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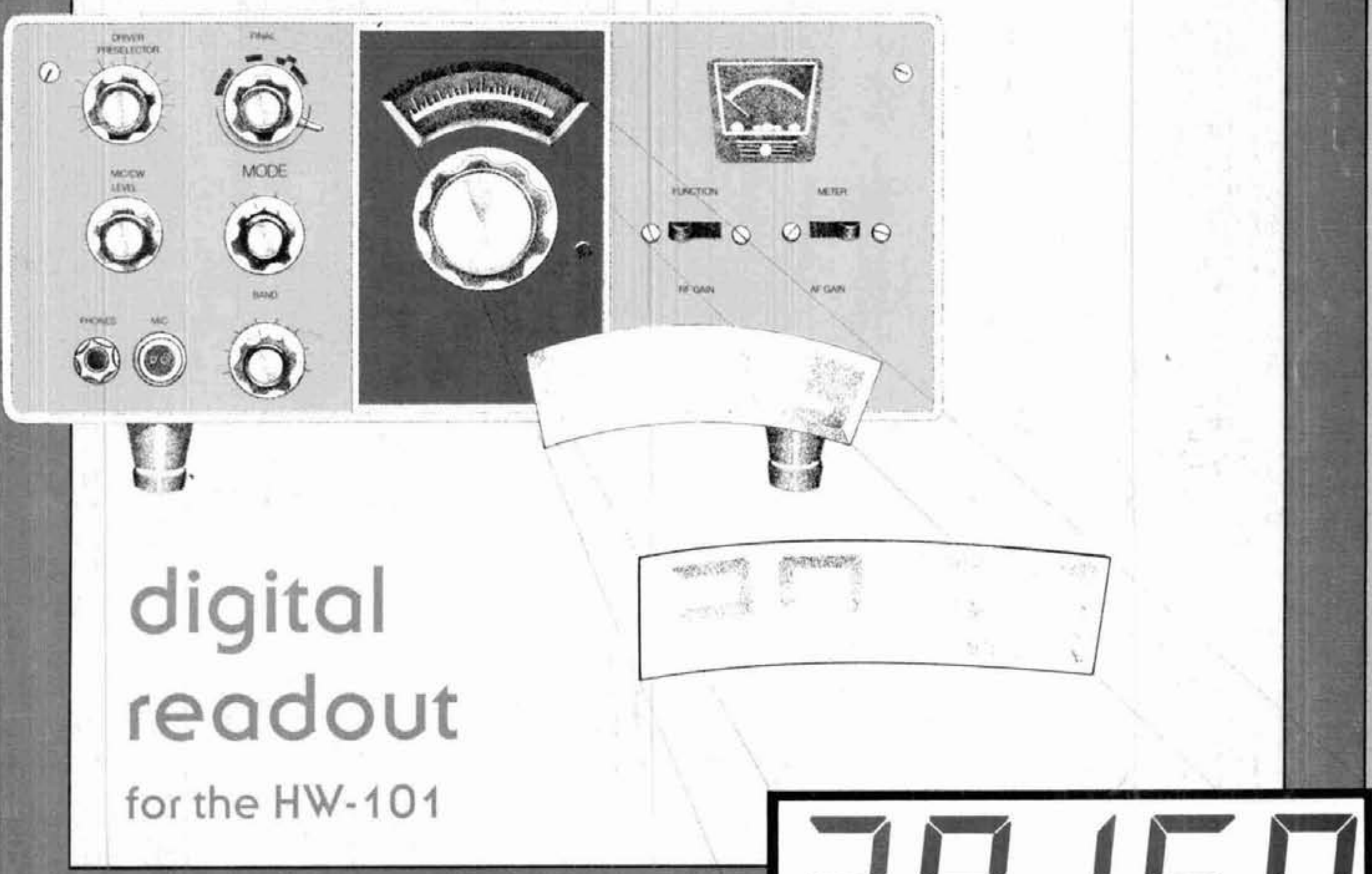

digital readout for the HW-101

hr

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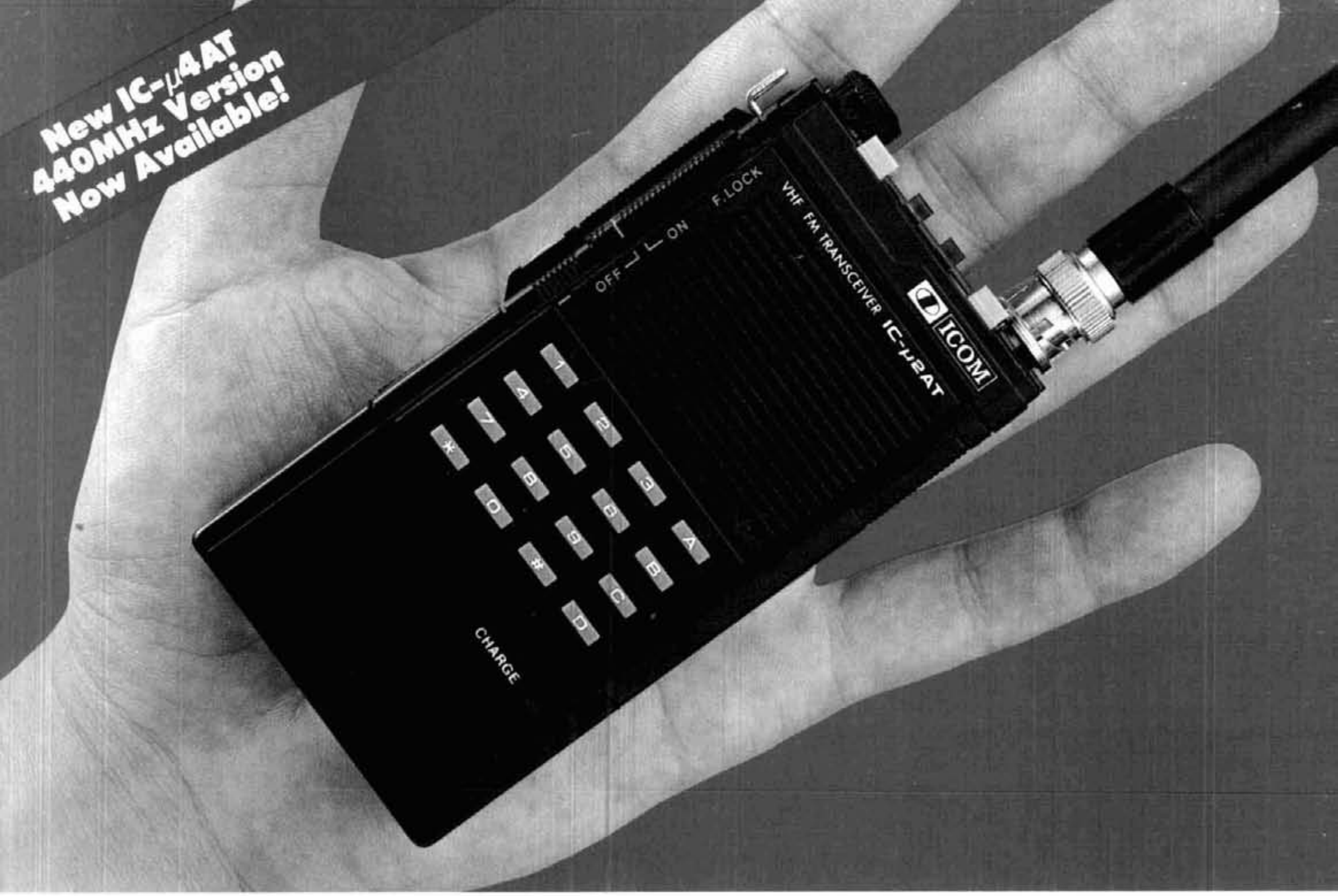

