Wow! A pileup calling me! This is difficult, as all signals are zero-beat and all about the same strength! Sort of like 20 meters, I say to myself. Through the din I can make out...14 (Italy) and W...DU. The other calls are lost. After two minutes, I've just been able to pull out one complete call...here it is: HB9QQ (Switzerland)

I'm really surprised, as the Swiss station is a new one I've never heard before. I've tried schedules with him off and on since 1976 with no luck, and now here he is, big as life! The big, 24-Yagi array does the job, and I pick him out of a moonbounce pile-up on a CQ. Times do change on vhf! Pierre is running about 339. A good signal. He gives me 539 and we sign off.

Time for another CQ? No, sked-time with G4IDR in England is coming up. This will be a tough one as he's only running a single long Yagi and 400 watts. He can only aim at his horizon since his Yagi is used mainly for tropospheric and meteor scatter work. But now his setting moon is in line with his antenna and the prearranged sked time is upon us.

Watching the sweep second hand on my clock, I begin my calling sequence and pause between characters to listen to my own echo. It is very strong. Now, I listen for Dave, G4IDR. Nothing. I wait for two minutes and start calling again. Half-way through my calling period I detect a signal during the keying sequence. It is very, very weak and sounds like background flutter.

The signal builds up slightly. I hold my breath and close my eyes...an old trick which seems to concentrate hearing comprehension. Parts of a call come through "...1WH...4...DR."

In my next calling sequence I start sending the letter M in the last 30 seconds. This told Dave I was getting parts of his call. Now, I again listen and Dave's moonbounce signal picks up a bit to allow a few sets of calls to sneak through, then a slow, gradual slide into the background noise begins. Faraday rotation has struck again!

From experience I know it will be at least ten or fifteen minutes before I hear him again. I send a batch of Os to G4IDR, telling him I have received the call sets. Moonset in Europe for G4IDR is 0812, and at 0800 I start to hear him again after a 40-minute lapse. Excitement builds as I strain to hear him. I figuratively crawl down the earphone cord. He is building up, now...at 0804 he is much stronger, in fact, now moving the S meter! The whole 2-minute sequence is nearly Q5 copy.

I acknowledge his transmission with enthusiasm, stopping at 0810 as I know he's lost my signals.

Suddenly, the telephone rings and I jump involuntarily. None other than Dave, G4IDR, is on the line from England! He's so excited he can hardly talk. He was running 400 watts output into a single, 19 element Boomer Yagi. But the surprise was that he had removed the front six feet of the boom and the associated elements so that he could turn the antenna in his small yard. He had a 3-dB loss in his feedline, moreover, giving him only 200 watts into a "lobotomized" Yagi beam! I exchanged excited words with him, set up a new sked, then turned back to the receiver for more listening.

The moon has set in Europe, so I switch my calling period from even 2 minutes to the odd ones and call CQ. There's WB0QMN coming back, weak but readable. I answer Tom and give him a 339 report. No reply. Where did he go? Another call. No reply.

As I start to call again, the phone rings for the second time. It is Tom, WB0QMN.

"Do you know what you just heard?", he asks. "I was running my 10-watt exciter into my moonbounce array! Ten watts! I nearly fell out of my chair when you came back. I decided you must be working someone else and that my ears tricked me. So I didn't reply. Then when you called again..."

"Surely the QRP DX report of the century," I replied. "No way to top that one."

The moonbounce DX session was over by now. The moon "window" was closed. I flipped off all the control switches and headed up the stairs for a quick wink of sleep before I had to go to work. Not a bad "DX window" for 2-meter moonbounce work. Too bad I didn't get the Italian station. Maybe next time...
genesis of a synthesizer

Design and construction of a low-cost 2-meter synthesizer

Several years ago, after purchasing an inexpensive 2-meter rig for the car, I realized that crystals for this new toy were rather expensive. If I loaded up all 23 channels I would have more invested in quartz than in the rig! Clearly, a synthesizer was needed, and so the search for ideas began.

A search of the literature revealed that most designs used TTL, consumed lots of power, used two (or three) crystals in a mixing scheme, and could be improved upon with a dash of newer technology.

Next, some design objectives were laid down. These were the following:

1. Coverage of the entire 2-meter band in 5-kHz increments
2. Adequate output drive at 12 MHz (transmit) and 45 MHz (receive)
3. Switch-selectable offsets of +600 kHz, −600 kHz, or simplex operation
4. Low power consumption (less than 250 mA)
5. Good temperature stability, small physical size, and low cost (less than $100)

Happily, these objectives have been met, and the result is what follows.

system design

Referring to fig. 1, the system block diagram, we see that the reference frequency for the phase detector is derived from a very stable 6.82666-MHz crystal oscillator. This signal is divided by 4096 to provide the 1.666-kHz reference frequency. The phase detector output is smoothed to dc by the loop filter and controls the VCO frequency. This frequency is divided by 2 before being applied to a divide-by-N counter. N is determined by the settings of the thumbwheel switches and the choice of offset.

The divide-by-N counter output supplies the second input to the phase detector, closing the feedback loop. The receive and transmit outputs are the VCO frequency and the VCO frequency divided by four respectively. This scheme was the simplest I could devise consistent with my needs. Now, let’s fill in the blocks.

how it plays

Refer to the schematic, fig. 2. It was suggested to me that, for best frequency stability, the reference oscillator should be in the 5-10 MHz range. For this reason, the crystal is a 6.82666-MHz unit, cut for 30-pF load capacitance. U1, a CD4060B containing the oscillator circuit and an on-chip divide-by-4096 counter, provides the 1.666-kHz reference. (Note the heavy temperature compensation.) Also, the load capacitance can be adjusted slightly to offset the crystal frequency for +5 kHz channel spacing. Zener regulation provides excellent stability over an 11-15 volt supply range.

The desire for low-power consumption made the MC14046 (or RCA CD4046) a logical choice for the phase detector. The loop filter was adapted from the design of DJ2LR1 and was designed to provide a worst-case settling time of about 50 ms. The output of the loop filter controls the frequency of an MC1648 VCO, tuned by an MV104 varactor. A 2N2369, Q1, converts the VCO output (an ECL square wave) into a TTL-compatible signal to drive the output buffer and divide-by-four circuits.

This signal is divided by two by U14, an SN74S74

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The flip-flop output is then level-translated to clock U15, an MC12013 dual-modulus prescaler. U3-U8, and U15, form the divide-by-N counter. Note that, since the MC12013 output is at ≈ 2.5 MHz, subsequent stages can be relatively low-speed CMOS devices. The divide-by-N arrangement divides the VCO signal down to 1.666 kHz for the phase detector. It's based on the scheme used by K4VB and WA4GJT. The divide-by-N counter is programmed in two ways: first, according to whether you're in transmit or receive mode (Q4 and associated circuit); second, by U9-U12 in conjunction with the thumbwheel switches and the transmit offset selection toggle switch, S2. U9-U12 form a two-decade BCD adder/subtractor capable of adding 0.6 MHz (600 kHz), or zero MHz, or subtracting 0.6 MHz from the thumbwheel switch settings.

Finally the 12- and 45-MHz signals are gated and buffered by U16 to provide low-impedance output drive. (Gating the output signals on or off helps to reduce overall current consumption.) A LM340T-5 provides regulated +5 volts for all the non-CMOS logic.

As you can see from the photos, the unit is very compact. All the CMOS circuits are mounted on a piece of Veroboard measuring 3.25 by 3.25 inches (8.3 by 8.3 cm) and are supported by four 0.25-inch (6.5 mm) standoffs. The remaining circuitry is on a double-sided PC board measuring 2-7/8 by 2-7/8 inches (73 by 73 mm). A resist pen was used to make the circuit trails.

The circuit paths are etched on the top of the PC board, and the bottom is left unetched for a ground and to shield the more sensitive circuit from any CMOS switching garbage.

Be sure to remove a small area of copper (using a small drill bit or deburring tool) from the area around the holes where any ungrounded components protrude. In addition, I fashioned a piece of thin copper into a VCO shield. Be sure that it's grounded! The general circuit board layouts are shown in fig. 3.

Feedthrough caps (500 pF) filter any rf from the PTT and +12-volt lines, while the transmit and receive outputs are taken from a pair of phono sock-
fig. 2. Schematic diagram of the 2-meter synthesizer. Reference oscillator operates in the range 5-10 MHz for best stability. Crystal is cut for 30-pF load capacitance.
Inside the 2-meter synthesizer. All CMOS circuits are mounted on a piece of Veroboard and are supported by four standoffs. Remaining circuitry is on a double-sided PC board.

...etc. The 5-volt regulator is bolted to the rear of the case for good heat dissipation.

checkout and alignment

After all of your wiring is done, I suggest checking all the interconnections with an ohmmeter. This doesn’t really take too long and often saves a lot of time later on.

Once you’re satisfied that all is in order, set the thumbwheels and toggle switches for 144-MHz simplex. Ground the PTT line and apply power. If all is well, you should be drawing about 200 mA and there should be a 12-MHz waveform at the transmit output. Lifting the PTT line from ground should cause a 44.433-MHz signal to appear at the receive output.

If all isn’t well, start a check with your oscilloscope probe, starting at the reference oscillator and working your way around the loop. Finally, use a frequency counter to adjust the crystal oscillator right onto frequency. Check for proper operation of the transmit offsets (remember that the thumbwheel switches show the received frequency). Opening the +5 kHz toggle switch should shift both receive and transmit outputs by the equivalent of 5 kHz at 144 MHz.

installation

Only five connections are required between the synthesizer and your rig. These are: +12V, ground, PTT line, and receive and transmit inputs. The latter two should be coaxial cable. Try to terminate both coax lines with somewhere between 50 and 100 ohms. K9LHA provides excellent interfacing suggestions in his article.3
A common occurrence in outboard synthesizer installations is one of vhf rf coming back into the synthesizer through the two interconnecting coaxial lines. My setup was such a case, and the results were very evident — nobody could understand a thing I said for all of the squealing and hum! The cure was to install a pair of in-line lowpass filters, thus stopping the vhf rf before it can get inside the synthesizer. Circuit details are given in fig. 4.

results

After the rf feedback problem was licked, I enlisted the help of several local Amateurs in evaluating the synthesizer. All reported that the signal was spot-on frequency. The audio on transmit is as good using the synthesizer as when using crystal control. Received signals are also of similar quality. Measured frequency drift was ±50 Hz at the 12-MHz output between the ambient temperatures provided by a deep freeze and a mildly hot oven. Best of all, the project came in within the budgeted price, thanks partially to some keen scrounging.

fig. 4. In-line lowpass filters prevent rf from re-entering the synthesizer through the interconnecting coax cables.

acknowledgments

I’d like to thank the authors mentioned previously for the ideas suggested in their articles. Also thanks to my friend Mike Blake, VE3HFP, for his comments and suggestions (and for having the patience to put up with me).

references

Check these state-of-the-art specifications

- Power Capability: 2500 W PEP
- Frequency Range: Continuous 3.0 to 30 MHz (Including WARC Bands).
- Impedance Matching: 10 ohms to 300 ohms to 50 ohms resistive.
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Have you been telling your wife and kids what a hot-shot code operator you were back in the big war? Your wife was probably impressed, and your kids were spellbound each time you related your war stories. Or perhaps you wax nostalgic over your wireless days in that rusty old oil tanker? Wasn’t that the vessel whose officers recruited high-speed operators from Joe’s waterfront bar? Didn’t you copy code eight hours a day at 50 words a minute from that coastal station? A most remarkable achievement — particularly since that Navy station never transmitted faster than 18 words per minute!

Perhaps you’re a newcomer, just beginning to learn the code. If you have the ability to tune out these old timers, you should do very well indeed. They may tell you about the old-time wireless operator (or did he work for Western Union?) who waited on customers, made change, drank coffee, smoked a pipe, read the paper, and copied Morse code all at the same time. (For some strange reason the narrators can never remember the name of this operator of yesteryear.) The longer these old operators are away from Morse code, the faster they used to copy it.

If you fit into any of the categories mentioned, or are new to Amateur Radio, then now is the moment of truth: now is the time to put your fist where your mouth is. I propose a threefold challenge:

1. The first is a sanctioned code contest to determine a national CW champion.
2. Next is a challenge to manufacturers of CW-oriented equipment to provide a suitable gift certificate to make the effort worthwhile.
3. Finally, I propose that ham radio magazine sponsor and perpetuate this contest on an annual basis, with a special award to anyone officially exceeding the current world’s record. Quite a challenge. Are you game?

What about this record? According to the Guinness Book of World Records, “The highest recorded speed at which anyone has received Morse code is 75.2 words per minute, — over 17 symbols per second. This was achieved by Ted R. McElroy (W1JYN) in a tournament at Asheville, North Carolina, on July 2, 1939.”

On that same day, Ted set another record. He copied the American Morse Code at a speed of 77 words per minute. Following the contest, Ted wrote a letter to his old instructor, Walt Candler, in which he complained that the transmitting apparatus would not go any faster, and that there wasn’t any competi-

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tion. Ted wrote, "You can't have a contest unless there is competition."

When Ted first learned the code, he used a buzzer set and an ancient typewriter. Consequently, it took him nearly nine months to reach the modest speed of 50 words per minute. So what is the problem now? Why hasn't this record been broken? We're surrounded by electronic keyboards, buffered typewriters, and memory devices that Ted McElroy never dreamed of. Isn't it time to break this record? Perhaps this challenge will initiate a serious attempt to do so.

the competition

I know a number of operators who can copy Morse in excess of 75 words per minute. Just listen to Bill Eitel, W6UF, and the members of the Five-Star Net as they roar along at this speed. They can do it! Have you heard K7BW and his super speed contacts with N6AQ? Watch Evelyn Headings, W7LLD, make a believer out of you as she copies at nearly 60 words per minute with a pencil. That's right — with a pencil. Can she break the world's record? Sure she can.

Jerry Ferrell, WB7VK1, has a certificate for 69.4 words per minute. Can he break the record? Well, he can as soon as he upgrades to General class and gets off the Novice bands. After that his code should begin to improve. However, he may be the first Novice to exceed 75 words per minute. There are many operators that can, and will, break this 42-year-old record. Why not this year?

getting started

If you're a beginner you might ask how to proceed. First, you should learn to type at 75 words per minute without error. Many operators copy in their heads and lose the ability to transcribe and produce "hard copy" of what they receive. In a sanctioned contest this is a must.

What about the code? That's the easy part. However, a word of advice. The first half hour of your initial exposure to code will determine your learning curve. You must develop correct practice habits. Here are some tips. Stay away from those who reside in self-pity as they struggle to attain 5 words per minute but never practice. Don't listen to the "experts" who passed 13 words per minute for just one minute, one time, down at the FCC office. You can do it! Just a little correct practice every day and you can be a winner. Enter that next club code contest and you're on your way.

contest rules

How about those club code contests? Have you ever listened to what is called code? The guy running the contest can't make a tape that runs over 20 words per minute, so he doubles the tape speed. Hey, don't do that, fella! It sounds like pure garbage. Give the guy who copies a chance!

What about official rules? For a world record to be valid, the contest must be held under rules similar to those in effect at the time Ted McElroy participated. According to those original rules, hard copy was submitted by each contestant. In the event of a tie, the text was checked for capitalization of each sentence and each proper noun. Text was selected, just before the contest, from old newspapers. Dates and common punctuation were permissible. Copy was machine-generated and transmitted. Dot-to-dash ratio was a one-to-three ratio with standard seven-element spacing between words. Contestants were allowed to bring their own typewriters and earphones. Three judges evaluated the contestants.

word count

What about word count? Our grandfathers counted four letters for each word. Many Amateurs now count five letters for each word. If the bit rate per letter in the alphabet is computed, it will be found that the average bit rate is just in excess of 11.3846 bits per letter. This amounts to 56.923 average bits per word, plus word space. For years the military used the word CODEX, which contains 56 bits of information, plus word space.

In 1922, a count was made of newspaper print, and it was found that the average five-letter word contained only 50 bits of information. The word PARIS contains 50 bits of information and is the timing word now used by the FCC. This later rate, plus word space, should be the standard count.