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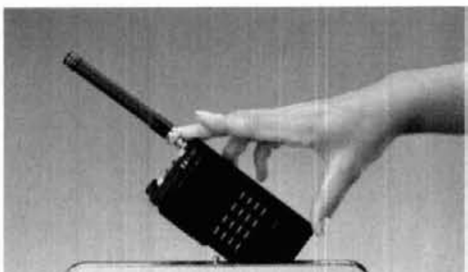

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Amateur Radio's Retiree of The Year

There's a slim, funny book of cartoons making its way around the office these days. Titled, It's Time To Retire When. . .," it makes a case for retiring when . . . you start calling everybody "kids" . . . you hear yourself saying, "We already tried that and it didn't work" . . . more than half your income comes from winning sports pools . . . you tell "war stories" and the "kids" ask, "Which war?"

Now, we don't know much about retirement because the only one of us who's been around long enough to be retired has retired — and *un*retired — three times. But we do know that our readers and authors who claim to be retired seem to be just as busy and involved in the business of living as anybody else. Try getting them to answer the phone on a Tuesday afternoon. Forget it. They're out building something in the shop, tinkering with antennas, volunteering in community service, or traveling. Sometimes they're even starting new businesses or careers, packing two or three or four lifetimes into one.

We expect such will be the case with Barry Goldwater, K7UGA, Amateur Radio's unofficial Retiree of the Year. Moments before the 99th Congress concluded its work, he delivered a characteristically succinct farewell address, bringing his distinguished political career to a close with fewer than 100 words. His equally notable military career had come to an end in 1967, when, with the rank of Major General, he retired from the United States Air Force Reserve.

There aren't enough pages in this or any other magazine to begin to describe what this one man has done for Amateur Radio. Licensed as 6BPI in 1923 — and later, in the early 1960's, after a period of inactivity, as K7UGA — Goldwater has, over the years, been ham radio's indispensable ally on Capitol Hill. Besides working behind the scenes with integrity and finesse, he sponsored much enabling legislation, including that which led to the implementation of the VEC program and the ARRL/FCC Amateur Auxiliary.

During the Vietnam era, Goldwater's station, staffed by volunteers and operating around the clock, ran more than 240,000 phone patches from service personnel in Southeast Asia to families and friends back home. As the war wound down, RTTY replaced phone patches and 150,000 more messages were passed. Though Goldwater's busy schedule left little time for operating, his station manager — Tom Moore, W7FCQ, AFA6PU/AFF6C — told us that whenever the Senator was in town, particularly over the Christmas/New Year's recess, he'd frequently join the volunteers, often taking a full eight-hour shift.

The Senator's equipment, said to put many a broadcaster's station to shame, was based on a four-function Collins 208-U3 transmitter. A Collins 237B rotatable log periodic (6.5 to 30 MHz) with a 64-foot boom (longest element: 81 feet) was mounted on an 80-foot tower atop a hill 200 feet above ground, which was already some 2200 feet ASL. Traffic handling continued until January, 1983, when diminished activity in Southeast Asia allowed the station to be closed.

According to Tom Moore, most of the volunteers at K7UGA were retirees who "just wanted to help out." (Tom had a dual purpose: his son was a POW, and he joined the crew partly in hope of contacting him. Though they never connected through K7UGA, they were eventually reunited. Now retired, Tom still handles traffic from Southeast Asia, with 24,000 "Mom and Dad Morale" messages passed — an average of 500 per month — since the closing of K7UGA.)

Although we can't begin to do justice, in this small space, to Barry Goldwater's contributions to Amateur Radio, there is enough room to say a heartfelt "Thanks" and wish him all the best in his retirement. We'll be watching, with interest and appreciation, to see what he does next.

Dorothy Rosa, KA1LBO
Assistant Editor

It's Time To Retire When... is published by Ivory Tower Publishing Co., Inc., Watertown, Massachusetts.

packet board update

Dear HR:

A number of improvements have been made to the HAPN packet board described in our article, "A Packet Radio TNC for the IBM PC" [August, 1986, page 10]. Readers who have purchased, or plan to purchase, the bare board should be sure to follow the assembly instructions provided on the HAPN-1 diskette (ASSEMBLY.LST) rather than the instructions presented in the article. Otherwise, there's bound to be some confusion regarding the parts list and parts designations. Also, an oscilloscope is no longer required for setting up the board.

Jack Botner, VE3LNY
Hamilton and Area Packet Network

SSTV on the C64

Dear HR:

Thank you for publishing our article concerning receiving and transmitting SSTV via Commodore 64 without any external interface ["Get on SSTV — With the C64," October, 1986, page 2 43]. It is a great honor for us.

Copies of the complete machine language program, with two pages of instructions, are available on disk or cassette directly from us. Machine code means immediate transmission (the long delay to compose the picture affects only the BASIC version) and easy TX/RX functions; surely readers who have had problems in loading the published listings will be glad to know that.

I have never heard of the references Jim Grubbs, K9EI, mentioned in his translation of our article. They are not available in Italy. In the future we will try to surprise you with an article including some of the incredible software we are preparing.

On another topic, I was in the hell of Beirut in the Italian Army (United Nations contingent) and I have lots of pictures in my mind which cannot be forgotten. I very vividly remember the day which changed my life, when while patrolling in our tank, we were distracted by some gunfire and drove in the direction from which it came. We realized that a few U.S. Marines whose car was set on fire were defending their lives in a corner of a building. Maneuvering our tank and using it as shield, we succeeded in getting all of the marines into a safe position — or so we thought until seconds after, when I realized that one of them had been shot and was lying on the ground, still under fire. I immediately jumped out of our tank, and together with a brave Marine, among screams and shots, succeeded in getting that poor young man safely inside.

I remember nothing after that, since I had been shot myself and the world became black over me. Hospitals and re-education centers did not make the miracle; meanwhile I have lost my job and problems to the nervous system affect me. So thanks to the computers, I survive for the time being by writing articles and programs for magazines.

From time to time, a question comes to mind: was a medal and some words spoken in a speech by a Prime Minister worth so many problems and pain? Well, no matter — the true recompense is knowing that the life of a man was saved.

The name of the spring which pulled me out of my secure tank was simply altruism and solidarity, qualities common among us Amateur Radio operators. Would I do it again? Certainly, *yes* — though possibly in a less instinctive way.

Giuseppe Cameroni, I2CAB
Vigevano, Italy

should VEs issue callsigns?

Dear HR:

I propose that the FCC end the waiting period for previously unlicensed applicants (i.e., those who had no prior callsign) who pass VE examinations.

The FCC would issue random blocks of 2x3 callsigns to VECs in unmarked envelopes. The VECs would not be *issuing* the calls (the FCC does that); they would merely be *distributing* the callsigns to successful applicants at each test session, acting on the FCC's behalf just as they're doing when they administer Amateur radio exams.

The expiration date of each call would be ten years after the date of the examination. New Amateurs who didn't like their new calls could simply send in a form 610 and request a callsign change.

As soon as applicants received their callsigns, they could get on the air and enjoy their new privileges immediately. The FCC could still cancel the licenses of any newly-licensed Amateurs found in violation of FCC rules.