Addition of numbers and punctuation will change the average transmitted rate. That's right. Transmitted Morse will not be at a constant speed. Speed must be averaged. For this reason, the only acceptable count must be the total bits of information transmitted in a prescribed time frame. Determining the total number of bits transmitted and average speed per minute is a simple program for any computer.

Ever listen to the experts that stand around a ham-fest code contest and comment, "That's not 30 words per minute. I can copy that in my head." They are probably the same people who are afraid to try the Extra class code examination. Perhaps all of their copy is in their head. Now is the time for them to put their ears where their mouth is.

Perhaps soon there will be sanctioned state, regional, and national code contests. Then it will be your chance! Practice a little every day beginning today, then participate in the next contest. I intend to participate. I intend to beat the world's record. How about you? Hope to see you there!

ham radio
tracking satellites

inelliptical orbits

Computer program
and sample problem
for tracking OSCAR

The launch failure of the first AMSAT-OSCAR Phase III satellite was unfortunate but is only a temporary setback. The delay before the next launch will give many Amateurs a chance to get better prepared. This article contains information to enable an Amateur, with the aid of a computer or calculator, to track, in azimuth and elevation, a satellite in an elliptical orbit.

The altitude and velocity of a satellite in a circular orbit are nearly constant. However, both altitude and velocity are always changing during an elliptical orbit. Communication range is greatest at the apogee: the point of maximum altitude. This condition corresponds to the point of minimum velocity with respect to an observer on earth. A low velocity means low Doppler shift; it also means that the satellite will remain in view for a longer time and will not demand rapid antenna tracking.

The spot on the earth surface directly beneath the satellite is called the subsatellite point. A plot of the path of this point is the ground track and must include the effects of earth rotation. If the altitude and subsatellite point are known at a given time, the azimuth and elevation can be found using the same equations as for circular orbits.

Ground station latitude, $\delta g$, and longitude, $\lambda g$, will be considered positive if the latitude is in the northern hemisphere and the longitude is west of the prime meridian. South latitude and east longitude must be entered as negative numbers.

sample program

A program for the HP-41C programmable calculator and printer was written to test the equations and to learn more about elliptic orbits. Table 1 shows the variable storage locations. Let's work through an example. Our ground station is located in Los Angeles with $\delta g = 34^\circ$ and $\lambda g = 118^\circ$. The orbital parameters are:

By Paul C. Bunnell, WA6VJR, 1053 Nordhal Road, San Marcos, California 92069
| R02= 0.685 |
| R03= 328 |
| R10= 15 |
| R11= 9 |
| R12= 21.05 |
| R14= 0.5592 |
| R15= 0.8290 |
| R16= 0.8387 |
| R17= 118 |
| R18= 210 |
| R19= 3963.2 |
| R20= 100 |
| R21= 0.1768 |

**R00 = λ**  
**R01 = Re/Re**  
**R02 = e**  
**R04 = Ps**  
**R05 = COSφs**  
**R06 = E or COSθ**  
**R07 = δs or eCOS-1**  
**R08 = Δt**  
**R09 = λs or SINθ**  
**R10 = TIME INCR.**  
**R11 = λref**  
**R12 = Tref**  
**R13 = SINδs**  
**R14 = SINθs**  
**R15 = COSδs**  
**R16 = SINi**  
**R17 = λs**  
**R18 = 0**  
**R19 = Re**  
**R20 = ORBIT**  
**R21 = μ**

**Table 1. Storage locations of problem variables.**

<table>
<thead>
<tr>
<th>TIME</th>
<th>LST</th>
<th>LONG</th>
<th>RNG</th>
<th>0</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>-36</td>
<td>21.4</td>
<td>104.2</td>
<td>5.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-21</td>
<td>23.1</td>
<td>106.6</td>
<td>5.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-36</td>
<td>24.8</td>
<td>109.0</td>
<td>5.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-15</td>
<td>26.5</td>
<td>111.3</td>
<td>5.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 2. Problem initial conditions.**

<table>
<thead>
<tr>
<th>TIME</th>
<th>LST</th>
<th>LONG</th>
<th>RNG</th>
<th>0</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>-36</td>
<td>21.4</td>
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<td>5.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-21</td>
<td>23.1</td>
<td>106.6</td>
<td>5.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-36</td>
<td>24.8</td>
<td>109.0</td>
<td>5.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-15</td>
<td>26.5</td>
<td>111.3</td>
<td>5.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The radius of the earth, $R_e$, is 3963.2 statute miles, the normalized gravitational constant, $\mu'$, is 0.176842228. We will choose time increments of 15 minutes. These initial conditions are stored as shown in **Table 2**. If ground track information is desired, the program is started at label E. The calculator halts and prompts you for the number of the orbit you wish to investigate. Let's look at orbit 105. Enter that number and press the R/S key to resume program execution.

In a few minutes **Table 3** is printed. The apogee is at time 0, negative times occur before apogee, and the RNG (maximum range) column is in 1000s of statute miles. Also note that negative latitudes are in the southern hemisphere. To print the range with dimensions of kilometers or nautical miles, it's only necessary to enter $R_e$ in those units.

**Table 3. Printout of sample problem showing tracking parameters. Range is in thousands of statute miles.**

| reference orbit No. | 100 |
| time reference at apogee (Tref) | 21.0500 |
| longitude reference at apogee (λref) | 9° |
| inclination (i) | 57° |
| argument of perigee (Ω) | 210° |
| eccentricity (e) | 0.685 |
| period of ½ orbit (P) | 328 minutes |

The radius of the earth, $R_e$, is 3963.2 statute miles, the normalized gravitational constant, $\mu'$, is 0.176842228. We will choose time increments of 15 minutes. These initial conditions are stored as shown in **Table 2**. If ground track information is desired, the program is started at label E. The calculator halts and prompts you for the number of the orbit you wish to investigate. Let's look at orbit 105. Enter that number and press the R/S key to resume program execution.

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The ground track can be plotted on a northern hemisphere polar map or just a piece of polar graph paper. I found it useful to use a transparent overlay, pivoted at the north pole. The ground track is marked on the overlay in grease pencil and may be rotated to any desired position. Maximum range information may be used to determine if the satellite is within range of any two ground stations.

Another part of the program calculates satellite azimuth and elevation. Only lines in which the satellite is above the horizon are printed. Start the program as follows, showing how azimuth and elevation change with time. The asterisk locates the time of apogee. It’s not necessary to re-enter any of the orbital constants to plot other orbits. But, keep in mind that elliptic orbits suffer perturbations with time, and the latest orbital parameters available should be used.

The program requires one memory module and uses the 82143A peripheral printer. Data storage registers should be sized to 022. If a card reader is available, the program fits on two magnetic cards.

We’re approaching a new era in Amateur satellite communications. New techniques and skills will be developed in the next few years as we gain experience. I hope this article will contribute to those efforts.

### ORBIT 105

<table>
<thead>
<tr>
<th>TIME</th>
<th>AZIMUTH</th>
<th>ELEVATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>23:38</td>
<td>139</td>
<td>5</td>
</tr>
<tr>
<td>23:45</td>
<td>135</td>
<td>12</td>
</tr>
<tr>
<td>0:00</td>
<td>132</td>
<td>18</td>
</tr>
<tr>
<td>0:15</td>
<td>129</td>
<td>23</td>
</tr>
<tr>
<td>0:30</td>
<td>128</td>
<td>28</td>
</tr>
<tr>
<td>0:45</td>
<td>127</td>
<td>32</td>
</tr>
<tr>
<td>1:00</td>
<td>126</td>
<td>36</td>
</tr>
<tr>
<td>1:15</td>
<td>126</td>
<td>41</td>
</tr>
<tr>
<td>1:30</td>
<td>126</td>
<td>45</td>
</tr>
<tr>
<td>1:45</td>
<td>126</td>
<td>48</td>
</tr>
<tr>
<td>2:00</td>
<td>127</td>
<td>52</td>
</tr>
<tr>
<td>2:15</td>
<td>127</td>
<td>56</td>
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<tr>
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<td>59</td>
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<td>2:45</td>
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<td>63</td>
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<tr>
<td>3:00</td>
<td>131</td>
<td>66</td>
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<td>133</td>
<td>69</td>
</tr>
<tr>
<td>3:30</td>
<td>135</td>
<td>73</td>
</tr>
<tr>
<td>3:45*</td>
<td>137</td>
<td>76</td>
</tr>
<tr>
<td>4:00</td>
<td>141</td>
<td>79</td>
</tr>
</tbody>
</table>

Table 4. Tracking dynamics showing satellite azimuth and elevation as functions of time.

### bibliography


### appendix

The derivation of the equations is covered in the references, but there are several points of interest. Fig. A1 is a view perpendicular to the plane of an elliptic orbit. The earth is at one focus, \( F \), and the satellite at position \( S \). Also shown are the apogee, \( A \); perigee, \( P \); one-half major axis, \( a \); and one-half minor axis, \( b \).

![fig. 1. Geometry of the tracking problem for elliptical orbits.](image)

A circle has been constructed with center, \( O \), bisecting \( AP \), and with radius \( a \). Angle \( E \) is identified as the elliptic anomaly, and \( \Gamma \) is the true anomaly. Both \( E \) and \( \Gamma \) are related to the mean anomaly, \( M \) (see eqs. A1 and A3).

The problem to be solved (sometimes called the Kepler problem) is to find \( E \), given \( \Delta \) (the time of flight from \( S \) to \( A \)). With \( E \) known \( \Gamma \) can be found from eq. A3, and the satellite position with respect to the earth is then established.

We start the solution by approximating the value for \( E \), calculating \( M' \), and generating an error term, \( \xi \). \( E' \) is formed and checked in eq. A2 to see if the error term has been reduced to zero. If not, return to eq. A1, substituting \( E'' \) for \( E \), and repeat the process. Only four or five iterations are necessary for an accuracy of 1 part in one million.

\( \lambda_s \) is commonly called the longitude of the ascending node. It is derived from the argument of perigee, \( \Omega \). The location of the subsatellite point is given by latitude, \( \delta_s \), and the longitude, \( \lambda_s \). \( R_s \) is the instantaneous satellite distance from the center of the earth. The maximum range is an arc on the surface of the earth from the subsatellite point to a location where the satellite elevation drops to zero.
01 LBL "ST"
02 XEQ 04
03 STO 00
04 STO 05
05 XEQ 06
06 "TIME A"
07 AVIEW
08 XEQ 07
09 XEQ 08
10 FIX 2
11 60
12 71
13 RCL 12
14 HR
15 +
16 RND
17 FIX 0
18 24
19 MOD
20 INT
21 10
22 X<Y?
23 "Y?"
24 ARCL Y
25 "-"
26 LASTX
27 FIX 0
28 60
29 +
30 X<Y?
31 "-"
32 ARCL X
33 RCL 08
34 X=0?
35 "-"
36 X#0?
37 RCL 07
38 ELEV
39 RCL 17
40 RCL 09
41 -
42 SIN
43 STO 06
44 X<Y L
45 COS
46 RCL 15
47 +
48 RCL 04
49 +
50 RCL 14
51 RCL 13
52 +
53 +
54 STO 05
55 RCL 14
56 -
57 -
58 RCL 15
59 -
60 RCL 05
61 ACOS
62 SIN
63 STO 09
64 -
65 ACOS
66 RCL 06
67 SIGN
68 +
69 MOD
70 "ELEV"
71 XEQ 08
72 "F"
73 RCL 05
74 RCL 01
75 -
76 RCL 09
77 80 STO 05
78 SQR
79 RCL 06
80 XEQ 04
81 STO 00
82 RCL 04
83 STO 00
84 "GROUND"
85 AVIEW
86 XEQ 12
87 XEQ 01
88 "TIME"
89 LAT
90 XEQ 07
91 RCL 03
92 XEQ 01
93 FIX 0
94 XEQ 02
95 FIX 1
96 RCL 07
97 XEQ 08
98 RCL 09
99 XEQ 08
100 RCL 01
101 ACOS
102 D-R
103 RCL 19
104 +
105 ,1
106 %
107 XEQ 06
108 STO 03
109 RCL 01
110 x=0?
111 2
112 RCL 08
113 RCL 03
114 /
115 -
116 PI
117 STO 01
118 STO 06
119 ENTER
120 LBL 00
121 CLX
122 RCL 06
123 R-D
124 RCL 02
125 P-R
126 1
127 -
128 STO 07
129 CLX
130 RCL 06
131 -
132 +
133 RND
134 RCL 07
135 /
If you've been "reading the mail" on recent transmissions from the hams listed above, you've heard the kind of solid copy that rates a Q5. One reason is that they've recently switched to Shure's new 444D SSB/FM Base Station Microphone. We've been getting glowing reports on the 444D's switch-selectable dual impedance feature which makes for compatibility and changeability from rig to rig, improved million-cycle PTT control bar (with vox/normal switch and continuous-on capability); and its comprehensive all-new wiring guide. The cable leads are arranged to permit immediate hook-up to transmitters with either isolated or grounded switching. Ask the hams who own one.

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additional definitions:

- $p_s$ = period of $\frac{1}{2}$ orbit
- $e$ = eccentricity
- $i$ = inclination
- $\Omega$ = argument of perigee
- $\lambda_{ref}$ = longitude reference at apogee
- $Re$ = radius of earth
- $Rs$ = distance from earth center to satellite
- $\mu'$ = normalized gravitational constant
- $\delta g$ = ground station latitude
- $\lambda g$ = ground station longitude

Let $M = \pi \left(1 - \frac{\Delta t}{p_s}\right)$ in radians

$$ M' = e \sin \left(\frac{360E}{2\pi}\right) - E $$

$$ \xi = \frac{M' - M}{e \cos E - 1} $$

$$ E' = E - \xi $$

$$ \Gamma = \text{SIGN}(\Delta t) \cos^{-1} \left( \frac{\cos E - e}{e \cos E - 1} \right) $$

$$ \delta_0 = \sin^{-1} \left( -\sin \Omega \sin i \right) $$

$$ \lambda_0 = \text{SIGN}(\delta_0) \cos^{-1} \left( \frac{\cos \Omega}{\cos \delta_0} \right) $$

$$ \delta s = \sin^{-1} \left( -\sin(\Omega + \Gamma) \sin i \right) $$

$$ \lambda s = \text{SIGN}(\delta s) \cos^{-1} \left( \frac{\cos (\Omega + \Gamma)}{\cos \delta s} \right) + \frac{\Delta t}{3.989} $$

$$ -\lambda_0 + \lambda_{ref} $$

$$ Re = \frac{\mu' (1 - e^2) (p_s/\pi)^{2/3}}{1 - e \cos \Gamma} $$

maximum range $= \frac{Re \cdot 2\pi}{1000} \left[ \cos^{-1} \left( \frac{Re}{Rs} \right) \right]$

$$ \theta = \cos^{-1} \left( \sin \delta s \sin \delta g + \cos \delta s \cos \delta g \cos (\lambda s - \lambda g) \right) $$

azimuth $= \cos^{-1} \left( \frac{\sin \delta s \cos \theta \sin \delta g}{\cos \delta g \sin \theta} \right)$

if $\sin (\lambda s - \lambda g) < 0$, azimuth $= 360 - \text{azimuth}$

elevation $= \tan^{-1} \left( \frac{\cos \theta \cdot Re/Re}{\sin \theta} \right)$

Note: $\text{SIGN}(x) = -1$ if $x$ is negative

$+1$ if $x$ is positive or zero

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More Details? CHECK — OFF Page 110

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65M MOUL RD — HILTON, NY 14468

March 1981
Many Amateur experimenters have learned from experience that active solid-state devices are not as forgiving as vacuum tubes. A 6L6 for example can absorb considerable abuse and keep right on working; long ago we discovered we could avoid a catastrophic failure by quickly switching off the power supply when the plate began to glow.

Unfortunately, solid-state devices don’t provide us with that opportunity. High-performance devices such as vhf or microwave transistors react quickly and violently when overloaded; the time required for a GASFET to destroy itself is considerably less than a microsecond. In view of the relatively high cost (and consequent scarcity) of these devices, it seems appropriate to attack the problem at the source — the power source.

Accidents can and do happen. Consider a typical 0-30 volt bench power supply adjusted to 10 volts output, connected to a transistor circuit for test. If the supply includes a large capacitor across its output terminals, it is a potential transistor killer. In the event we should inadvertently increase the output voltage (perhaps by bumping the knob), even though the power supply’s current limiting mechanism should react properly to the ensuing overcurrent condition, the energy already stored in the output capacitor can create a transient that may destroy the transistor.

**built-in protection**

If a circuit employing a bipolar transistor is to be tested at known, fixed voltage and current, protection can be built in. The single-stage transistor amplifier shown in fig. 1 is a typical example. An amplifier of this kind is essentially damage proof.

**general-purpose regulator**

A general-purpose bench power supply regulator is illustrated in fig. 2. This regulator is particularly useful when testing power amplifiers. It includes provisions for setting the maximum available voltage and current levels to desired safe values. In the circuit shown, the 12-volt zener at the output is used as backup for the MOSFET shunt regulator. If the regulator should fail, the zener would limit the output to 12 volts.

R1 sets the maximum available load power, which in this case is 1.011 watts:

\[
P_o(\text{max}) = \frac{(E_{in})^2}{4RI}
\]

where \( E_{in} = 18.7 \) (manufacturer’s tolerance)
\( R1 = 91.5 \text{ percent (tolerance)} \)

\[
P_o(\text{max}) = \frac{(18.7)^2}{4(86.45)} = 1.011 \text{ watts}
\]

Note that this maximum power condition provides 98.9 milliamperes and 9.0 volts. Any increase in load

**By Henry H. Cross, W1OOP, 111 Birds Hill Avenue, Needham, Massachusetts 02192**
current beyond this point will take the shunt regulator off-line, and the output voltage (and load power) will drop, as shown in fig. 3. The maximum current the regulator can supply is 198 milliamperes.

To provide flexibility, the bench regulator should include provisions for changing R1. I suggest that the control be located where it normally would be inaccessible; this is insurance against accidentally changing its value. In any event, avoid making R1 a front-panel control knob.

You can adjust the transient response of the shunt regulator for minimum overshoot by selecting specific values for C1 and R3. Use a telegraph key as a momentary shorting device while observing the output voltage on a high-speed oscilloscope. I used a combination of 180 ohms and a 0.01-μF capacitor for proper damping, but other supplies may require different values. Also check the transient response when the power supply is turned on and off. R8 and C3 provide high-frequency feedback for stability.

The bench power supply regulator also includes an adjustable 5-volt negative supply. A 741 op amp is included to provide good regulation; only a limited current capacity is needed. Gate bias should reduce (become less negative) in response to clockwise rotation of the control. VD should increase with clockwise control rotation. In either case, current in-
creases with clockwise rotation. With some additional effort, you may be able to adjust the control-circuit parameter values so that the output voltage and current match the dial readings.

**low-voltage regulators**

Lower power GASFETS generally require 5-50 milliamperes at approximately 3 volts. It would be desirable to use a 4-volt zener at the output in this case as backup for the shunt regulator; however, since zeners in this voltage range don't exhibit the sharp knees of higher voltage types, the regulator is in need of some other kind of protective device.

Fig. 4 illustrates a crowbar circuit that can solve this problem. The circuit consists of a shunt SCR that fires when the regulator output voltage exceeds a preset value. The drop across the forward-conducting SCR is about 0.8 volt, not small enough to turn the supply completely off, but low enough to provide a good measure of protection.

An LM339 comparator functions as an open-loop op amp. R6 is adjusted so that the output will go low if the regulator output exceeds 3.1 volts. When this happens, the trigger voltage goes high, firing the SCR. Note that the anode sustaining current is about...
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* **Special front-end circuitry** employing the high level double balanced mixer and 48 MHz "up-converted" 1st i-f for superior general coverage, image rejection and strong signal handling performance.

* **Complete front-end bandpass filters** are included that operate from hf thru vlf. External vlf preselectors are not required.

* **10 dB pushbutton-controlled broadband preamp** can be activated on all ranges above 1.5 MHz. Low noise design.

* **Various optional selectivity filters** for cw, RTTY and a-m are switch-selected from the front panel. Ssb filter standard.

* **Special new low distortion “synchro-phase” a-m detector** provides superior international shortwave broadcast reception. This new technique permits 3 kHz a-m sideband response with the use of a 4 kHz filter for better interference rejection.

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**Model 1240**

- **The famous Drake full electronic passband tuning system** is employed, permitting the passband position to be adjusted for any selectivity filter. This is a great aid in interference rejection.

- **Three agc time constants plus “Off”** are switch-selected from the front panel.

- **Complete transceive/separate functions** when used with the Drake TR7 transceiver are included, along with separate R7 R.I.T. control.

- **Special multi-function antenna selector/50 ohm splitter** is switch-selected from the front panel, and provides simultaneous dual receive with the TR7. This makes possible the reception of two different frequencies at the same time. Main and alternate antennas and vhf/uhf converters may also be selected with this switching network.

- **The digital readout** of the R7 may be used as a 150 MHz counter, and is switched from the front panel. Access thru rear panel connector.

- **The built-in power supply** operates from 100, 120, 200, 240 V-ac, 50/60 Hz, or nominal 13.8 V-dc.

- **The R7 includes a built-in speaker**, or an external Drake MS7 speaker may be used.

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5 milliamperes, and it might be less than what the FET is drawing; so we have to keep triggering it. Normally the current through R6 is pulled to ground through the associated forward conducting transistor Q2.

Another comparator compares the voltage across current-sensing resistor R2 against a bucking voltage. When the preset current limit is exceeded, the SCR triggers. R5 is the current-limit control.

Both comparators are operated from a single power supply, with the GND terminals grounded. Under this condition, operation may become erratic if any of the op amp inputs go below ground by more than 0.5 volt. To avoid a possible problem here, the HP2800 diode and 510-ohm resistor should be included as shown.

The current meters are located across terminals b-c, after the crowbar (for obvious reasons). If the crowbar circuit should fire, the output voltage will drop to some value less than 1 volt, and the current will fall to a low value. To reset the regulator, turn off both power supplies, wait one second or longer, and turn them back on again. Note that the order in which the supplies are turned on or off is unimportant because, if the negative voltage is lacking, the positive voltage will not come on.

If a double-pole, single-throw toggle switch were connected between the regulated input voltages and the regulator, it would function as a RESET control. This is indicated at the left in fig. 4. The reset switches are normally closed.

The circuits of figs. 2 and 4 also include LEDs, which indicate that each power supply is on. Another LED indicates that the overcurrent circuit has tripped. When not otherwise indicated, the transistors are 2N3904 or 2N2222s. The comparators are LM339, 393, 2901, or 2903s.

summary

Power supplies used for experimental purposes should be equipped with fail-safe regulators, including:

1. Reverse voltage protection
2. Overvoltage protection
3. Thermal runaway protection
4. Limited available power

Regulators should be equipped with limit controls on output voltage and current. (Limit controls should not be confused with adjustments.) Shunt-type regulators can be power limited and stable without requiring a large energy-storing, transistor-killing capacitor across the output terminals. Simple electronic biasing circuits are generally best.
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More Details? CHECK—OFF Page 110
Entries must be by letter or post card only. No telephone requests will be accepted. All entries will be acknowledged when received. Those judged to be most informative to the most Amateurs will be published. Questions must relate to Amateur Radio.

Readers are invited to send a card with the question they feel is most useful that appears in each issue. Each month’s winner will receive a prize. We will give a prize for the most popular question of the year. In the case of two or more questions on the same subject, the one arriving the earliest will be used.

congratulations to...

WD5GMF, for his question about decibels (dB) in the September, 1980, issue of Ham Radio Horizons. Several readers commented on the usefulness of that question and the answer given. The subject of dB has mystified thousands of Amateurs and still shows up in discussions of electronics theory and in an exam question now and then. Thanks to WD5GMF for asking the question and thanks to those of you who took the time to comment.

narrow-band voice modulation

Please explain the narrow-band voice modulation system now being used by some Amateurs. Paul Drunen, KA4CMZ.

This modulation system is being tried in both Amateur and commercial radio circles, with the expectation that it will allow more signals per band, or permit closer spacing of channelized communications such as vhf business, police, and aircraft. The principle of operation is to carefully shape the audio from the microphone by slicing it into essential segments, then processing those segments before they reach the modulator.

There are several natural gaps in speech; some of these gaps are essential and some are not. One non-essential gap occurs between approximately 600 and 1,000 Hz. Speech sounds below 600 Hz are essential and preserved. Sounds above approximately 1,500 Hz up to 2,500 or 3,000, are essential and are likewise preserved. There are small gaps in this high range, and they, too, are essential for the understanding of speech, thus are preserved along with the sounds.

The sounds below 600 Hz are transmitted as is, but those in the upper band of 1,500-2,500 Hz are inverted and shifted lower in frequency, then combined with the low (250-600 Hz) audio, and fed to the modulator. This process not only closes the non-essential gap just above 600 Hz, but also reduces the total width of the audio signal to something like 250-1,600 Hz (there is an optional system that provides up to 2,100-Hz width if desired).

Additionally, the audio signal is processed for more nearly constant amplitude in the transmitter (compressed), and then expanded in the receiver, in a process called compandoring.

The modified audio must be fed through a special circuit in the receiver to eliminate the processing, which restores the proper gap and turns the audio “right-side-up.”

At this time, the system uses several specialized ICs in the transmitter and receiver. It is undergoing many tests and evaluations of effectiveness for Amateur and commercial use.

recommended reading


USB, LSB, or DSB?

Would you please explain the difference between USB, LSB, and Double Sideband. Stephen Serio.

Fig. 1 will help you understand these three modes of voice communication, and how they got that way. At A, you see an ordinary amplitude-modulated carrier, abbreviated a-m. It is a natural outcome of the process of modulating an rf signal with a voice signal. It is made up of a carrier and two sidebands, one above and one below the carrier.

If the modulation takes place in a balanced modulator, the carrier is balanced out (nullled), and the result is two sidebands with no carrier, B.
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SA-X-1 TRANSISTOR RF AMP
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The next step is to filter out the unwanted sideband by a mechanical or crystal filter that passes only the sideband you want, C. To obtain the other sideband, you could use another filter to pass that one and reject the unwanted one. However, that’s too expensive.

A simpler, and less-expensive way, is to change the frequency of the crystal that supplied the carrier for the modulator in the first place. Thus you simply shift the unwanted sideband to the other side of the filter’s window, as shown at D.

To properly receive SSB, you only have to duplicate the frequency of the carrier oscillator, and place it on the correct side of the sideband you want to hear, which will duplicate the original a-m signal minus one sideband.

**final protection**

I’ve used an SWR meter with various antenna tuners, and have managed to load up many types of antennas, such as random lengths of wire, zipcord, window screens, and fences. Results have often been surprisingly good. Can I be confident that a load somewhere near 50 ohms is presented to my transmitter, when it works okay, and the SWR reads below 2:1? I don’t want to damage the final stage on my Argonaut. John F. Leahy, WB6CKN.

The only time you can be reasonably sure that your transmitter is working into 50 ohms is when the reading on your SWR meter is 1:1. At any reading higher than this, the impedance at the transmitter is something else. The reading might be 1.5:1, 1.8:1, or 2:1 at the SWR meter, but what is it at the end of the piece of coax that connects to the transmitter? The apparent SWR changes with the length of the coax, and can be something entirely different a few feet down the line from the meter. Try setting up your tuner for a 2:1 reading on 10 meters. Don’t touch any tuning controls, and add a 5-foot (1.5-meter) piece of coax between the tuner and the SWR meter. It will probably read something other than 2:1.

As to how your transmitter likes this sort of treatment, if it puts out reasonable power without overheating, there’s no problem. Ten-Tec says that the output transistors are rugged enough to withstand an open or short circuit (but, of course, long-term operation with a very high SWR is not recommended), thus an SWR of 2:1 doesn’t present any real danger.

**velocity factor**

What is velocity factor? I’ve seen it in various antenna articles but haven’t yet found a good definition. Richard Anderson.

Velocity factor is a property of transmission lines that must be taken into account when calculating the physical length of a tuned line or a matching transformer made from the line. The velocity of a radio wave traveling down the line is less than in free space. It varies from about 0.95 for polyethylene-dielectric coaxial cables to 0.975 for open-wire (air dielectric) transmission lines.

**efficiency**

I’ve read about antenna tuners and Transmatches in several publications, but nothing is mentioned about their efficiency. I’ve noticed that most gear is listed at 50-70 per cent efficiency, so can I assume that with 100 watts dc input into a Transmatch that I’ll get 50 to 75 watts output? S. Capasso, KA1ETB.

First of all, you don’t run dc input to a Transmatch or antenna tuner. Dc input numbers refer only to amplifiers or the final stage of a transmitter. A good linear amplifier, as used for SSB, would work at 40 to 60 per cent efficiency, and a class-C amplifier (for CW or fm) can sometimes get up to 70 per cent.

However, the efficiency of a passive device such as an antenna tuner is determined by the losses of the wire in its coils and the material in the toroid (if any). A good antenna tuner with air-wound coils will have very little loss — 5 per cent or less. Using a toroidal balun transformer can introduce more losses, depending on the material used and the frequency of operation, anywhere from 10 to 40 per cent. Sometimes you have to accept these losses to use an unconventional antenna, or to use one antenna on more than one band. It’s better if you can design your antenna for an input impedance of 50 ohms, and do without the antenna tuner, if at all possible.
transmission-line circuit design

Using distributed resonant circuits for VHF/UHF transmission lines

This is part 4 of a 5-part article dealing with the design of resonant transmission lines. In part 1, which appeared in *ham radio* for November, 1980, I presented the governing expressions for calculating the parameters for twelve transmission-line configurations. Programs were given using the HP-97 printer capability.

Parts 2 and 3 discussed the geometry and presented the calculator programs for solving the equations for eight of the twelve line configurations: coaxial lines; parallel plates; parallel wires in air; single wire over a plane (*ham radio*, January, 1981); circular wire between planes; parallel wires over a plane; circular wire in an open trough; parallel wires between planes/rectangular box (*ham radio*, February, 1981).

In this part of the article, the last four of the twelve line configurations are examined: circular wire in a square shield; stripline over a plane; stripline centered between parallel planes; and the helical resonator. Part 5 will provide a summary of what has been discussed and show a design example for a 2-meter amplifier.

**circular wire in a square shield**

This is not a usual configuration encountered or designed, because the square cavity configuration imposes complexities due to its geometry. However, it is often chosen in the design of production filters and diplexers because dip-braze techniques can be readily used, mitigating other difficulties. The formulation yielding $Z_0$ (reference 5) is:

$$Z_0 = \frac{59.96}{\sqrt{\varepsilon_r}} \ln \left(1.0787 \frac{w}{d}\right)$$  \hspace{1cm} (41)

where $Z_0$ = transmission-line impedance (ohms)
$\varepsilon_r$ = dielectric constant
$w$ = width of each side
$d$ = diameter of center conductor

![diagram](image)

**Fig. 18** shows $Z_0$ versus $w/d$ for common values. **Table 35** is the HP-67/97 program for calculating the unknown from the known variables. **Table 36** identifies the storage registers used. **Table 37** shows how the program is controlled.