The FCC could use their existing sealed-envelope technology for distributing callsigns to the VECs. The VE group would then request a specific number of callsigns for their test session and pass the callsigns out to successful applicants.

Each callsign — known only to the FCC until the envelope is opened — would be printed on the license form. The VE would add the successful applicant's name and address and the expiration date of the license, giving one copy to the new licensee and sending another to the FCC for processing.

It's interesting to note that there's no waiting period when you get your driver's license. You get your license and drive off. When you pass an Amatuer Radio exam, you should be able to get your license, go home, and use those new privileges right away.

Conrad Ekstrom, WB1GXM
Claremont, New Hampshire 03743

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- SW-200A/B SWR/power meters:
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a true-frequency digital readout for the HW-101

Try this simple mod for more precise tuning

If you've ever operated an HW-101, you know how frustrating it can be to try to tune it to a specific frequency; the main tuning dial simply isn't precise enough. In an effort to solve the problem, I decided to add a digital readout to my rig.

I didn't really want to *build* one; I just wanted to find an old SB-650 Digital Frequency Display, the Heathkit readout designed to accompany its HW- and SB- series equipment. But I couldn't find one for sale locally, and Heath had long ago sold out its final inventory. I decided to go ahead on my own. I tried to get a copy of the SB-650 manual, but Heath had no more.

Why this seeming obsession with the SB-650? In order to develop a reading from an HW-101, all three transceiver oscillators must be sampled and multiplexed into the counter section in proper sequence. The counting circuitry itself is more or less standard, but the multiplexing circuit is the key to success. I knew that Heath's circuit worked, and the gating and logic tables I came up with looked too unwieldy to be correct.

Photo A. The top, bottom, and digit boards (left to right), are shown interconnected and ready for mounting.

Although Heath couldn't provide a manual, the company did supply several schematics of the multiplexing and time chain circuitry. The multiplexing used in my readout more or less duplicates the Heath circuit.

theory of operation

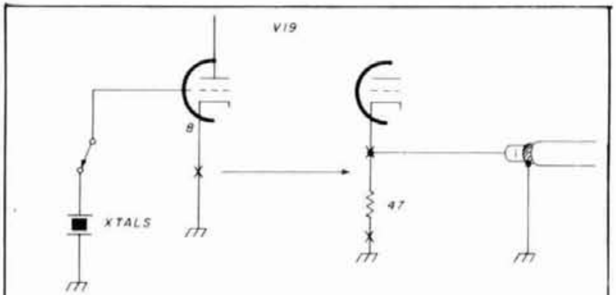
A transceiver digital readout is basically a frequency counter preceded by processing circuits that allow proper sampling of the circuits in the transceiver that determine the final operating frequency. In the HW-101 the operating frequency is determined by heterodyne action among three oscillators. The heterodyne oscillator is a high-frequency oscillator, while the carrier and VFO oscillators are relatively low in frequency. Both the carrier and VFO frequencies are essentially *subtracted* from the higher-frequency heterodyne oscillator frequency to establish the operating frequency. The processing circuitry of the readout first enters the highest frequency into the counters, then subtracts, one at a time, the other two oscillator frequencies from it. The true operating frequency is then presented to the digital display through the latches. (Although the "addition" and "subtraction" mixing takes place in different stages of the transceiver for Transmit than for Receive, the same oscillators ultimately perform the same job. Thus by tapping the oscillator outputs, the readout is accurate to within 100 Hz ± clock error, and reads the same frequency in either send or receive mode.)

system flow

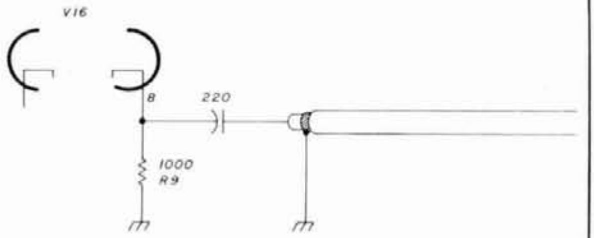
In the transceiver, samples of the three oscillators are connected by coax to phono jacks added to the back of the transceiver chassis. These are connected by 36-inch phono cables to three input phono jacks on the back of the readout chassis. (See **fig. 1** for transceiver sampling hookups.)

Each jack connects to an input stage consisting of a 40673 MOSFET preamp and a 2SC945 (or 276-2016) pulse-shaper circuit. After passing through buffer gates in U1 and being divided by four in frequency in flip-flop

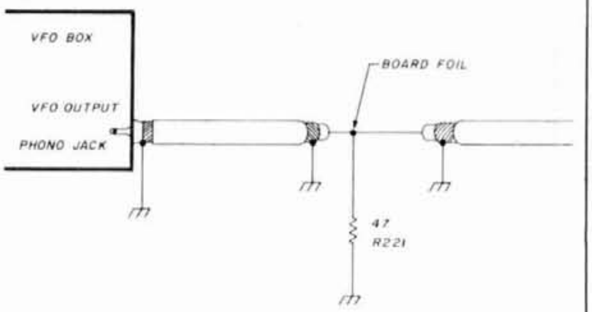
By Ed Murdoch, NU4F, Route 1, Box 238, Omega, Georgia 31775



Heterodyne Oscillator: bandpass board, Tube V19, Pin 8 (cathode). This cathode is normally grounded. Break foil at X, solder 47Ω watt resistor across break. Connect center of coax to tube pin side, shield to adjacent foil ground. Coax goes to phono jack on rear of chassis.



Carrier Oscillator: modulator board, Tube V16, pin 8 (cathodes). This point also connects to other cathode of V16. These are already above ground with appropriate RF voltage. Coax is coupled to pin 8 foil through 220 pF capacitor.



VFO: bandpass circuit board. Sampling coax connects to point on board where output coax of tube V20 connects. Connect coax center conductor to the foil point adjacent to high side of R221 (47 ohms).

fig. 1. Transceiver sampling connections (all connections made to underside of board). Each length of coax goes to a phono jack installed on the back of the transceiver chassis. Regular 36-inch shielded phono cables connect to digital readout.

U2, these three circuits are gated sequentially into the Least Significant Digit (LSD) counter, U17, by multiplexer chips U3, U4, and U13 through U15. The gating pulses for *enable* and *inhibit* are developed from the timing chain combination of oscillator-buffer-feedback gates U5, divide-by-four flip-flop U6, and time-division decade counters U7 through U12. The reset pulses for pulse counters U17 through U22 come from U15, pin 3. The reset pulses for divide-by-four flip-flop U2 come from U16, pin 6. The transfer pulses for the latches come from U16, pin 3.

In order to feed the correct oscillator signal to the counters at the proper time, a time frame of four intervals is established. This is done by gating several combinations of outputs from U10, U11, and U12 in the timing chain. These in turn are interlocked by other gates to allow each oscillator to be counted once per frame and

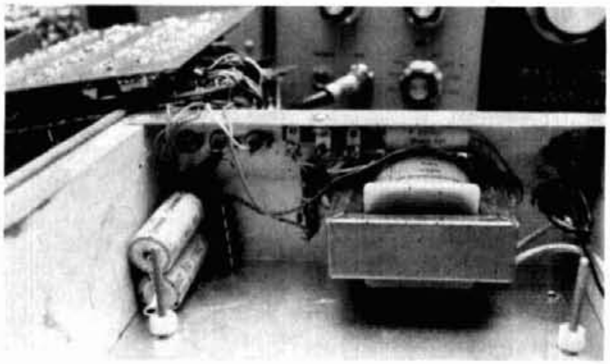


Photo B. Power supply components are mounted on rear chassis wall.

shifted to the up count (add) or the down count (subtract), as is appropriate. The fourth interval is used for pulse development by the RC network connected between U13, pin 8 and ground. After both reset pulses and the transfer pulse have been established, the next clock pulse starts the cycle again.