**Table 35. HP-67/97 program for calculating $Z_0$ and $w/d$ for a wire in a square shield:**

<table>
<thead>
<tr>
<th>step</th>
<th>HP-97 key</th>
<th>HP-97 code</th>
</tr>
</thead>
<tbody>
<tr>
<td>001</td>
<td>*LBLA</td>
<td>21 11</td>
</tr>
<tr>
<td>002</td>
<td>STO0</td>
<td>35 00</td>
</tr>
<tr>
<td>003</td>
<td>$\sqrt{X}$</td>
<td>54</td>
</tr>
<tr>
<td>004</td>
<td>STO1</td>
<td>35 01</td>
</tr>
<tr>
<td>005</td>
<td>RTN</td>
<td>24</td>
</tr>
<tr>
<td>006</td>
<td>*LBLB</td>
<td>21 12</td>
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<td>007</td>
<td>STO2</td>
<td>35 02</td>
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<td>008</td>
<td>$R_1$</td>
<td>-31</td>
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<td>009</td>
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<tr>
<td>010</td>
<td>RCL2</td>
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<tr>
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<td>050</td>
</tr>
<tr>
<td>016</td>
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<td>00</td>
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</tr>
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</tr>
<tr>
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</tr>
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</tr>
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</tr>
<tr>
<td>029</td>
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<td>STO5</td>
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</tr>
<tr>
<td>034</td>
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<td>51</td>
</tr>
<tr>
<td>035</td>
<td>*LBLC</td>
<td>21 13</td>
</tr>
</tbody>
</table>

**By H.M. Meyer, Jr., W6GGV, 29330 Whitley Collins Drive, Rancho Palos Verdes, California 90274**
table 38. Register contents for HP-67/97 program for calculating $Z_0$ and $w/d$ for a wire in a square shield.

<table>
<thead>
<tr>
<th>Register</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>STO 0</td>
<td>$\varepsilon_r$</td>
</tr>
<tr>
<td>STO 1</td>
<td>$\sqrt{\varepsilon_r}$</td>
</tr>
<tr>
<td>STO 2</td>
<td>$d$</td>
</tr>
<tr>
<td>STO 3</td>
<td>$w$</td>
</tr>
<tr>
<td>STO 4</td>
<td>$w/d$</td>
</tr>
<tr>
<td>STO 5</td>
<td>$Z_0$</td>
</tr>
<tr>
<td>STO 6</td>
<td>INTERIM</td>
</tr>
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</table>

table 37. HP-67/97 program control for calculating $Z_0$ and $w/d$ for a wire in a square shield:

- calculates $\sqrt{\varepsilon_r}$ enter $\varepsilon_r$ press A
- calculates $Z_0$ enter $w$ press ENTER
- calculates $w/d$ enter $d$ press B
- calculates $Z_0$ enter $w$ press C
- calculates $w/d$ enter $Z_0$ press D

Note: If no value for $\varepsilon_r$ is entered, program assumes $\varepsilon_r = 1 = \text{air}$.

For the calculation of line $Z_0$ the method in table 39 is used. The formulations from reference 3 are:

\[
\Delta w = \frac{1}{\pi} \ln \left( \frac{4e}{\sqrt{(\frac{t}{h})^2 + \left(\frac{1}{\pi h} - \frac{1}{w/h} - 0.26\right)^2}} \right)\]

\[
\frac{\Delta w'}{2} = \frac{1 + 1/\varepsilon_r}{2} \Delta w\]

\[
w = w - \Delta w'
\]

For the calculation of line $Z_0$ the method in table 39 is used. The formulations from reference 3 are:

\[
\Delta w = \frac{1}{\pi} \ln \left( \frac{4e}{\sqrt{(\frac{t}{h})^2 + \left(\frac{1}{\pi} - \frac{1}{w} + 1.10\right)^2}} \right)\]

\[
\Delta w' = \frac{1 + 1/\varepsilon_r}{2} \Delta w\]

\[
w' = w + \Delta w'
\]

\[
Z_0 = \frac{42.4}{\sqrt{\varepsilon_r + 1}} \ln \left\{ \left[ 1 + \left( \frac{4h}{w} \right) \left( \sqrt{\frac{14 + 8/\varepsilon_r}{11}} \left( \frac{4h}{w} \right) + \left( \frac{14 + 8/\varepsilon_r}{11} \right) \left( \frac{4h}{w} \right) \right) \right] \right\}
\]

fig. 18. $Z_0$ versus $w/d$ for a circular wire in a square shield.

stripline over a plane

This is perhaps one of the more useful transmission line configurations presently in use. Its applications are primarily stimulated by solid-state technology and the subsequent extensive use of microwave integrated circuits. One original formu-
table 40. HP-67/97 program for calculating $w$ and $Z_y$ for a stripline over a plane:

<table>
<thead>
<tr>
<th>step</th>
<th>HP-97 key</th>
<th>HP-97 code</th>
<th>step</th>
<th>HP-97 key</th>
<th>HP-97 code</th>
<th>step</th>
<th>HP-97 key</th>
<th>HP-97 code</th>
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<td>RTN</td>
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<td>113</td>
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</tr>
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<td>1</td>
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<td>114</td>
<td>+</td>
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<td>01</td>
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<td>-35</td>
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<td>RCL1</td>
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<td>x</td>
<td>-35</td>
<td>198</td>
<td>4</td>
<td>04</td>
</tr>
</tbody>
</table>
Table 40 is the HP-67/97 program used to calculate $Z_0$ and $w$. Table 41 identifies the storage registers used, and table 42 describes how the program is controlled.

A sample problem might readily explain how the program is used. Enter line $Z_0$, 50 ohms; dielectric constant, $\varepsilon_r$, 2.5; height, $h$, 1.0 mm; and thickness, $t$, 0.1 mm. Calculate the stripline width as indicated in table 42, $w = 2.7038$ mm. Using this value for $w$, calculate $Z_0$ from the same parameters, $Z_0 = 49.9974$ ohms, which is in good agreement with the originally specified 50 ohms.*

Table 43. Values of $Z_0$ for $w/h$ versus $t/h$ for various values of $\varepsilon_r$, for a stripline over a plane:

<table>
<thead>
<tr>
<th>$w/h$</th>
<th>$t/h$</th>
<th>$\varepsilon_r = 1.0$</th>
<th>$\varepsilon_r = 4.6$</th>
<th>$\varepsilon_r = 12$</th>
<th>$\varepsilon_r = 16$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.1</td>
<td>0.2</td>
<td>0.4</td>
<td>1.0</td>
<td>0.1</td>
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<td>166.47</td>
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<td>161.66</td>
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<td>27.90</td>
<td>27.19</td>
<td>28.12</td>
</tr>
</tbody>
</table>

*Reference 3 sample problem is the same as that presented here, but the result for $w$ is given as 2.75 mm. Since the reverse procedure here produces a $Z_0$ of 49.9974 ohms, which is in good agreement with the initial value of 50 ohms specified, perhaps a typographical error accounts for this discrepancy.

Fig. 18. $Z_0$ versus $w/h$ for selected values of $t/h$ for a stripline over a plane, $\varepsilon_r = 1$. 

*Reference 3 sample problem is the same as that presented here, but the result for $w$ is given as 2.75 mm. Since the reverse procedure here produces a $Z_0$ of 49.9974 ohms, which is in good agreement with the initial value of 50 ohms specified, perhaps a typographical error accounts for this discrepancy.
The HP-67/97 program was written in this manner to provide a built-in self-check. No graphs are provided for this configuration except for $e=1$ in fig. 19. This is because their number is too numerous to present all of the variables. Table 43, for which the value of $Z_0$ is given for useful values of $w/h$ versus $t/h$, also provides for values of $e$, of 1, 4, 8, 12, and 16. From these data additional graphs can be prepared covering specific ranges of interest.

**stripline centered between parallel planes**

Previously, the impedance of a stripline centered between parallel planes could be determined only from the work published in reference 6 and a subsequent distillation in reference 4. However, H.A. Wheeler, in 1978 (reference 21), provided an empirically derived formulation permitting direct synthesis with excellent accuracy. This is done in much the same way as for a stripline over a plane previously discussed.

When it is desired to calculate $Z_0$ with $h$, $t$, $w$, and $e$, known, the method is described in table 45. The formulation used to calculate $Z_0$ is:

$$Z_0 = \frac{30}{\sqrt{\varepsilon_r n}} \left[ 1 + \frac{1}{2} \left( \frac{16h}{\pi w'} \right)^2 + 6.27 \right]$$

where $m$ is defined in eq. 54.

Table 46 is an HP-67/97 program for calculating $Z_0$ and $w$. Table 47 identifies the storage registers used, and table 48 describes how the program is controlled.

A sample problem was run using $Z_0=50$, $\varepsilon_r=1$, $h=1$, and $t=0.0625$. The $w$ yielded was 2.7687. The reverse was run using the $w$ just calculated. The resulting $Z_0$ was 51.31, which is within the limits described in reference 2.

Fig. 20 displays $w/h$ versus various values of $t/h$ for a stripline between parallel planes, $\varepsilon_r=1$.

$w' = w + \Delta w$

$$\Delta w = \frac{\sqrt{\varepsilon_r n}}{\pi} \frac{e}{\left( \frac{4h}{t} + 1 \right)} \left[ \frac{1}{4h} \frac{1}{w} + \frac{1}{4\pi} \frac{w}{t} + 0.26 \right]^m$$

$$\frac{w'}{h} = \frac{16}{\pi} \frac{\sqrt{(e^{2\pi r} - 1) + 1.568}}{(e^{2\pi r} - 1)}$$

$$w = \sqrt{\varepsilon_r} \frac{Z_0}{377}$$

$$m = \frac{6}{3 + \frac{t}{h}}$$

where $m$ is defined in eq. 54.

**table 44. Method of calculating stripline width:**

1. Specify $h$, $t$, $Z_0$, and $\varepsilon_r$.
2. Determine $w'$ (from eq. 50).
3. Determine $\frac{w'}{h}$ (from eq. 51).
4. Determine $w$ (from eq. 52).

**table 45. Method of calculating stripline $Z_0$:**

1. Determine $\Delta w$ (from eq. 56).
2. Determine $w'$ (from eq. 56).
3. Determine $Z_0$ (from eq. 57).
### Table 46. HP-67/97 program for calculating $\omega$ and $Z_0$ for a stripline between ground planes:

<table>
<thead>
<tr>
<th>Step</th>
<th>HP-97 key</th>
<th>HP-97 code</th>
<th>Step</th>
<th>HP-97 key</th>
<th>HP-97 code</th>
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<th>HP-97 key</th>
<th>HP-97 code</th>
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<th>HP-97 key</th>
<th>HP-97 code</th>
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<td></td>
<td>$e^x$</td>
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</tr>
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<td>35 05</td>
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<td>051</td>
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<td>36 07</td>
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<td>RCL7</td>
<td>36 07</td>
</tr>
</tbody>
</table>

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*March 1981*
Helical resonators are a form of transmission line extensively used in vhf/uhf applications. The major advantage is high unloaded Q in a very small physical space, thus permitting the realization of compact filters in this frequency spectrum.

Using the reasonably accurate, simple formulation presented in references 4 and 8, an HP-67/97 program was written permitting the design to be realized. Reference 9 provides a detailed design procedure and analysis.

The helical resonator configuration is shown in fig. 21. The method for calculating the desired dimensions is given in table 50. The detailed program steps are shown in table 51 with the storage-register contents identified in table 52. Program control is shown in table 53.

A sample problem was run. The line $Z_0$ was specified at 70 ohms at 144 MHz, and all the resonator parameters were determined: $D = 0.97$ inch, $d = 0.53$ inch, $L = 1.46$ inches, $n = 13.57$ turns, $Q_u$ circular = 383, and $Q_u$ square = 700. Where square and circular, refer to the outside cavity configuration.

<table>
<thead>
<tr>
<th>Table 47. Register contents for HP-67/97 program for calculating $w$ and $Z_0$ for stripline between ground planes:</th>
</tr>
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<tbody>
<tr>
<td>STO 0 $Z_0$</td>
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<tr>
<td>STO 1 $\sqrt{\varepsilon_r}$</td>
</tr>
<tr>
<td>STO 2 $r$</td>
</tr>
<tr>
<td>STO 3 $h$</td>
</tr>
<tr>
<td>STO 4 $t$</td>
</tr>
<tr>
<td>STO 5 $t/h$</td>
</tr>
<tr>
<td>STO 6 $m$</td>
</tr>
</tbody>
</table>

| Table 49. Values of $Z_0$ for $w/h$ versus $t/h$ for various values of $\varepsilon_r$ for a stripline between parallel planes: |
|-----------------|-----------------|-----------------|-----------------|
| $w/h$ | $t/h$ | $\varepsilon_r = 1.0$ | $\varepsilon_r = 4$ | $\varepsilon_r = 8$ | $\varepsilon_r = 12$ |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| 0.1 | 229.34 | 221.95 | 206.47 | 166.70 | 83.35 | 58.94 |
| 0.4 | 151.45 | 149.38 | 144.46 | 127.64 | 63.82 | 49.72 |
| 0.8 | 112.06 | 111.05 | 108.57 | 99.43 | 54.29 | 45.13 |
| 1.0 | 99.79 | 99.00 | 97.06 | 89.77 | 59.26 | 54.82 |
| 4 | 38.33 | 32.81 | 37.93 | 36.78 | 35.28 | 35.15 |
| 10 | 17.29 | 17.26 | 17.21 | 16.97 | 17.32 | 16.71 |

| Table 50. Method of calculating helical-resonator parameters:|
|-----------------|-----------------|-----------------|-----------------|
| 1. Specify $Z_0$ (ohms) and frequency (MHz). |
| 2. Calculate $D$, $d$, $L$, $n$, $Q_u$ circular, $Q_u$ square, and coil pitch from the equations below. |

$$D = \frac{9800}{FZ_0}$$
$$d = 0.55D$$
$$L = 1.5D$$
$$n = 1900$$
$$Q_u \text{ circular} = 30\sqrt{FD}$$
$$Q_u \text{ square} = 1.2Q_u$$
$$\text{coil pitch} = \frac{DF}{2300} = \frac{L-D/2}{n}$$
table 51. HP-67/97 program for calculating helical resonator parameters:

<table>
<thead>
<tr>
<th>step</th>
<th>HP-97 key</th>
<th>HP-97 code</th>
<th>HP-97 key</th>
<th>HP-97 code</th>
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Acknowledgments

Comments by S. Harrison, WB6PKA, Dr. R.M. Searing, and T.C. McDermott, III, NSEG, are gratefully acknowledged. The most valuable contributions were provided by B.L. Reardon, to whom the author is singularly indebted.

References


Bibliography


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Sensitivity: Less than 25 mV to 150 MHz
Less than 150 mV to 500 MHz
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10.0 Hz (50 MHz range)
100.0 Hz (500 MHz range)
Display: 7 digits 0.4" LED
Time base: 1.0 ppm TCXO 20-40°C
Power: 12 VAC @ 250 ma

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Note: Sensitivity is based on a 50 ohm source into a 50 ohm load. The high frequency range is calibrated to 100 Hz. 500 MHz input through 600 MHz output through 10 MHz TCXO time base is available on request. Sensivity is based on a 50 ohm source into a 50 ohm load.
add fm to your receiver

The fm mode of operation has been around for a long while, but not until the two-meter range had it been used extensively for Amateur communications. Fm has become commonplace on vhf and uhf frequencies, but now its use is becoming more and more popular in the 29.500 through 29.700 MHz range (10-meter fm). It has always been the forgotten mode on your lowband transceiver. If you wanted to pioneer this spectrum, a piece of commercial-band equipment was your only alternative. But wait. What have we here? Comtronics FM-80, Azden 2800, and now fm on the 901-DM. **There must be someone up there!**

Commercially built ham transceivers as well as many converted CB radios have generated new life to an almost forgotten part of the ten-meter band. Don’t scoff at the mention of converted CBs, as these are among some of the top performers when properly converted.

Described here is a conversion that can be made to any receiver using a 455-kHz i-f to add true fm to its current capabilities. The circuit can be built on a piece of vector board approximately two inches (50 mm) square, allowing it to fit nicely in even the smallest transceiver.

By John LaMartina, K3NXU, 105 Skyview Drive, Shrewsbury, Pennsylvania 17361

The chip selected is an MC 1358. Although designed for TV sound service, it works excellently at 455 kHz for nbfm applications. This chip functions as an i-f amplifier, limiter, fm detector and audio driver.

**basic operation**

The 455-kHz i-f input to the IC is acquired from the last 455-kHz i-f amplifier. The fm signal is detected and set to the i-f by transformer T1. The audio is fed to an audio driver with more than enough gain to properly drive your existing audio amplifier.

**construction**

The use of a low-profile IC socket doesn’t affect
the performance of the i-f stage. Personally, I prefer to use them whenever possible (cheap insurance). In addition, try to keep all leads as short as possible. Capacitor C2 may not be required if the transformer selected is already at resonance.

**installation**

The existing detector stages of the receiver are left intact so as to not disable the S-meter and squelch function.

1. Connect the 455-kHz i-f input to the base of the last i-f amplifier transistor.
2. The audio output pad of the fm board connects to the top of the volume control pot. The existing lead to this point must be removed or switched off so as to not receive fm and the existing receiver mode simultaneously.
3. Connect 12 Vdc and ground from the receiver to the conversion board.

**adjustment**

The only adjustment necessary will be that of transformer T1. This should be set for maximum audio response upon the reception of a signal, either on the air or from an fm signal/tone generator. If too much drive is being delivered from the audio driver stage, insert a 100k resistor between C5 and the top of the volume control.

**closing comments**

I have installed several of these fm conversions and have had complete success with each.

Predrilled PC boards with complete wiring diagram are available from the author for $5.00 each.

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Get on 220 MHz all modes with your present 2 meter rig!

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Installation is easy!
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The new Lunar 220/TV is Linearized for maximum utilization of all authorized modes. In addition, it has automatic T-R functions, either RF sensed or hard keyed. In the repeat mode the 1 MHz offset adds to the 600 KHz in your 2 meter radio to give you the 1.6 MHz required on 220 MHz.

BASIC SPECIFICATIONS

Rx N.F.: 2.5 dB nom.
Rx Conversion Gain: 25 dB nom.

... at last ...
your shack organized!
A beautiful piece of furniture — your XYL will love it!

$16450 S-F RADIO DESK
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Designed with angled rear shelf for your viewing comfort and ease of operation.

FINISHES: Walnut or Teak Stain.

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This new generation RF Wattmeter with nine-mode system versatility reads...

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INTRODUCING SONY'S NEW DIGITAL DIRECT ACCESS RECEIVER!

only $299.95 plus $5.00 shipping

Revolutionary Direct Access Digital Shortwave Scanner

- Continuous Scanning of LW, MW, SW, & FM Bands
- Instant Fingertip Tuning—No More Knobs!
- 6 Memories for Any Mode (AM, SSB/CW, & FM)
- Dual PLL Frequency Synthesized—No Drift!

A WHOLE NEW BREED OF RADIO IS HERE NOW! No other short wave receiver combines so many advanced features for both operating convenience and high performance as does the new Sony ICF-2001. Once you have operated this exciting new radio, you'll be spoiled forever! Direct access tuning eliminates conventional tuning knobs and dials with a convenient digital keyboard and Liquid Crystal Display (LCD) for accurate frequency readout to within 1 KHz. Instant fingertip tuning, up to 8 memory presets, and continuous scanning features make the ICF-2001 the ultimate in convenience.

Compare the following features against any receiver currently available and you will have to agree that the Sony ICF 2001 is the best value in shortwave receivers today:

DUAL PLL SYNTHESIZER CIRCUITRY covers entire 150 KHz to 29.999 MHz band. PLL1 circuit has 100 KHz step while PLL2 handles 1 KHz step, both of which are controlled by separate quartz crystal oscillators for precise, no-drift tuning. DUAL CONVERSION SUPERHETERODYNE circuitry assures superior AM reception and high image rejection characteristics. The 10.7 MHz IF of the FM band is utilized as the 2nd IF of the AM band. A new type of crystal filter made especially for this purpose realizes clearer reception than commonly used ceramic filters. ALL FET FRONT END for high sensitivity and interference rejection. Inter-modulation, cross modulation, and spurious interference are effectively rejected. FET RF AMP contributes to superior image rejection, high sensitivity, and good signal to noise ratio. Both strong and weak stations are received with minimal distortion.

OPERATIONAL FEATURES

INSTANT FINGERTIP TUNING with the calculator-type key board enables the operator to have instant access to any frequency in the LW, MW, SW, and FM bands. And the LCD digital frequency display confirms the exact, drift-free signal being received. AUTOMATIC SCANNING of the above bands. Continuous scanning of any desired portion of the band is achieved by setting the "L1" and "L2" keys to define the range to be scanned. The scanner can stop automatically on strong signals, or it can be done manually. MANUAL SEARCH is similar to the manual scan mode and is useful for quick signal searching. The "UP" and "DOWN" keys let the tuner search for you. The "FAST" key increases the search rate for faster signal detection. MEMORY PRESETS. Six memory keys hold desired stations for instant one-key tuning in any mode (AM, SSB/CW, and FM), and also, the "L1" and "L2" keys can give you two more memory slots when not used for scanning. OTHER FEATURES: Local, normal, DX sensitivity selector for AM; SSB/CW compensator; 90 min. sleep timer; AM Ant. Adjust.

SPECIFICATIONS

CIRCUIT SYSTEM: FM Superheterodyne; AM Dual conversion superheterodyne. SIGNAL CIRCUITRY: 4 IC's; 11 FET's; 23 Transistors; 16 Diodes. AUXILIARY CIRCUITRY: 5 IC's; 1 LSI; 5 LED's; 25 Transistors; 9 Diodes. FREQUENCY RANGE: FM 76-108 MHz; AM 150-29.999 KHz. INTERMEDIATE FREQUENCY: FM 10.7 MHz; AM 1st 66.35 MHz; 2nd 10.7 MHz. ANTENNAS: FM telescopic, ext. ant. terminal; AM telescopic, built-in ferrite bar, ext. ant. terminal. POWER: 4.5 VDC/120 VAC DIMENSIONS: 12 1/4" (W) X 2 1/4" (H) X 6 3/4" (D). WEIGHT: 3 lb. 15 oz. (1.8 kg)

SPECTRONICS INC.
1009 GARFIELD ST. OAK PARK, IL 60304

PHONE (312) 848-6777

march 1981
article (January, 1975) points out the best DX frequencies in each band. Toward the end of March (associated with the equinox, which is on March 20 at 1703 UT), the geomagnetic field is easily disturbed. The equatorial plane of the sun lines up through space with the earth’s equator, giving particles a more direct path to the earth’s polar regions. Disturbances are prevalent under this condition. DX can be from unusual locations because of the ionosphere’s erratic movements. East-west paths are generally poorer; otherwise during undisturbed times, over-the-pole DX paths are better during the equinox season.

**band-by-band summary**

*Six meters* will provide some excellent openings to South Africa from the eastern U.S. and from the western and central U.S. to Australia and New Zealand around local noon-time. The openings are more probable during high solar flux values.

*Ten, fifteen, and twenty meters* will be full of signals from morning into weather affects DX, right?

Besides keeping us indoors or outside? Yes! March and April are months in which weather is usually a series of spring storms bringing rain to much of our country. These storms are usually fronts of warm and cold air, which produce the year’s first major thunderstorms. Thunderstorms mean noise (static) that affects the signal-to-noise ratio of our receivers, decreasing readability.

Thunderstorm static propagated from far off is the main overall noise level of our lower-frequency hf bands. The average noise from the thunderstorms all over the world going on at once makes this noise level. However, as a particular storm front comes near, a significant increase in the noise level can be heard. The first notice of this noise increase is at a one-hop distance away (about 600-1200 miles or 960-1920 km) when the storm front is about a day or so to the west of your location. Next, the noise will usually decrease as the storm moves closer; that is, until it is within a ground-wave distance of 50-60 miles or 80-96 km (near line of sight). Thunderstorm static is then worse, mainly individual crashes, and it becomes part of the local noise. As the storm moves away a similar decrease, then an increase, is heard in a day or so again as the front moves on. You can check this out for your location by coordinating the TV weather program with your operating/listening experience. The effect is more noticeable on the lower frequency bands.

In looking for the rare DX, you may want to make the best use of your time by tracking the storms to give you the best chance at quiet noise conditions. Remember, too, the DX station’s operating times and frequencies. An article in the November, 1980, issue of *CQ* lists the foreign national holidays (consider when the DX is home from work), and a *QST*
ASSOCIATED RADIO
8012 CONSER BOX 4327
OVERLAND PARK, KANSAS 66204

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TO OBTAIN THE NEXT UNSERVICED BARGAIN LIST SEND A SELF ADDRESSED STAMPED ENVELOPE.

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An 8044 with Speedometer*

8044M

from CURTIS

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- Ek-480M: Above plus speedometer 149.95
- I-486: InstructoMate 124.95
- M-480: MemoryMate 124.95
- IM-480: Instructo-MemoryMate 179.95
- KB-48C: Morse KeyboardMate 199.95
- KB-4800: Morse-RTTY keyboard 378.95

Above prices FOB factory

8044: Keyer-On-A-Chip (April 80) $77.98
8044-3: IC, PCB, Socket, Manual 24.95
8044-4: Semi-Kit 54.95

"(SMALL incl. speedometer font) add $5.00

8045: Morse Keyboard-On-A-Chip IC 59.95
8045-1: IC, PCB, FFC, Sockets, Manual 69.95
8045-2: Semi-Kit 159.95
8046: Instructokeyer-On-A-Chip IC 249.95
8046-1: Semi-Kit 79.95
8047: Message Memory-On-A-Chip IC 39.95
8047-1: IC, PCB, RAM, Sockets, Manual 69.95

(Add $1.75 on kites for postage and handling)

Curtis Electro Devices, Inc.
(617) 484-7223
Box 4000, Mountain View, CA 94040

YOU'VE SEEN THE MAGAZINE ARTICLES
Here's what you can expect from the DX ENGINEERING
RF Speech Processor

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- IMPROVES INTELLIGIBILITY
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- UNIQUE PLUG-IN UNIT — NO MODIFICATIONS REQUIRED

This is RF Envelope Clipping— 
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Models Now Available
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T-4, T-4X, T-4XB, T-4XC $128.50 ea.
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Watch for other models later!

DX Engineering
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Box 232-HR Rego Park, NY 11374

Tell 'em you saw it in HAM RADIO!
### Description of Components

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1K x 8 Eprom</td>
<td>$5.00</td>
</tr>
<tr>
<td>2K x 8 5V single supply</td>
<td>$9.99</td>
</tr>
<tr>
<td>1K x 4 Static</td>
<td>$5.00</td>
</tr>
<tr>
<td>4K x 1 Dynamic Ram</td>
<td>$2.99</td>
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<tr>
<td>16K x 1 Dynamic Ram</td>
<td>$5.00</td>
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<tr>
<td>32K Eprom</td>
<td>$39.95</td>
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### Description of Other Components

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microprocessor</td>
<td>$9.99</td>
</tr>
<tr>
<td>CRT Controller</td>
<td>$25.00</td>
</tr>
<tr>
<td>SSDA</td>
<td>$5.00</td>
</tr>
<tr>
<td>Microprocessor</td>
<td>$5.00</td>
</tr>
<tr>
<td>Microprocessor</td>
<td>$10.99</td>
</tr>
<tr>
<td>Microprocessor</td>
<td>$8.99</td>
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<tr>
<td>P10</td>
<td>$9.99</td>
</tr>
<tr>
<td>S10/0</td>
<td>$22.50</td>
</tr>
<tr>
<td>S10/1</td>
<td>$22.50</td>
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<tr>
<td>D/A Converter</td>
<td>$6.99</td>
</tr>
<tr>
<td>Four Bit Microprocessor</td>
<td>$4.99</td>
</tr>
<tr>
<td>DMA Controller</td>
<td>$8.99</td>
</tr>
<tr>
<td>64 x 4 FIFO</td>
<td>$3.00</td>
</tr>
<tr>
<td>Clock with alarm</td>
<td>$5.99</td>
</tr>
<tr>
<td>8 Bit Microcomputer with programmable/erasable EPROM</td>
<td>$60.00</td>
</tr>
<tr>
<td>6 Bit D/A</td>
<td>$3.25</td>
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### Description of Transformer

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.3 VCT @ 6Amps</td>
<td>$6.99</td>
</tr>
<tr>
<td>24V @ 1Amp</td>
<td>$5.99</td>
</tr>
<tr>
<td>25.2VCT @ 2Amps</td>
<td>$6.99</td>
</tr>
<tr>
<td>10VCT @ 3Amps</td>
<td>$7.99</td>
</tr>
<tr>
<td>20VCT @ 1Amp</td>
<td>$4.99</td>
</tr>
<tr>
<td>12.6VCT @ 2Amps</td>
<td>$4.99</td>
</tr>
<tr>
<td>28VCT @ 100 MA</td>
<td>$4.99</td>
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### Description of Other Components

<table>
<thead>
<tr>
<th>Description</th>
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<tbody>
<tr>
<td>MRF472</td>
<td>12.5 VDC, 27 MHz</td>
</tr>
<tr>
<td>4 Watts output, 10 dB gain</td>
<td>$1.69 each</td>
</tr>
<tr>
<td>CARBIDE Circuit Board Drill Bits for PCB Boards</td>
<td>5 mix for $5.00</td>
</tr>
<tr>
<td>MURATA CERAMIC FILTERS</td>
<td>SFD 455D 455 KHz $2.00</td>
</tr>
<tr>
<td>SFB 455D 455 KHz 1.60</td>
<td></td>
</tr>
<tr>
<td>CFM 455E 455 KHz 5.50</td>
<td></td>
</tr>
<tr>
<td>SFE 10.7 MA 10.7 MHz 2.99</td>
<td></td>
</tr>
<tr>
<td>ATLAS CRYSTAL FILTERS FOR ATLAS HAM GEAR</td>
<td>5.5/2 - 2.7/8</td>
</tr>
<tr>
<td>5.595 - 2.7/8/U</td>
<td></td>
</tr>
<tr>
<td>5.645 - 2.7/8</td>
<td></td>
</tr>
<tr>
<td>5.595 - .500/4/CW YOUR CHOICE</td>
<td></td>
</tr>
<tr>
<td>5.595 - 2.7 USB $12.99 each</td>
<td></td>
</tr>
<tr>
<td>5.595 - 2.7/8/L</td>
<td></td>
</tr>
<tr>
<td>5.595 - 2.7 LSB</td>
<td></td>
</tr>
<tr>
<td>9.0 - USB/CW</td>
<td></td>
</tr>
<tr>
<td>J310 N-CHANNEL J-FET 450 MHz</td>
<td></td>
</tr>
<tr>
<td>Good for VHF/UHF Amplifier, Oscillator and Mixers, 3/$1.00</td>
<td></td>
</tr>
<tr>
<td>AMPHENOL COAX RELAY</td>
<td>26 VDC Coil SPDT #360-11892-13</td>
</tr>
<tr>
<td>100 watts Good up to 18 Ghz</td>
<td></td>
</tr>
<tr>
<td>$19.99 each</td>
<td></td>
</tr>
<tr>
<td>78M05 Same as 7805 but only ½ Amp @ 5 VDC 49¢ each or 10/$3.00</td>
<td></td>
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### Description of Transformers

<table>
<thead>
<tr>
<th>Description</th>
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<tbody>
<tr>
<td>F-18X 6.3 VCT @ 6Amps</td>
<td>$6.99</td>
</tr>
<tr>
<td>F-46X 24V @ 1Amp</td>
<td>$5.99</td>
</tr>
<tr>
<td>F-41X 25.2VCT @ 2Amps</td>
<td>$6.99</td>
</tr>
<tr>
<td>P-8380 10VCT @ 3Amps</td>
<td>$7.99</td>
</tr>
<tr>
<td>P-8604 20VCT @ 1Amp</td>
<td>$4.99</td>
</tr>
<tr>
<td>K-32B 28VCT @ 100 MA</td>
<td>$4.99</td>
</tr>
<tr>
<td>E30554 Dual 17V @ 1Amp ea</td>
<td>$6.99</td>
</tr>
</tbody>
</table>

### Description of Transformer

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>12.5 VDC, 3-30 MHz</td>
<td>$3.99</td>
</tr>
<tr>
<td>80 Watts output, 12 dB gain</td>
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### Description of Other Components