The counting section, which consists of a cascaded series of six 74LS192 up/down decade counters (with one counter for each display digit), provides a frequency divided-by-ten output to the following counter and its parallel output to its own digit decoder in binary-coded decimal (1-2-4-8, also referred to as ABCD in the accompanying figures). Therefore each counter has what it needs to produce the correct reading for its own LED digit, which it feeds to the digit by way of a 74LS75 latch. The divided-by-ten output is then passed on to the next counter chip, which acts in a similar fashion.

Each storage latch holds the previously transmitted number until the transfer pulse occurs, causing the latches to accept the newest measurement offered by their respective counter's ABCD outputs. Each of these "updates" is caused by a combination of reset pulses to the various flip-flops and counters so that each new count is synchronized. The latches feed the ABCD data to the input lines of their respective 74LS47 BCD to seven-segment decoder/drivers, which decode the ABCD numbers and provide the drive for the correct segments of the seven-segment display digit.

Overall synchronization is established by a master clock oscillator from which the various pulses, time intervals, and switching sequences are derived. The time occurrence of the individual gating pulses is also determined by frequency division (by divide-by-four flip-flops 74LS73, and by divide-by-ten and divide-by-two counters 74LS90). The clock frequency of 1 MHz was chosen to make frequency-division factors easily obtainable.

construction

The circuits were planned on quad paper and then built up on two 4 1/2 x 6 5/8-inch circuit boards and one 2 3/4 x 3 3/4-inch board (**Photo A**). The two large

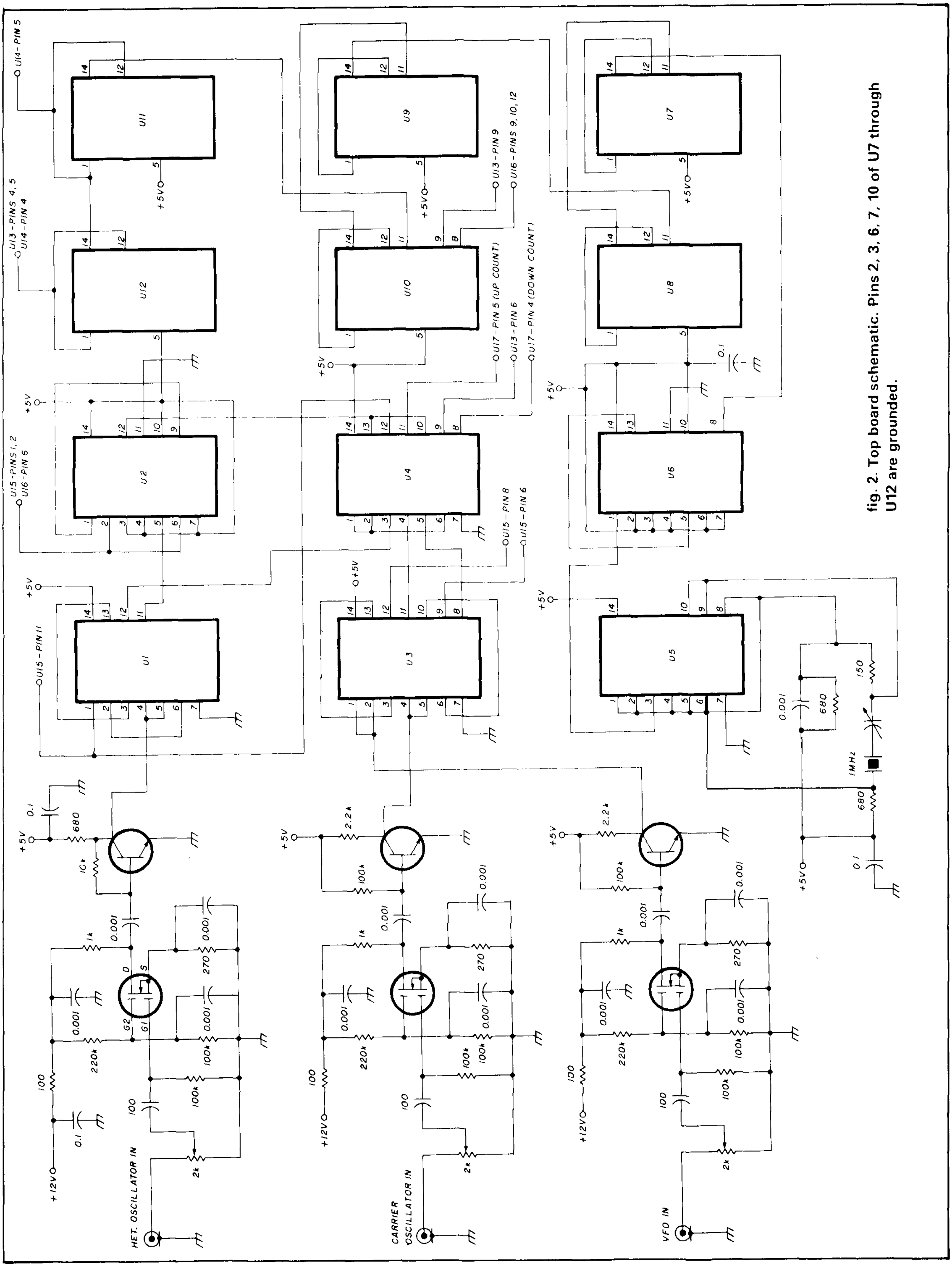


fig. 2. Top board schematic. Pins 2, 3, 6, 7, 10 of U7 through U12 are grounded.

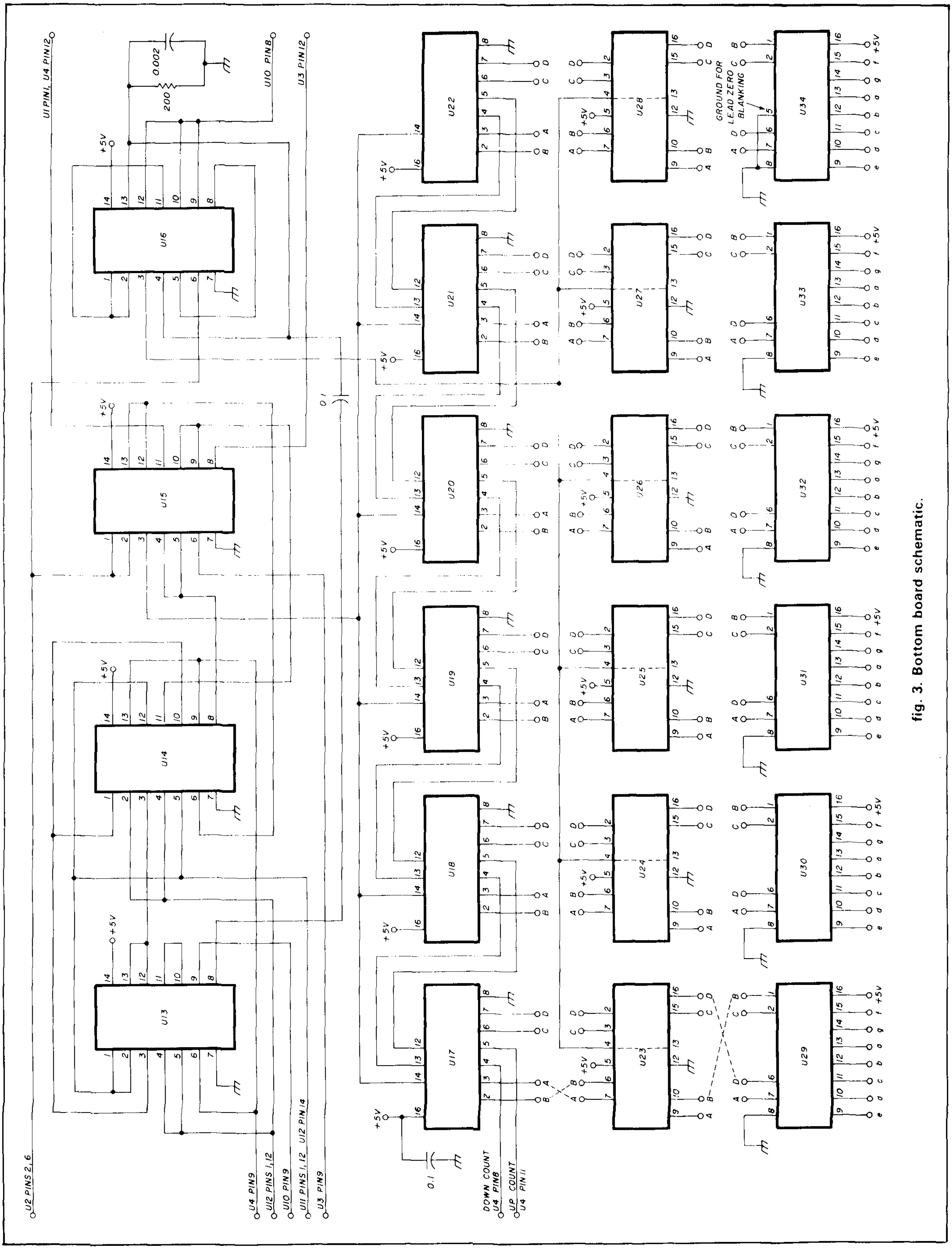


fig. 3. Bottom board schematic.

Table 1. Parts list. Cost of project should be approximately $85.00.

40673 MOSFETs	MHz Electronics*
2SC945 Transistor	Radio Shack 276-2051 or 276-2016 or MPS 3904
U1,U3,U4,U5	74LS00 QuadNand Gates**
U2,U6	74LS73 Dual J-K flip-flops**
U7-U12	74LS90 Decade (bi-quinary) counters**
U17-U22	74LS192 up/down decade counters†
U23-U28	74LS75 Quad latch**
U29-U34	74LS47 BCD/seven-segment decoder/driver**
0.3-inch seven-segment digit display	Radio Shack 276-053 (common anode)
Chassis	No. EDCH-288†
Top and bottom boards	Radio Shack 276-147

*MHz Electronics, 2111 West Camelback Road, Phoenix, Arizona 85015.
**DoKay Electronics, 2100 De La Cruz Boulevard, Santa Clara, California 95050.
†All Electronics, P.O. Box 20406, Los Angeles, California 90006.

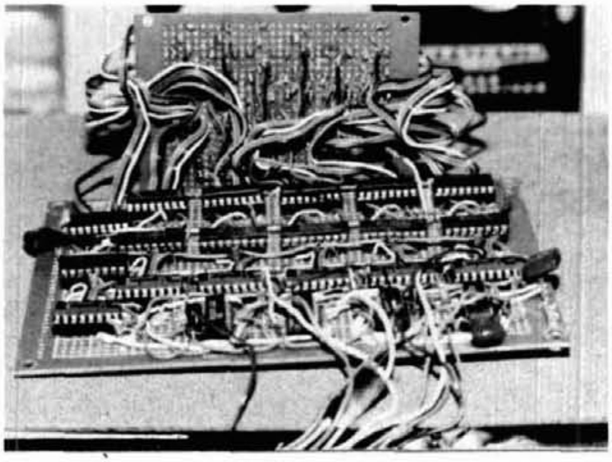


Photo D. A closer view of the bottom and digit boards illustrates interconnections.

boards are mounted upside-down in the chassis and separated by spacers. The top board contains the input wave shaping circuits, the timing chain, and part of the multiplex circuitry. The bottom board contains the remainder of the multiplex circuitry, the counters, latches, and decoder/drivers. The outputs of the decoder/drivers are cabled to their respective segment dropping resistors mounted on the third board, which also holds the digits. This board is at right angles to the other boards. A window is cut in the chassis front to accommodate the digits.

The power supply parts are mounted on the rear wall of the chassis. So are the three input jacks. Prototype wiring is shown in **Photo B**; the input wiring was later *changed to coax.*

building the chassis

The first step is to determine the location of each part. Next, mark off and drill the mounting holes for the input phono jacks, the fuse holder, and front panel switch. Then drill the transformer and heat-sink-regulator mounting holes, tie-point holes, and holes in the chassis top for the circuit board bolts.

With an awl, mark guidelines for cutting the digit window. Drill holes in diagonally opposite corners of the outline to accommodate the sabre saw blade and cut the rough opening. *This is a tricky and possibly dangerous step, so I'd suggest you secure the chassis firmly in a vise while you make the cut.* Stay slightly to the inside of the guidelines; use a small, flat file to smooth the edge of the opening to its finished size. For the window its self, I cut a piece of clear plastic (box covers are ideal) and glued it into place.

Photo A also shows the approximate board locations of all parts and wiring paths for the multiplexer interconnections. Other wiring shown in the remaining figures according to normal schematic drafting practice.

the power supply

The power supply (**fig. 5**) is typical of so-called "economy" supplies in that a single secondary winding is used to develop two voltage levels. (The MOSFETs need 12 volts; the rest uses 5 volts. Both are regulated.) The transformer supplies 18 volts ac through a bridge rectifier to the filter for the 12-volt section, regulated by a 12-volt Zener diode; a center tap provides 9 volts ac to the filter of the 7805 5-volt regulator.

The power supply components, installed on the back of the chassis, are partially supported by tie points. The 7805 regulator is mounted on a standard T-220 type heat sink positioned directly against the chassis for improved heat removal. With the circuit boards in place, it's a pretty close fit; I blew out a bridge rectifier and the fuse by not watching a test probe closely enough while making tests. I have now covered exposed terminals with a tape wrap.

circuit boards

The digit display board (**fig. 4** and **Photo C**) contains the six LED digits, sockets, and 42 1/2-watt 330-ohm dropping resistors — one resistor per digit segment. This board should be wired first. Note that this is the only place wire-wrap sockets are used. This is because I planned to support the digit board against the chassis front by its cable pressure and put several turns on each pin for extra stability. I made a seven-wire color-coded combination for each digit: a four-wire section plus a three-wire section.

After making all cable solder connections, cut off all

the pins except the 5-volt supply pins to about 1/4 inch, leave these longer (about 1/2 inch) so that the 5-volt bus can be run straight across.

There are no grounds on the digit board. Each segment "grounds" through its driver connection when activated; these are common anode devices.