<table>
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<tr>
<th>Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>EIMAC FINGER STOCK #Y-302 36 in. long x ½ in.</td>
<td>$4.99</td>
</tr>
</tbody>
</table>

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More Details? CHECK-OFF Page 110

March 1981 81
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MRF227 2.13 MMC2369 15.00 SALE PRICE $19.99
MRF238 10.00 MMC2484 15.25
MRF240 14.62 MMC3960A 24.30 1900 MHz to 2500 MHz DOWNCONVERTERS
MRF245 28.87 MWA110 6.92 Intended for amateur radio use.
MRF247 28.87 MWA120 7.38 Tunable from channel 2 thru 6.
MRF262 6.25 MWA130 8.08 34 dB gain 2.5 to 3 dB noise.
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MRF422 38.25 MWA330 9.23 $39.99
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MRF428A 38.25 $69.95
MRF426 8.87 TUBES Power Supply Kit - Box, PCB and parts
MRF426A 8.87 6DK6 $ 5.00 $49.99
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MRF449A 10.61 6MJ6/6LQ6/6JE6C 6.00 $79.99
MRF450 11.00 6LF6/6MH6 5.00 Power Supply assembled
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MRF454A 21.83 4CX250R 69.00 MRF901 $ 3.99
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MRF455A 14.08 4CX350A/8321 100.00 .001 Chip Caps 1.00
4CX350F/J/8904 100.00 Power Supply PCB 4.99
MRF472 2.50 4CX1500B/8660 300.00 Downconverter PCB 19.99
MRF473 2.90 811A 20.00
MRF475 2.90 6360 4.69
MRF476 2.25 6939 7.99
MRF477 10.00 6146 5.00
MRF485 3.00 6146A 5.69
MRF492 20.40 6146B/8298 7.95
MRF502 0.93 6146W 12.00
MRF504 2.00 6550A 8.00
MRF629 3.00 8908 9.00
MRF648 26.87 8950 9.00
MRF650 3.99 4-400A 71.00
MRF652 9.41 4-400C 80.00
MRF672 3.00 5728/T160L 44.00
MRF691 4.29 7289 9.95
MRF5176 11.73 3-1000Z 229.00
MRF8004 1.39 3-500Z 129.99 Continuous Tone Buzzers
BFR90 1.00 110VAC MUFFIN FANS
BFR91 1.25 New $11.95 Used $5.95
BFR96 1.50 PL259 TERMINATION 52 Ohm 5 Watts

NO ORDERS UNDER $10
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Check, money order, or credit cards are welcome. (Master Charge and VISA only)

No personal checks or certified personal checks for foreign countries accepted.

Money order or cashier’s check in U.S. funds only. Letters of credit are not acceptable.

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

All parts returned due to customer error will be subject to a 15% restock charge.

If we are out of an item ordered, we will try to replace it with an equal or better part unless you specify not to, or we will back order the item, or refund your money.

**Prices are subject to change without notice.** Prices supersede all previously published. Some items offered are limited to small quantities and are subject to prior sale.

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

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

### Prices

<table>
<thead>
<tr>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE555 Timer</td>
<td>39¢ each or 10/$3.00</td>
</tr>
<tr>
<td>NEW DUAL COLON LED</td>
<td>$12.99 each</td>
</tr>
<tr>
<td>1000 PIV</td>
<td>$6.99 each</td>
</tr>
<tr>
<td>HIGH VOLTAGE CAPS</td>
<td>$15.00</td>
</tr>
<tr>
<td>200 MFD @ 400 VDC OR 2700 MFD @ 400 VDC</td>
<td>$15.00</td>
</tr>
<tr>
<td>LED'S</td>
<td>$8.99 each</td>
</tr>
<tr>
<td>Micro-Mini Watch Crystals</td>
<td>$3.00 each</td>
</tr>
<tr>
<td>NEW GE OPTO COUPLERS 4N26</td>
<td>69¢ each or 10/$5.00</td>
</tr>
<tr>
<td>MICRO-MINI LED'S</td>
<td>$1.00 each</td>
</tr>
<tr>
<td>NEW &amp; USED BCD SWITCHES</td>
<td>$7.00 each</td>
</tr>
<tr>
<td>3 switch with end plates</td>
<td>$6.95 each</td>
</tr>
<tr>
<td>PLASTIC TO-3 SOCKETS</td>
<td>4/$1.00</td>
</tr>
</tbody>
</table>

**More Details? CHECK OFF Page 110**

**NE555V Timers**

39¢ each or 10/$3.00

**NEW Dual Colon LED**

69¢ each or 10/$5.00

**HEP170 1000 PIV**

2.5 Amps 25¢ each or 100/$15.00

**NEW Rotron Biscuit Fans**

Model BT2A1 115 VAC

$12.99 each

**TORIN TA700 FANS NEW**

Model A30340

$8.99 each

**230 VAC @ .78 Amps**

$29.99 each

**DOOR KNOB CAPS**

$8.99 New $6.95 Used
inexpensive five-eighth wave ground plane

A year or so ago, my wife won a bicycle flag as a door prize at a meeting. I do own a bicycle but I have no need for such a flag. The other day, I took this work of art out from behind the bedroom door and transformed it into a 2-meter antenna. I measured off approximately 4 feet (1.2 meters) of wire, brought it down the “flag pole” and wound a ten-turn coil at the bottom. I had a coaxial chassis connector (with a missing center conductor) which I drilled to fit the plastic pole. I then soldered on four 20-inch (50-cm) radials made of No. 12 (2.1-mm) wire. I wrapped the pole with tape, just under the radials, to hold them at the proper level. I soldered the shield of some RG-58/U cable to the radials, and the center conductor to the bottom of the coil.

I fired up the 2-meter rig, and connected an SWR meter into the line; it showed about 2.5:1. I took off a turn of wire; this dropped the SWR to 2:1. I then started cutting the vertical wire an inch at a time, and cut once too often. By pushing all of the coil turns tight together, I came up with 1.1:1 — close enough.

The photograph shows the bicycle-flag antenna in place on the house.

Bob Baird, W7CSD

the best way to get an antenna into a tree

For many years the Los Alamos Amateur Radio Club has set up Field Day in the nearby Jemez Mountains, which are well supplied with tall Douglas fir and spruce trees. Each year we struggled with the problem of getting the antennas up into the trees. We’ve tried everything: climbing, throwing a weighted line, using a bow and arrow. Finally, about three years ago, K5QIN developed an ingenious but inexpensive device, which was the ultimate solution.

A slingshot was wedged to a spincasting reel. The Wrist Rocket brand slingshot uses surgical rubber tubing as the elastic; it’s surprisingly powerful. Fastened to the handle of the slingshot is the spincasting reel. A one-ounce sinker is tied to the fish line. For ease of finding the sinker, I tied on a piece of bright red tape.

To use, merely unlock the reel, stand near the base of the tree, and fire upward at about a 60-degree angle. The weight easily clears 60-80 foot (18-24 meter) trees, and almost invariably falls all the way to the ground. Remove the sinker from the end of the line (cut it — fish line is cheap) and tie on a light nylon twine, such as 50-120 pound (23-54 kg) test. Then reel back the fish line steadily, until the twine returns to the ground. You can then connect whatever stronger line is needed to raise the antenna.
antenna bridge calculations

Here is a composite version, using the TRS80, Level 2, of Anderson’s fine series of programs, first listed in the May, 1978, issue of *Ham Radio*. Readers should refer to that article for the formulas used and other background material.

Paul Manacek, K6GK

Alan Hack, WABVLX

3. The small weight rarely tangles in the trees.

We have built several of these and find them among the handiest devices ever invented.

The advantages of this system are these:

1. It’s inexpensive. I bought a spin-cast reel on sale for less than $3, spent $5 on the slingshot, and got 2000 feet (610 meters) of 6-pound-test (2.7-kg) monofilament for about $1.25. One ounce (28.4g) sinkers cost about 12 cents.

2. If the line becomes tangled, just break it, abandon it, and try again. This is not the case with a bow and arrow, as archers are reluctant to lose expensive arrows.

5. It’s inexpensive. I bought a spin-cast reel on sale for less than $3, spent $5 on the slingshot, and got 2000 feet (610 meters) of 6-pound-test (2.7-kg) monofilament for about $1.25. One ounce (28.4g) sinkers cost about 12 cents.

2. If the line becomes tangled, just break it, abandon it, and try again. This is not the case with a bow and arrow, as archers are reluctant to lose expensive arrows.

Lines 10, 17, 20, and 300, as written, should duplicate the results given in programs 1 and 2 using the same input data, and can be edited as required.

Paul Manacek, K6GK
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HELP! A Baptist church affiliated youth summer camp needs Ham help. 2 Meter and HF radios are urgently needed to provide emergency communications for a Brushy Mountain mountain to the nearest phone, which is 5 miles away. Donated equipment is tax deductible. Contact Richard Bailey, Amity, PA 16311. (412) 225-1265.

WANTED: Collins 455 kHz mechanical filters, F455 variety. Give me bandwidth, condition and price. W7QTO, Paul Sexauer, 515 Lee Road, West Chicago, IL 60185.


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ATLAS DD6-C and 350XL Digital Dial/Frequency Counters, $175.00 plus $3.00 UPS. AFCP, 8840 Alcott St., Fort Worth, TX 76116.

WANTED: Help in completing the largest collection of Hallicrafters equipment in the world. Urgently needed are receivers, aluminum colored panels, back lighted plastic dials with "airplane" hands, early transmitters, unusual accessories, etc. Chuck Dachis, WD6EOG, "The Hallicrafters Collector", 4550 Russell Drive, Austin, Texas 78745.

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Coming Events
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CALIFORNIA: The 6th West Coast Computer Fair on April 3-5 in San Francisco. Program includes 50 to 120 speakers, over 400 exhibits, and between 20,000 and 24,000 are expected. More info: Jim Warren (415) 851-7075.

MARYLAND: Greater Baltimore Hamore and Computerfest on March 29 at the Maryland State Fairgrounds, Timonium, Maryland. Gates open at 8:00. Admission is $3.00. Speakers, demonstrations, indoor flea market, outdoor tailgating, indoor shoe show for dealers/ commercial displays, prize giveaways, free parking and much more. Exit 16 A-138, two miles north of I-95 near Baltimore. Talk-in on 146.1767 and 146.3949. More information is available at the event. Tickets are $3.00 at the door. (410) 321-1404.

MISSOURI: Missouri State ARRl Convention/Northwest Missouri Hamfest on April 11-12. Old airport, Kansas City, Missouri. Over 500,000 square feet of commercial, flea market, forums, free parking. Information: P.H.D., P.O. Box 11, Liberty, Missouri 64068.

NEBRASKA: The Hamore 5 on March 21 at the Marina Inn in So. Sioux City. Doors open at 9:00. Exhibits, Flea Market, contests, programs, dinner banquet, and more. More info: Dick Pliner, WQFO or Glen Holder, KOTT. Advance registration: Jerry Smith, WODU, Box 14, Akron, Iowa 51001.

NEW HAMPSHIRE: Auctionfest '81 on March 21 sponsored by the Interstate Repeater Society, P.O. Box 94, Nashua, NH 03060. Location: Hilton in Merrimack. Doors open at 9:00 AM. Vendor exhibits and more $5.00 and $75.00 for Flea Market rooms. Auction begins at 1:00 PM. For accommodations, reservations, more information: write WB1FRE.

NEW JERSEY: Crestnut Ridge Radio Club's Ham Radio and Computer Flea Market on April 4 from 9:00 AM to 3:00 PM at the Educational Building, Saddle River Reform Church, East Saddle River at Weas Road in Upper Saddle River, New Jersey. No admission fee. Tables are $10.00 and not included in the fee. Contact: Jack Meaghen, WZEHD, (201) 656-8306 or Neil Abitbol, WA6ZEN (201) 787-3575.

NEW JERSEY: Annual Flemington, N.J. Hamfest Saturday, March 21 from 8:30 to 3:00 at the Hunterdon Central High School, Flemington, New Jersey. 25,000 square feet of indoor and outdoor display. Crowds of 10,000 attend. Sale of Ham Radio and Computer Equipment. For questions or info call 201-786-4060 or write Cherryville Repeater Assoc., P.O. Box 264, Trevorton, N.J. 08881.

NEW JERSEY: The Old Bridge Radio Association's first annual auction of ham radio, electronic, and computer gear on March 1 at the Cheesecake Firehouse, Routes 35 and 9, in Old Bridge. Exhibition begins at 11:00 AM at noon. Refreshments available. More info, call Fred at (201) 257-8753.

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OPERATING EVENTS

MARCH 21st - 22nd: Tennessee QSO Party from 2100Z (the 21st) to 0000Z (the 22nd) and from 1400Z to 2200Z on the 22nd. Tennessee stations give signal report and county. Out of state, give signal report and state, province or country. Same station on different bands allowed. Operation limited to frequencies below 450 MHz. Two 6 hour period required. Phone: 3900, 7280, 21300, 21950. Novices within their own band. QSOs: For logs: May 1, 1981. SASE to Ted Double. GBCDWH, 1419 Favel Dr., Memphis, Tennessee 38116.

MARCH 21st - 22nd: S.A.R.G. Spring RTTY Contest 1981. From 0000 GMT Saturday until 0000 GMT Monday. Total contest is 48 hours, but no more than 30 hours of operation is permitted. 18 hours of non-operating time may be taken at any time, but no less than 3 hours must be summarized. Bands: 3.5, 7.0, 14.0, 21.0 and 28.0 MHz. Amateur bands only. More info or logs (deadline: May 15th) to: SASE to Ted Double, GBCDWH, 1419 Favel Dr., Memphis, Tennessee 38116.


MARCH 28th and 29th: Spring VHF QSO Party sponsored by the Ramapo Mountain ARC from 18002 Sat-Sun until 00002 GMT Monday. Total contest is 48 hours, but no more than 30 hours of operation is permitted. 18 hours of non-operating time may be taken at any time, but no less than 3 hours must be summarized. Bands: 3.5, 7.0, 14.0, 21.0 and 28.0 MHz. Amateur bands only. More info or logs (deadline: May 15th) to: SASE to Ted Double, GBCDWH, 1419 Favel Dr., Memphis, Tennessee 38116.

CENTURY 21 ARC - Low power - QRP's - CW nets - Contests - Awards - SASE K4EBW.

ATTENTION FIREFIGHTERS! A firefighter net is being formed and will be operating on 10 meters. Times are 1500Z, 2100Z and 0100Z. The frequency is 28.7 MHz. More information: SASE and four first class stamps to Claude L. Fant, Jr., WA6CPP, 6329Fairway Ave., Hamilton, Ohio 45023. You will be sent a list of firefighters in the net and other information.

AWARD INFORMATION: The "10K-20K" award, for stations operating on 10 and 20 meters. More information: SASE and four first class stamps to Claude L. Fant, Jr., WA6CPP, 13779 North Wells Lane, Lodi, California 95240. Work 10 or 20 stations in the outlying territories and possess owners with the appropriate call letters (KD4, KH6, KPH, etc.). Send log data and SASE to WAECP. Send three logs postcard for entry form. More information: Deadline: April 27th. Ramapo Mountain ARC, P.O. Box 364, Oakland, NJ 07436.

PENNSYLVANIA: Penn Wireless Association, Inc. will hold its Tradefest '81 on March 29 at the National Guard Armory, South Hampton Rd. and Roosevelt Blvd., (Rte. 1). A meeting of the Pennsylvania Turnpike exit #28. General admission is $3. Prizes, refreshments, displays and surprises. Talk-in on 146.1157.6 and 52. Contact Thomas Gallagher, WB3DFP, P.O. Box 734, Langhorne, Pennsylvania 19047.

TEXAS: Midland Amateur Radio Club's annual swapfest on March 14 from 1:00 to 7:00 and March 15 starting at 8:00. Doorprizes and more. Pre-registration is $4.50 or $5.00 at the door. Talk-in on 146.1146.7.

WISCONSIN: The Madison Area Repeater Association's ninth annual Madison Swapfest on Saturday, April 5 at the Dane County Exposition Center in Madison. Exhibits, flea market, door prizes and more. Contact: John Gallagher, W3DFD. P.O. Box 2403, Madison, Wisconsin 53754.