The two decimal point positions are grounded through 330-ohm resistors over to the front ground bus on the bottom board. These decimal points divide the six digits into MHz and KHz separations.

the bottom board

The bottom board contains multiplexer chips U13 through U16, decade counters U17 through U22, latches U23-U28, and decoder/driver chips U29 through U34, plus sockets (**Photo D**).

You'll have to offset three chips to fit all the parts on the board, but this poses no problem. In fact, it actually helps; because the column of offset chips represents the most-significant-digit position, you'll have a handy reference point to which you can refer as you add parts to the board.

Photo E shows the location of the two ground buses,

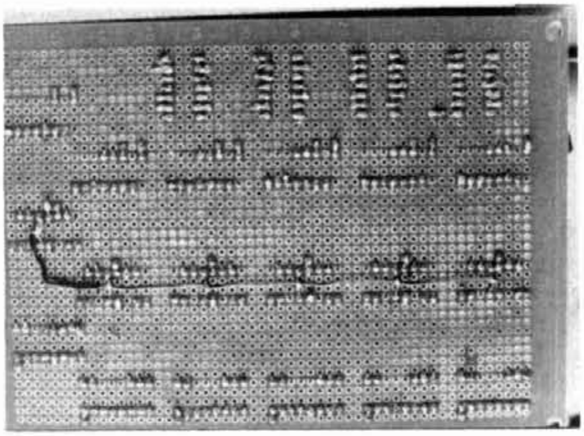


Photo E. Rear view of bottom board shows closeness of solder points and bus for latches that transfer pulse feed.

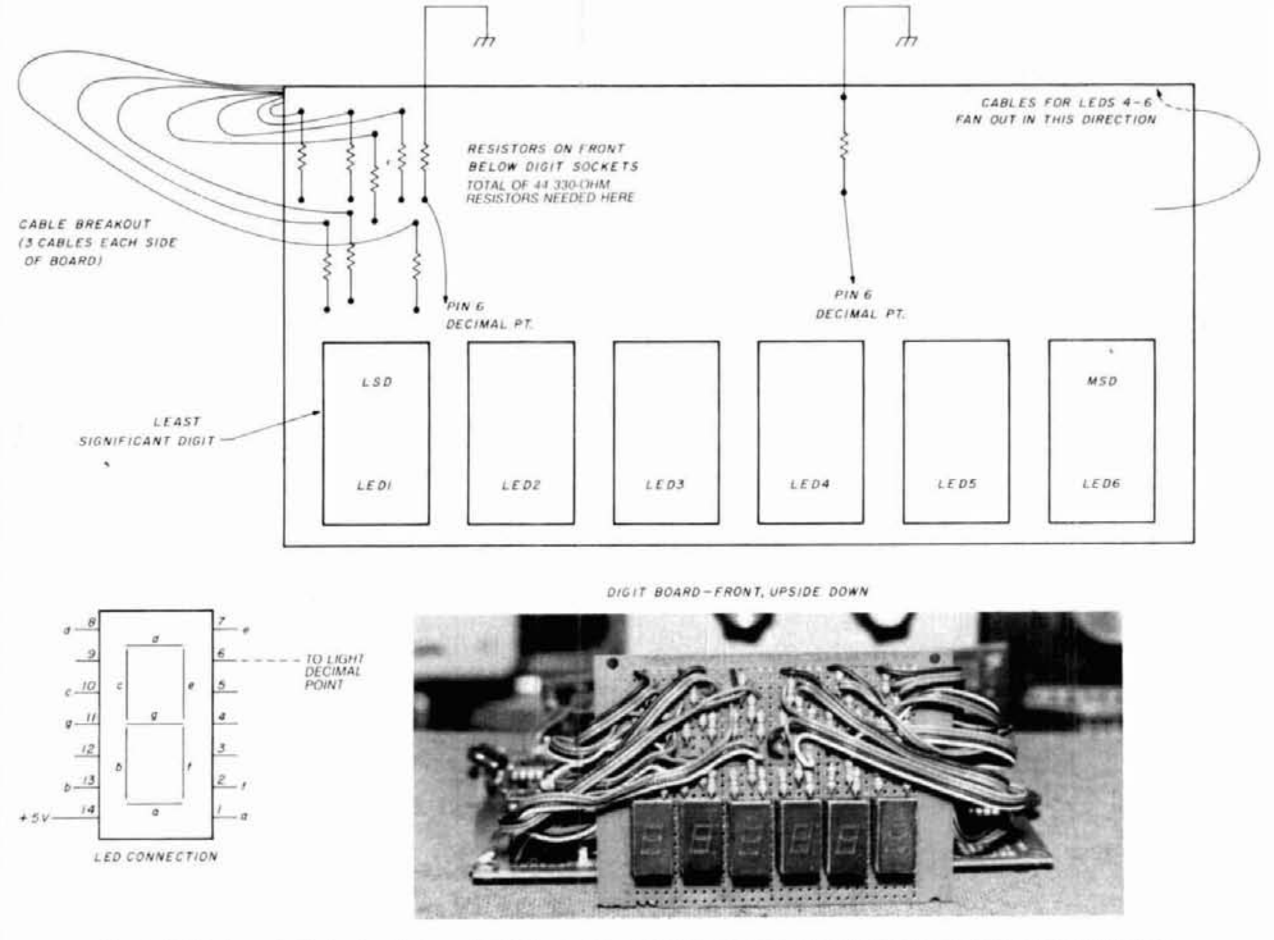


fig. 4. Digit board. Outputs of decoder/drivers are cabled to their respective segment dropping resistors. One cable section per digit goes to corresponding decoder on bottom board. Seven 330-ohm resistors per digit — except for LEDs No. 1 and No. 4, which have a resistor going from pin 6 to ground.

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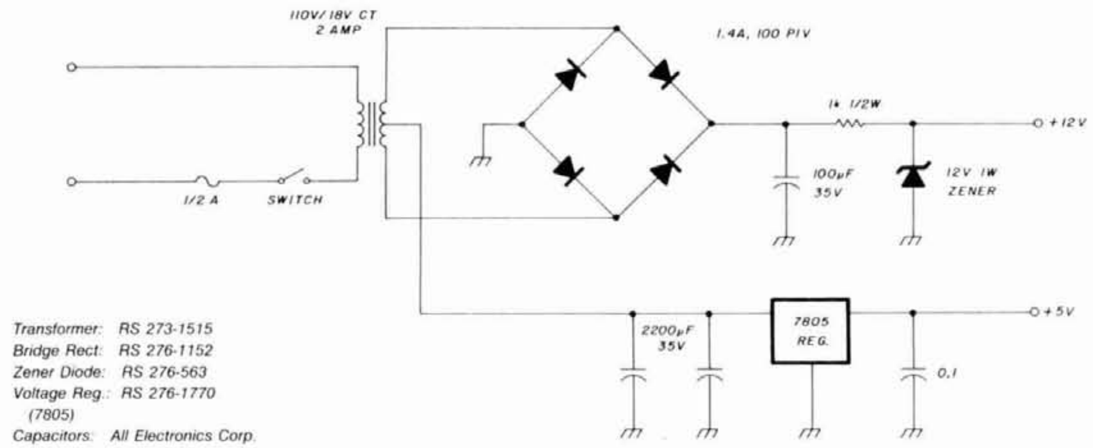

fig. 5. Power supply schematic.

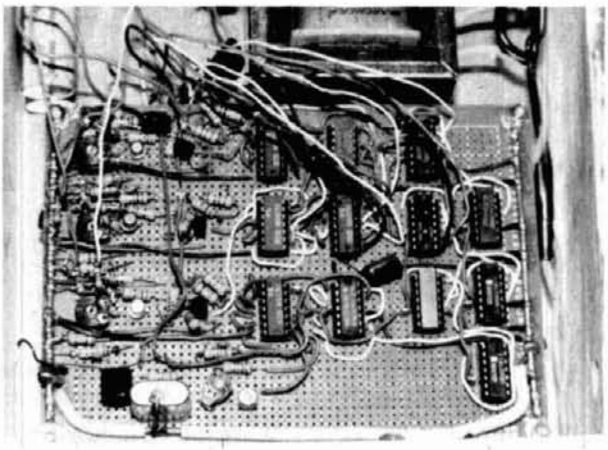

Photo F. Clock oscillator has prominent location in lower left corner of top board view.

made from No. 12 wire and secured by lugs to the board mounting bolts. (While not an ideal ground, it works.) The photo also illustrates the closeness of the solder points on the pins. This was the part of the whole project that most concerned me. I tried to cut each wire so that after inserting it through the top of the board there would be just the right amount of bare wire left to bend over flat against the pin and spin around with a wiring tool so that no further wire cutting would be necessary. I'd crimp it slightly with my long-nose pliers to assure a tight fit and then solder very carefully. In the counter section of the board I soldered corresponding wires or corresponding cabled ABCD data runs. Then I verified both continuity and the absence of adjacent pin shorts before continuing. This approach paid off. I found two adjacent pin shorts and one cold solder joint that I fixed immediately, saving years of anguish. As I went along I also aligned any bent pins.

In this same photo you can see a bus running under the center line of the latch sockets. This bus carries the transfer pulse to pins 4 and 13 of each latch, which are connected together on the bottom of the board (shown by dotted lines in **fig. X**). There simply wasn't room for this run on the top side.

Because the local Radio Shack was out of small 0.1-pF tantalum capacitors, I used their larger, standard PC-type for transient bypass and fitted them as best I could.

Most of the wiring of the multiplexer chips — on both bottom board and top board — is in the form of interconnection of gates in the same chip or in other multiplexer chips. On the bottom board I started at pin 1 on the top left side of chip U13 and went numerically pin-by-pin, finishing out each chip before going to the next. I made a color-coded tabulation of the off-board wires, leaving these about six inches long for later connection to the top board.

top board

The top board (**fig. 2** and **Photo F**) contains the input preamp/pulse-shaper circuits, the clock oscillator U5, and associated time-division chips U6 through U12, as well as multiplexer chips U1 through U4.

Friends, I didn't know how many of life's simple pleasures I'd missed until I started working on the top board. As with the other board, I determined the layout on a board-size piece of quad paper. In an attempt to keep the input wires short, I crowded the preamp stages. Besides giving the whole thing the look of last year's campfire, it began to look as if I might have an interstage coupling problem on my hands. Actually, the only place such coupling ever did occur was between the wires from the input jacks. After I no longer had to remove the top board for anything, I changed these to coax.

I installed the 40673 preamp and 2SC945 pulse shaper circuits first, using 1/8-watt trim pots as the input impedance for each preamp, but I just tacked on the wires from the input jacks. I expected to have to experiment with the resistance to get it in the right range for the input circuits. (The samples from the transceiver have to develop a voltage across a load at their respective input stages to apply to the MOSFET gate inputs. There is a limit as to the amount of current flow through this load. The optimum resistance worked out to be about 2 k (which is the input impedance listed on the spec sheet for the SB-650).

Radio Shack couldn't help with 2-k pots, so I replaced the original 1-k units with 5-k, 1/2-watt trim pots, paralleled with a 3.3-k resistor under the board. This arrangement works perfectly. (**Figure 4** shows only a 2-k variable resistance.)

Though the 40673 ***MOSFET*** circuit is similar to that used in the SB-650, I first saw it in an article in *QST*.[1] The crystal clock oscillator design was also taken from this article.

The components of the 2SC945 pulse-shaping circuits were determined by experiment because I couldn't find any characteristics curves to determine the proper parameters for saturation.

Rather than worry about socket contact resistance and corrosion, I direct-wired the transistors. To minimize the danger of static blowout of the MOSFETs, I borrowed a dc-operated isolation-type iron from Bobby Hobby, KA4DPF, the friend who took the photo for this article.

Next I wired the clock oscillator, which was almost a vacation by comparison. I then mounted all the sockets for the IC chips. I wired miltiplexer chips U1 through U4 and the oscillator chip, U5, first. I followed the same wiring scheme on this multiplexer section as on the bottom board (starting at pin 1, upper left, etc.).

Then I wired time-division chips U6 through U12. Except for the divide-by-four flip-flop U6, the wiring almost duplicates itself from chip to chip. Chips U7 through U12 require that pins 2, 3, 6, 7, and 10 all be grounded. To prevent chaos, I first connected these pins on each chip together on the underside of the board, then connected them to a ground bus. I had to use a little spaghetti here and there to avoid other pins.

final assembly

Connecting the digit board to the bottom board is the first step in the final assembly.

Figure 4 shows a section of seven-conductor cable going to each digit resistor area. The cable is split into two sections each to allow for more flexibility in positioning the board against the window. Using the color coding of the various wires, I tabulated a wiring plan that made it quick and easy to connect the cable ends to the proper pins on the decoder/driver sockets. When I first planned this arrangement I was concerned that the digit board might not be secure enough without direct mounting on the chassis. Not to worry — you couldn't knock it loose with a baseball bat. Finally I connected those almost-forgotten off-board wires from the bottom board to their top-board destinations.

The main boards are mounted on four 1 1/2-inch, 6/32 bolts protruding downward from the top of the chassis (viewed in normal operating position). A 3/8-inch nylon spacer on each bolt separates the chassis from the bottom board, which is secured with washers and nuts. (The ground lead from the 2200 μF filter combination connects to a lug at the nearest bolt.) Three-quarter-inch aluminum spacers on the bolts support the top board, which is secured by nuts. Lugs carrying the top board ground buses go under these nuts.

adjustments and calibration

Proper sampling levels are adjusted by placing the transceiver on the 29.5-MHz band, in the receive mode, and adjusting the three input trim pots to just slightly more than the level needed to cause a 29.5^{s} MHz reading to lock on the display.

First I adjusted the 1-MHz clock oscillator trimmer to zero beat with WWV, using a portable receiver loosely coupled to the oscillator gate section by an insulated wire wrapped around the receiver's telescope antenna. Even with the economy-type trimmer the frequency stays within a few Hz after several hours of warmup, varying no more than about 100 Hz after 24 hours of continuous operation.

With the trim pots set at minimum, I switched the transceiver to the 29-MHz range; the heterodyne oscillator is at its highest frequency here, and losses through the sampling circuitry are greatest. (In other words, if it works here it should work anywhere.) At this point the display read all zeros, as was appropriate. Then I advanced the heterodyne oscillator trim pot until a firm reading in the region of 38 MHz was showing (this is the frequency of the heterodyne oscillator crystal on this band).

Then I adjusted the carrier oscillator trim pot for a marked drop in frequency reading, to about 34 + MHz; I adjusted the VFO trim pot for a further drop to 29 + MHz. I advanced each trim pot slightly and closed up the chassis.