SWEDEN: The International Amateur Radio Meeting in Göteborg on April 4 and 5. All interested hams are invited. Exhibits, lectures, special displays plus more. The Swedish Maritime Mobile Radio Club and the Scandinavian Amateur Radio Telescope Group are having their annual meetings. Exhibitors and hams outside of Sweden are also welcome.
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- TH5JR X-Element Triband 138.95

AVAY/WB-10 80-Vertical 82.95

14AV/WB-10 40-Vertical 50.77

**CUSHCRAFT ANTENNAS**

- A4 New Triband Beam 10-15-20m 207.95
- A3 New Triband Beam 10-15-20m 168.10

AV3 X New 15-20-Vertical 39.40

AV5 New 15-30 Vertical 85.95

- ARX 2B New Ringo Ranger 33.95
- A22 7M "Boomer" DJF 220B 240 MHz "Boomer" 67.95

214B Jr. "Boomer" 144-146 MHz 57.30

214B Jr. "Boomer" 144-148 MHz 57.30

A147 11 Element 2m 32.25

**MINIQUAD K-9**

89.75

ALLIANCE HD73 96.10

CDE HAM IV ROTOR/CDS450 165.95/94.95

**MJF PRODUCTS COMPLETE LINE IN STOCK**

- MB5 New SWR Tuner 144.95

- 984 Deluxe 3 KW Tuner switch/mtr 252.95

- 981 3 KW Tuner with SWR/watt meter 169.85

- 946 1.5 KW Tuner switch/mtr 141.55

- 94B 300 watt deluxe tuner 122.00

- 94C 300 watt tuner switch/mtr 78.42

- 940 300 watt tuner switch/mtr 78.42

- 484 Grandmaster emery keyer 12 msg 121.72

- 482 2 msg Memory keyer 87.96

- 472 Pacesetter key with Bencher BY1 60.98

- 472X Pacesetter Keyer only 60.98

- 410 Professor Memory key 121.72

- 408 Deluxe Keyer with speed mtr 69.69

- 406 Deluxe keyer 58.95

- 752B Dual tunable filter 78.42

- 624 Deluxe phone patch 60.97

- 102 24 hour clock 30.95

- 555 RF Speech Processor

- 260/262 Dry Dumpy Loads 23.50/43.55

- 350 26 SWP PEP Meter 122.00

- 820 SWR/Watt meter + one sensor 58.95

- 825 Dual SWR/watt meter + one sensor 101.95

- CABLE R/G/Rf Semi-Flexible 26c/ft.

- 8 wire Rotor 2 ft. 16 ft. 62 ft.

- **BENCHER PADDLES**

- Black/Chrome. 35.90/43.75

- **ASTRON POWER SUPPLIES**

- (13.8 VDC)

- RS4A 3 amps continuous, 4 amp 30s 35.20

- R57A 5 amps continuous, 7 amp 48.00

- R52A 9 amps continuous, 12 AMP 66.25

- R52A 16 amps continuous, 20 AMP 87.20

- R52M same as RS50A + meters 109.50

- R53A 25 amps continuous, 35 AMP 139.30

- R53MA same as RS30A + meters 150.20

- **TELEX HAMHEADS-HEADPHONES**

- C410 Headphone 8.47

- C412 Headphone 22.95

- C412 Headphone 33.95

- PROCAM 200 Headset+ dual Imp. Mic 77.50

- BUCOM 300/1 watt Headset/dual Imp. Mic 69.95

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  We are the U.S. distributor for MITSUBISHI

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More Details? CHECK — OFF Page 110

---

**Van Garden Engineering**

**NEW 1981 EDITION**

**AMATEUR Radio Equipment Directory**

The most complete directory of Amateur Radio Equipment ever published—over 1,500 products—over 100 manufacturers/distributors. Includes prices, specifications and pictures of transmitters, receivers, antennae, towers, bases, power supplies, microphones, meters and related equipment.

**HI-Q BALUN**

- For dipoles, yagis, inverted vees & dipoles
- Replaces center insulator
- Puts power in antenna
- Broadband: 3-40 MHz
- Small, lightweight and waterproof
- 1:1 impedance ratio
- Helps eliminate TVI

With SO 239 connector

$10.95

**HI-Q ANTENNA CENTER INSULATOR**

Small, rugged, lightweight weatherproof replaces center insulator handles full legal power and more

$9.95

**HI-Q ANTENNA END INSULATORS**

Rugged, lightweight insulators made of high quality materials and superior design, durability, and performance. Will not absorb moisture or conduct power loss. Can be cut to length or parted to fit any length.

May be used for:
- Guy wire strain insulators
- End or center insulators for antennas

Construction of antenna loading costs or multiband traps

**DIPOLES**

**MODEL**

**BANDS**

**PRICE**

- Shortened dipoles
- Parallel dipoles
- Dipole shorteners

- USE WITH HI-Q CENTER INSULATOR

- Antenna accessories include:

- Built-in isolator, cable
- Double ended coax
- Receiver or VHF antenna
- RHCP or LHCP

- 20/40/80 Meter

- 10/20/40 Meter

- 10/15/20 Meter

- Antenna accessories include:

- Built-in isolator, cable
- Double ended coax
- Receiver or VHF antenna
- RHCP or LHCP

- 20/40/80 Meter

- 10/20/40 Meter

- 10/15/20 Meter

**Antenna accessories include:

- Built-in isolator, cable
- Double ended coax
- Receiver or VHF antenna
- RHCP or LHCP

- 20/40/80 Meter

- 10/20/40 Meter

- 10/15/20 Meter**
1900 MHz to 2500 MHz DOWN CONVERTER
This receiver is tunable over a range of 1900 to 2500 mc and is intended for amateur radio use. The local oscillator is voltage controlled (i.e., making the f range approximately 54 to 86 mc (Channels 2 to 7).

PC BOARD WITH DATA ................................................................. $19.99
PC BOARD WITH CHIP CAPACITORS 13. ................................... $44.99
PC BOARD WITH ALL PARTS FOR ASSEMBLY ......................... $60.00
PC BOARD WITH ALL PARTS FOR ASSEMBLY PLUS 2N6603 ...... $89.99
PC BOARD ASSEMBLED AND TESTED ....................................... $99.99
PC BOARD WITH ALL PARTS FOR ASSEMBLY, POWER SUPPLY AND ANTENNA .......................................................... $159.99

POWER SUPPLY ASSEMBLED AND TESTED ............................. $49.99
YAGI ANTENNA 4' LONG APPROX. 20 TO 23 dB GAIN ................ $59.99
YAGI ANTENNA 4' WITH TYPE (N, BNC, SMA Connector) ........... $64.99

2300 MHz DOWN CONVERTER
Includes converter mounted in antenna, power supply, plus 90 DAY WARRANTY .......................................................... $259.99
OPTION #1 MRF902 in front end (7 dB noise figure) .................... $299.99
OPTION #2 MRF902 in front end (5 dB noise figure) .................... $359.99

PC BOARD 2300 MHz DOWN CONVERTER ONLY
9 DB Noise Figure 23 dB gain in box with N conn. Input F conn. Output .......................................................... $149.99
7 DB Noise Figure 23 dB gain in box with N conn. Input F conn. Output .......................................................... $169.99
5 DB Noise Figure 23 dB gain in box with SMA conn. Input F conn. Output .......................................................... $189.99
DATA IS INCLUDED WITH KITS OR MAY BE PURCHASED SEPARATELY .......................................................... $15.00

Shipping and Handling Cost:
Receiver Kits add $1.50, Power Supply add $2.00, Antenna add $5.00, Option 1/2 add $3.00, For complete system add $7.50.

INTRODUCING THE HOWARD/COLEMAN TVRO CIRCUIT BOARDS

DUAL CONVERSION BOARD
This board provides conversion from the 3.7 to 4.2 band first to 900 MHz where gain and bandpass filtering are provided and, second, to 70 MHz. The board contains both local oscillators, one fixed and the other variable, and the second mixer. Construction is greatly simplified by the use of Hybrid IC amplifiers for the gain stages. Bare boards cost $25 and it is estimated that parts for construction will cost $70. (Note: The two Avantek VTO’s account for $225 of this cost.)
47 pF CHIP CAPACITORS ............................................................ $6.00
For use with dual conversion board. Consists of 6 — 47 pF.
70 MHz IF BOARD
This circuit provides about 43 dB gain with 50 ohm input and output impedance. It is designed to drive the HOWARD/COLEMAN TVRO Demodulator. The on-board bandpass filter can be tuned for bandwidths between 20 and 35 MHz with a passband ripple of less than 1/2 dB. Hybrid ICS are used for the gain stages. Bare boards cost $25. It is estimated that parts for construction will cost less than $40.
0.1 pF CHIP CAPACITORS ........................................................... $7.00
For use with 70 MHz IF Board. Consists of 7 — 0.1 pF.
DEMOLUATOR BOARD
This circuit takes the 70 MHz center frequency satellite TV signals in the 10 to 200 millivolt range, detects them using a phase locked loop, de-emphasizes and filters the result and amplifies the result to produce standard NTSC video. Other outputs include the audio subcarrier, a DC voltage proportional to the strength of the 70 MHz signal, and AFC voltage centered at about 2 volts DC. The bare boards cost $40 and total parts cost less than $30.
SINGLE AUDIO
This circuit recovers the audio signals from the 6.8 MHz frequency. The Miller 9051 coils are tuned to pass the 6.8 MHz subcarrier and the Miller 9052 coil tunes for recovery of the audio.
DUAL AUDIO
Duplicate of the single audio but also covers the 6.2 range.
DC CONTROL
This circuit controls the VTO’s, AFC and the S Meter.

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ALL PARTS PRIME AND GUARANTEED.
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Pricing includes $2.50 minimum for shipping or call for charges.
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11C102C 650 MHz Prescaler Divide by 5/6 16.50
11C83DC 1 GHz Divide by 248/256 Prescaler 29.90
11C70DC 600 MHz Flip/Flop with reset 12.30
11C58DC ECL VCM 4.53
11C44DC/MC4044 Phase Frequency Detector 3.82
11C24DC/MC4024 Dual TTL VCM 3.82
11C06DC UHF Prescaler 750 MHz D Type Flip/Flop 12.30
11C05DC 1 GHz Counter Divide by 4 50.00
11C01FC High Speed Dual 5-4 input NOR/NOR Gate 10.50

TRW BROADBAND AMPLIFIER MODEL CA615B
Frequency response 40 MHz to 300 MHz
Gain: 300 MHz 16 dB Min., 17.5 dB Max.
50 MHz 0 to –1 dB from 300 MHz
Voltage: 24 volts dc at 220 ma max.
$19.99

CARBIDE — CIRCUIT BOARD DRILL BITS FOR PCB BOARDS
Size: 35, 42, 47, 49, 51, 52
Size: 53, 54, 55, 56, 57, 58, 59, 61, 63, 64, 65
Size: 56 1.85
Size: 57 1.90
Size: 1.25 mm, 1.45 mm 2.00
Size: 3.20 mm 3.58

CRYSTAL FILTERS: TYCO 001-19880 same as 2194F
10.7 MHz Narrow Band Crystal Filter
3 dB bandwidth 15 kHz min. 20 dB bandwidth 60 kHz min. 40 dB bandwidth 150 kHz min.
Ultimate 50 db. Insertion loss 1.0 db max. Ripple 1.0 db max. Cl. 0 / + 5 if 3000 ohms.
$5.95

MURATA CERAMIC FILTERS
Models: SFD-4550 455 kHz
SFE-4550 455 kHz
CIFM-4550 455 kHz
SFE-10.7 10.7 MHz
$3.00

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Hewlett Packard:
401C TWT Amplifier 2 to 4 Gc 1 watt 30 dB gain $11500.00
808C 10 to 480 mc 1.5 uv to 5 v into 50 ohms Signal Generator 500.00
808D 10 to 420 mc 1 uv to 5 v into 50 ohms Signal Generator 500.00
812A 450 to 1200 mc 1 uv to 5 v into 50 ohms Signal Generator 750.00
814A 900 to 2100 mc Signal Generator 500.00
816A 1.8 to 4.2 Gc Signal Generator 500.00
818A 1.8 to 4.2 Gc Signal Generator 500.00
818B 3.8 to 7.2 Gc Signal Generator 400.00
818B 3.8 to 7.2 Gc Signal Generator 500.00
820A 7 to 11 Gc Signal Generator 400.00
623B Microwave Test Set 900.00
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955A 12.4 to 18 Gc Sweep Generator 900.00
Altech:
473 225 to 400 mc AM/FM Signal Generator 750.00
473 225 to 400 mc AM/FM Signal Generator 750.00

RF TRANSISTORS
<table>
<thead>
<tr>
<th>TYPE</th>
<th>PRICE</th>
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<tbody>
<tr>
<td>2N1651</td>
<td>$15.00</td>
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<td>2N590</td>
<td>$8.15</td>
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<td>MM1550</td>
<td>$10.00</td>
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CHIP CAPACITORS

We can supply any value chip capacit.

<table>
<thead>
<tr>
<th>VALUE</th>
<th>CAP</th>
<th>PRICES</th>
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</thead>
<tbody>
<tr>
<td>1 pf</td>
<td>2.7 pf</td>
<td>350 to 1500 pf</td>
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<tr>
<td>3.3 pf</td>
<td>3.3 pf</td>
<td>300 to 1200 pf</td>
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PRICES

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<th>PRICES</th>
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<td>600 to 2400 pf</td>
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<tr>
<td>101 to 1001</td>
<td>0.19</td>
<td>800 to 3200 pf</td>
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</tbody>
</table>

YOUR CHOICE $24.95

NEW TOLL-FREE NO. 800-528-0180 — please, orders only!
### Tektronix Test Equipment

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
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<tr>
<td>7265A</td>
<td>Waveform Generator</td>
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<tr>
<td>2250A</td>
<td>Dynamic Memory Storage System</td>
<td>$14.95</td>
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<td>2250B</td>
<td>Dynamic Memory Storage System</td>
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<td>2250C</td>
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<tr>
<td>2250Z</td>
<td>Dynamic Memory Storage System</td>
<td>$14.95</td>
</tr>
</tbody>
</table>

### Scopes with Plug-ins

- **MFR454**
  - $21.83
  - NPN SILICON RF POWER TRANSISTORS
  - Designed primarily for use in signal and audio amplifier stages.
  - Output Power = 4.0 Watts
  - Minimum Gain = 12 dB
  - Efficiency = 50%

- **MFR458**
  - $20.68
  - NPN SILICON RF POWER TRANSISTOR
  - Designed primarily for use in signal and audio amplifier stages.
  - Output Power = 4.0 Watts
  - Minimum Gain = 12 dB
  - Efficiency = 50%

- **MFR472**
  - $2.50
  - NPN SILICON RF POWER TRANSISTOR
  - Designed primarily for use in signal and audio amplifier stages.
  - Output Power = 12 W (PEP)
  - Minimum Gain = 40% (SSB)
  - Minimum Power Gain = 10 dB (PEP & CW)
  - Common Collector Characterization

- **MFR475**
  - $5.00
  - NPN SILICON RF POWER TRANSISTOR
  - Designed primarily for use in single sideband linear amplifier applications.
  - Output Power = 12 W (PEP)
  - Minimum Gain = 40% (SSB)
  - Minimum Power Gain = 10 dB (PEP & CW)

- **MHW710**
  - **- 2**
  - $46.45
  - UHF POWER AMPLIFIER MODULE
  - Designed primarily for use in signal and audio amplifier stages.
  - Output Power = 12 W (PEP)
  - Minimum Gain = 40% (SSB)
  - Minimum Power Gain = 10 dB (PEP & CW)
  - Common Collector Characterization

### Tubes

- **2656**
  - 4.50
  - 2656H
  - 2656E
  - 2656C
  - 2656B
  - 2656A
  - 2656
  - 2656G
  - 2656F
  - 2656D
  - 2656E
  - 2656F
  - 2656G
  - 2656H
  - 2656I
  - 2656J
  - 2656K
  - 2656L
  - 2656M
  - 2656N
  - 2656O
  - 2656P
  - 2656Q
  - 2656R
  - 2656S
  - 2656T
  - 2656U
  - 2656V
  - 2656W
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  - 2656Y
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Rx for a Bad Day

Is it one of those dull gloomy days when even the birds are walking, and it’s not a fit day to go out and put up that new sloper or inverted vee antenna you wanted to try? DX isn’t coming through yet because the MUF isn’t right, some jerk squeeled keeping the repeater or plays tunes on the Touchtone so that two meters isn’t fun at all. Maybe the wind played havoc with your beam last night and now it looks like a limp pretzel or some modern art object, or maybe your rig blew up in the middle of a QSO or just before that sked with a rare station in some far off land.

Any fool knows all these things aren’t going to happen to you at once. But if it is ‘one of those days’ maybe you can just forget the whole mess and brighten your and someone else’s day a little by taking some time to think of a fellow ham you admire and respect to nominate for Dayton’s “Amateur of the Year Award” for 1981. No, it’s not too early to think about it. It does take a little time and effort to nominate someone for “Amateur of the Year.”

What is the stature of this individual that we seek for recognition each year at Dayton?

First, he or she will be a well-respected person in the community, a leader, not only in amateur radio activity, but in civic activity as well. He will probably be licensed for at least 10 years or more for it is long term overall excellence in amateur radio that we are looking for.

His contribution to amateur radio may be in any of the hobby related areas. Possibly his greatest contribution is in the engineering field of our hobby, or his expertise may be in antenna design, some new type of modulation or an improvement to existing design, etc. Maybe he has contributed greatly to improvement of amateur regulations or possibly his contribution is the legal field of our hobby, a very important one these days. Get the idea? In short, an outstanding individual and amateur.

In 1974, another award was established, the “Special Achievement Award.” This award is just what it would seem to be — an award for one-time special event or specialized activity by an amateur or group of amateurs. This activity may be in the engineering field — QRP — DXpeditions — net activity — emergency work or any one-time outstanding activity related to the amateur radio hobby.

Nominees for both of these awards may be from anywhere in the world, not just the U.S.A.

So don’t just sit back and say, “Gee, somebody ought to nominate that guy for ‘Amateur of the Year.’” Don’t wait for George to do it. Give us all the details you can gather, especially activities that are directly attributable to him or her.

All nominations are carefully reviewed and are saved from one year to the next for future consideration and to allow some nominees to develop to their full potential. All nominations are considered for both awards, and the awards will be presented at the 1981 HAMVENTION Banquet.

So, have you nominated some one in the past? You may want to renominate him with an update on recent activities or just send in update information on his latest accomplishments.

Do it now! Besides, you may win a set of free tickets to the “HAMVENTION” for your nominee and yourself.

For more information or nomination blanks (not mandatory) write to the address below:

HAMVENTION
P.O. Box 44
Dayton, Ohio 45401
Attention: Awards Committee

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BASIC coding form

The Pocket-BASIC Coding Form by ARCsoft Publishers simplifies writing programs for the TRS-80 pocket computer. It's available in 50-sheet or 100-sheet pads and makes clear the relationship of overlapping memory locations such as A, A$, A(01), and A$(01).

Pocket-BASIC Coding Form displays the computer's fixed memories side-by-side with a large area for listing their contents. It also gives plenty of space for the programmer to label and list his flexible memories. The face of the form has space for program title, programmer's name, date, and page number plus ample room for special notes and comments.

The reverse of the 8 1/2 x 11 inch form is precision-ruled for thirty horizontal program lines, each divided by eighty vertical columns. Program lines are numbered in standard 10-300 line numbers in the margin for spotting at a glance. Vertical columns, left to right across the 11-inch width of the sheet, are numbered 1-80 for easy identification of available spaces in a standard TRS-80 pocket computer input memory. A program using all available steps and memories can be listed on the form's thirty lines by packing for maximum efficiency. Using shorter line contents, a very elaborate program can be listed on two sheets from a pad. The form can be used with any computer in the BASIC language.

Pads are available from ARCsoft Publishers, P.O. Box 132E, Woodbourne, Maryland 21798. Pads of fifty sheets sell for $2.95 plus $1.00 postage; pads of one hundred sheets sell for $3.95 plus $1.00 postage.

dual Schottkys

Two dual-power Schottky diodes that require no snubber networks have been introduced by TRW Power Semiconductors. The SD-231 and SD-232 diodes are dual diode versions of TRW's recently introduced SD-31 and SD-32 Schottky diodes. All four devices are high-voltage 30-amp diodes with a junction temperature rating of 175°C, which TRW says is higher than any comparable Schottky device.

The SD-231 is rated at 60 VRMM, the SD-232 at 50 VRMM. Both are housed in a TO-204MA package (formerly TO-3), and both are designed for rectification and commutation in high-current 5-volt logic supplies in military or industrial use. The two new diodes achieve avalanche protection with a shunt P-N diode, which is formed in addition to the Schottky barrier. This P-N diode breaks down at a lower voltage than the Schottky diode. But because the current is more evenly distributed along the P-N junction, large amounts of reverse energy can be tolerated. It is this ability to withstand high reverse energy, along with the devices' high voltage rating, that permit the SD-231/SD-232 dual diodes to be operated without the snubber networks previously required to protect Schottkys from avalanching.

In 100s, the SD-231 diode costs $8.81 and the SD-232 diode costs $7.95. Delivery is six to eight weeks. For further information, including data sheets, contact John Power, TRW Power Semiconductors, 14520 Aviation Boulevard, Lawndale, California 90260.

micro-miniature sub-audible tone encoder

Trans Com, Inc., introduces the new micro-miniature 401 sub-audible tone encoder. Measuring only 1.0 x 0.6 x 0.3 inch, the encoder can be installed in radios where other similar types of encoders cannot. The 401 has an operating range of 7 to 20 volts with a current consumption of only 4 mA. It is fully tunable from 67 Hz to 251 Hz and has an excellent temperature stability over a broad temperature range. Its features include compatibility with PL, CG and other CTCSS tone systems; small size; operating voltage 7-16 Vdc reverse polarity protected; operating current 4 mA, 12 Vdc; adjustable tone level 0 to 2 VPP; and low tone distortion, less than 1 percent THD. The tone stability is ±0.2 percent Hz from -20°C to +70°C, and there is a two-year warranty. Contact Trans Com, Inc., 1104A Ridge Avenue, Lombard, Illinois 60148.
1981 Radio Shack catalog

Radio Shack's new 176-page 1981 catalog is now available, free on request, from more than 6,000 participating stores and dealers nationwide. The catalog has 120 full-color pages and features the latest in everything electronic from computers and stereo components to toys and electronic games, parts, and accessories for home entertainment hobbyists and experimenters.

Among the products being offered for the first time are the TRS-80 Pocket Computer; the TRS-80 Color Computer; the TRS-80 Model III Desk-Top Computer; six new stereo receivers, two with digital quartz tuning; and five stereo cassette tape decks featuring Dolby noise-reduction circuits.

The new catalog includes the TRS-80 line of microcomputers, Realistic stereo components, CB equipment, radios, tape recorders, thirteen new electronic calculators, six digital clocks, seventeen electronic games, Archer antennas, Micronta test instruments, and ArcherKit and Science Fair hobby kits.

For further information contact Tandy Corporation/Radio Shack, 1800 One Tandy Center, Fort Worth, Texas 76102.

medium power Darlington transistors by Motorola

Motorola has announced a new series of complementary TO-92 Darlington transistors, designed specifically for preamplifier applications requiring a high dc current gain and an input impedance of several megohms. The low-cost, plastic-packaged transistors are available with breakdown voltage ratings of 40, 50, and 60 volts, a dc current gain of 10,000, and excellent current-gain linearity from 1 mA to 100 mA. Contact Motorola Semiconductor Products, Inc., P.O. Box 20912, Phoenix, Arizona 85012.

miniature frequency standard

The model YH-1100 miniature frequency standard provides specified output frequency in the range of 1 MHz - 60 MHz. Although measuring only 4.5 cubic inches (73.7 cc), the unit can provide a frequency stability of ±5 x 10^-8 per day. With an output that will drive up to 10 TTL loads, and operating from a single 5 Vdc input, it is ideal for digital applications where size and stability are critical.

The price is $175.00 for 100-unit quantities, with some common frequencies from stock.

For further information, write Greenray Industries, Inc., 840 West Church Road, Mechanicsburg, Pennsylvania 17055.

H.H. Smith catalog

Herman H. Smith, Inc., of Brooklyn, New York, is making available its newly published Catalog 810 for design engineers and purchasing agents. The recently produced, 100-page, full-line catalog features a number of new products, including the recently developed “safety engineered” test lead package, which permits the user to assemble complete test lead systems from standard shelf items to retrofit with existing and new equipment. These include prods, meter inputs, input adapters, and cables with connectors. Other new items offered in Smith’s Catalog 810 are an extended group of printed circuit board supports, flat wire cable clamps, and many new spacer types, including 3/16-inch O.D., 1/4-inch

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soldering iron stand

Wahl Clipper Corporation, manufacturers of the complete line of ISO-TIP brand soldering irons, has introduced a new "double-duty" soldering iron stand. The new stand is a combination soldering iron stand and caddy. When closed, the stand contains the soldering iron shaft and tip within the closed metal compartment, thus allowing an iron that has not yet completely cooled down to be placed in a tool box or caddy without damage to adjacent components. The compact, durable, yet lightweight soldering iron stand/caddy also protects the shaft and tip from possible damage in transit.

In the "open" position, the stand functions as a standard soldering iron stand, holding the iron within easy reach between uses. The stand also features a tip wiping sponge and well. For further information, contact Clipper Corporation, Sterling, Illinois 61081.

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COAX-SEAL comes in rolls, 60 inches (152 cm) long, 1/8 inch (3 mm) thick and 1/2 inch (13 mm) wide on backing paper. For more information, contact Universal Electronics, Inc., 1280 Aida Drive, Reynoldsburg, Ohio 43068.

dummy load

The new Ten-Tec Model 209 air-cooled rf dummy load is an excellent accessory for the ham shack or test bench. It allows transmitter operation for testing or alignment without disturbance to other Amateurs on the air.

Model 209 is rated at 300 watts for 30 seconds with derating curve for extended use. VSWR is 1.1:1 maximum from 0-30 MHz, 1.5:1 maximum for 30-150 MHz. The dummy load is housed in a perforated aluminum enclosure, dark painted for excellent heat dissipation. SO-239 connector is built-in for convenient installation. Price is $26.00. Contact Ten-Tec, Highway 411, East Sevierville, Tennessee 37862.

1021 DTMF receiver

The 1021 DTMF receiver is designed to detect and decode the six-
teen standard tones used for Touch Tone dialing. By incorporating the latest in technology it is possible to have a high-quality DTMF receiver measuring only 3.5 × 1.9 × 0.4 inch. The 1021 features low current consumption, typically 4 mA at 5 Vdc. The 1021 DTMF receiver consists of dual bandpass filters, dial tone rejector filter and limiters, a DTMF decoder with latched binary outputs, and a four to sixteen line converter. The input signal can vary from a level –30 dBm to 0 dBm with a digit detection time as short as 20 milliseconds. The four-bit binary and strobe outputs are provided through a five-pin header on the card; power and the sixteen discrete lines are available through a 25-pin connector with 0.1-inch spacing. When a digit is decoded, the strobe and digit line goes high for the duration of the tones detected. The binary outputs are normally set for 20 milliseconds, but can be lengthened. Both the filter and decoding circuits are crystal controlled for long term stability and accuracy. Contact Trans Com, Inc., 1104A Ridge Avenue, Lombard, Illinois 60148.

nick-free wire stripper

O.K. Machine and Tool introduces a new, all-purpose, manual wire stripper, the ST-300. It has a convenient adjustable stop for consistency in wire strip lengths. This easy-to-use tool strips 14 to 22 AWG solid and stranded wire cleanly and quickly. It strips Kynar, vinyl, polyethylene, rubber, neoprene, and irradiated vinyls — almost all insulation materials in use today. With one light squeeze of the handles, cutting blades cut through and remove up to ¾ inch of insulation. Heavy duty and reliable, the tool is ideal for appliance, automotive, electrical fixture, instrumentation and household wiring. The ST-300 won’t damage or nick wire. Available from stock for $9.95 from your local electronics distributor or directly from O.K. Machine and Tool Corporation, 3455 Conner Street, Bronx, New York 10475.

short circuit
optional sidetone

Those who are confused as to how to incorporate the optional sidetone into the CW keyboard program for the Apple II computer (October, 1980, *ham radio*) may find the following of interest. It is a program change for the addition of optional sidetone.

1. Enter monitor with CALL -151 or press RESET. (* cursor).
2. Type 30A: AD 30 C0 88 D0 F5 AD 58 C0 60.
3. Press RETURN.
4. Re-enter BASIC (CTRL C).
5. In both lines 5 and 6, change the number 774 to 772.
6. Delete Line 620 (DEL 620).

To delete the sidetone, merely run the program. Steps 1-4, however, must be repeated each time the sidetone option is to be used unless the poke statements in lines 18 to 23 are changed, starting at :POKE 778,173, in line 18.

Although left as an exercise, here's a hint for converting hexadecimal numbers to decimal: For a three-digit hex number, multiply the first digit by 16². Add (second digit × 16) plus third digit.

For a two-digit number, multiply the first by 16, add the second. Example: Convert $3A7 to decimal. On the Apple keyboard, type: PRINT 3*16\[2+10*16+7. (=935)."

Modifications in steps 5 and 6 are a permanent part of program, with or without sidetone.

contributed by
Bill Skeen, W6WR

updating the HW-2036

Those who would like a copy of the reverse side of the printed circuit boards in fig. 9 (page 55) of WA4BZP's article in the November, 1980, issue of *ham radio* may obtain one by sending a stamped, self-addressed envelope to *ham radio*, Greenville, NH 03048.
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March, 1981

Please use before April 30, 1981

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- Available in all 32 EIA standard CTCSS tones

SS-32 Encoder
- Size: .9” x 1.3” x .40”
- Available with either Group A or Group B tones

Frequencies Available:

<table>
<thead>
<tr>
<th>Group A</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>67.0 XZ</td>
<td>91.5 ZZ</td>
<td>118.8 2B</td>
</tr>
<tr>
<td>71.9 XA</td>
<td>94.8 ZA</td>
<td>123.0 3Z</td>
</tr>
<tr>
<td>74.4 WA</td>
<td>97.4 ZB</td>
<td>127.3 3A</td>
</tr>
<tr>
<td>77.0 XB</td>
<td>100.0 1Z</td>
<td>131.8 3B</td>
</tr>
<tr>
<td>79.7 SP</td>
<td>103.5 1A</td>
<td>136.5 4Z</td>
</tr>
<tr>
<td>82.5 YZ</td>
<td>107.2 1B</td>
<td>141.3 4A</td>
</tr>
<tr>
<td>85.4 YA</td>
<td>110.9 2Z</td>
<td>146.2 4B</td>
</tr>
<tr>
<td>88.5 YB</td>
<td>114.8 2A</td>
<td>151.4 5Z</td>
</tr>
</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>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>TEST-TONES:</td>
<td>TOUCH-TONES:</td>
<td>BURST-TONES:</td>
</tr>
<tr>
<td>600</td>
<td>697 1209</td>
<td>1600 1850 2150 2400</td>
</tr>
<tr>
<td>1000</td>
<td>770 1336</td>
<td>1650 1900 2200 2450</td>
</tr>
<tr>
<td>1500</td>
<td>852 1477</td>
<td>1700 1950 2250 2500</td>
</tr>
<tr>
<td>2175</td>
<td>941 1633</td>
<td>1750 2000 2300 2550</td>
</tr>
<tr>
<td>2805</td>
<td></td>
<td>1800 2100 2350</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

Wired and tested: TS-32 $59.95, SS-32 $29.95

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UNAUTHORIZED ALIGNMENT ARE NOT INCLUDED.
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