Naturally the first thing I did was to tune down to 7335.0 USB. As I brought up the audio gain, I heard, with perfect clarity, "This is CHU, Canada. The time is . . ." — one of the sweetest sounds I have ever heard.

This readout can be adapted to some other rigs. By using the heterodyne oscillator input only, it can be used for low-voltage level frequency counting, with 100-Hz resolution.

If you have any questions, write (please enclose SASE) and I'll try to help.

reference

1. Philip S. Rand, W1DBM, "The BEEPER: An Audible Frequency Readout for the Blind Amateur," *QST*, September, 1983, page 19.

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2.3-GHz prescaler

Extend your digital counter's dynamic range

Some years ago, I built a prescaler for my rf frequency counter which extended its operating range from 550 MHz to above 1300 MHz.[1] While this prescaler provided a means of measuring the frequency of 1296-MHz equipment accurately, it was never easy to use because of its limited input sensitivity.

Recently I built a prescaler for my present counter which virtually eliminates most of the shortcomings of that earlier model. This prescaler is based on a divide-by-two integrated circuit, the Telefunken U822, which operates well beyond 2000 MHz. Unlike my earlier design, this prescaler incorporates a preamplifier to increase the useful dynamic range so that the input signal level does not need to be closely controlled.

circuit development

The U822 is a low-cost silicon monolythic IC designed for the consumer market in such applications as cable TV tuners and satellite TV downconverters. Packaged in a four-lead plastic housing similar to those used for low-cost RF transistors such as the MRF 901, the U822 operates from several hundred MHz up to at least 2.0 GHz and produces a low-level output at one-half the input frequency. A similar device, the U824, is useful as a prescaler for 600-MHz counters and electrically quite similar to the U822. The only major difference between the two is that the U824 divides by four rather than two. Although this article describes the U822, the U824 can be installed in its place without circuit changes if a divide-by-four prescaler is desired.

dynamic range limitations

One problem with using the U822 to extend the operating frequency range of a digital counter is that the input power range (dynamic range) of the divider is quite limited. This means that the power level of the input signal must be held within close limits. If this is not done, the divider may not produce an output — or worse, it may produce a spurious output not at the correct frequency.

Generally the signals we wish to measure with a frequency counter aren't available at an optimum power level. Therefore it's more than a small nuisance to have to deal with the limited dynamic range of a divider in a prescaler used as a piece of test equipment. One solution to this problem is to increase the dynamic range of the prescaler. Then, we can be more confident that the output frequency is at exactly half the input frequency, and we'll be able to use the prescaler for a wide range of signal power levels.

limiting amplifier

One good way to increase the dynamic range of the prescaler is to place a limiting amplifier ahead of the divider. A limiting amplifier provides a constant output power over its entire input power range. Of course, all real amplifiers are limiting amplifiers in some sense, because there's a limit to their output power, but we usually don't try to operate them this way. The key point is this: a limiting amplifier will compress the dynamic range of the input signal to a much narrower output range, and this narrower output power range can be more suitable for the input of the digital divider. The question now is, what is the "suitable" range for the U822?

The data sheet for the U822 lists a minimum input signal power and frequency over which the divider is guaranteed to function properly. The input signal level must be greater than 150 millivolts RMS, and the divider will operate to a minimum of 2000 MHz. The maximum input signal power for operation isn't listed, but the maximum survival power (higher power may damage the device) is listed. In addition, the data sheet doesn't provide operational data on "typical" devices nor on operation *above* 2000 MHz. So, to design a limiting amplifier input for the prescaler, we need more detailed information on how the divider performs over a wide range of input power levels, and at various frequencies.

By Jerry Hinshaw, N6JH, 142 Kensington Place, Frederick, Maryland 21701

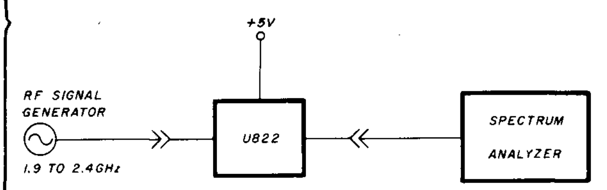

fig. 1. Test setup used to measure the operating range of the divider.

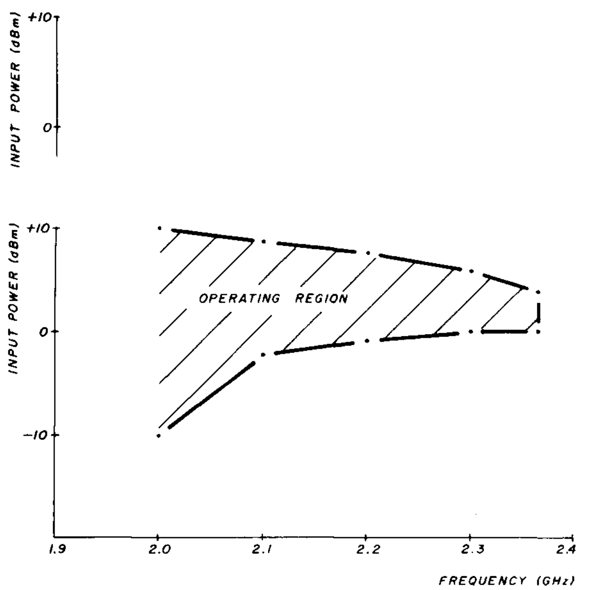

fig. 2. Operating range for the U822. RF inputs outside the shaded area produced unpredictable outputs.

tests determine operating range

To get this data, a U822 divider was tested using the setup shown in **fig. 1**. The input frequency and power level were adjusted while the output signal frequency was monitored using a spectrum analyzer. (The spectral display gives a more sensitive indication of when the divider is beginning to malfunction than does a frequency counter. This is because the spectrum analyzer shows when the divider output signal starts to break up or develop nonharmonic spurious products more quickly than these problems would appear on a digital counter display.) The divider was monitored from about 1800 MHz, where it has a fairly wide dynamic range, to about 2400 MHz, where the operating range is very narrow. The results of these measurements are plotted graphically in **fig. 2**. The supply voltage to the U822 was held constant at 5.0 volts for these measurements. It is probable that by carefully tuning the supply voltage slightly over the range of 4.8 to 5.2 volts, the maximum operating frequency could be increased. However, it's clear that we're near the limits of the device already, and further tuning would probably yield only marginal improvements.

U822 operating parameters

Figure 2 clearly shows that the maximum and minimum input power limits converge to a point at which only one unique power level can produce a reliable output signal from the divider. Pilots call such a region in a flight performance curve the "coffin corner;" although the consequences for us are fortunately not fatal, the convergence does indicate the practical limit for the device. To the left of this limit is the operating range, and the "window" of permissible powers increases rapidly as the input frequency is reduced. Also, we can see by inspection of the curve that a power level of +5 dBm will provide satisfactory operation to above 2300 MHz. This information on the operating power ranges of the divider is what's needed to design a limiting preamplifier for the prescaler.

Figure 2 also shows the minimum signal level needed to deliver good divide-by-two outputs. The required level ran from −12 dBm at 1800 MHz up to the +5 dBm intersection at 2400 MHz. Thus, the dynamic range of the input decreases from 20 dB at 1800 MHz to 11 dB at 2100 MHz, down to only 6 dB at 2300 MHz. This means that to measure the frequency of an unknown signal, its power would have to fall within this narrowing region. If a limiting preamplifier stage were placed in front of the divider, the operating dynamic range could be increased both above and below the limits of the divider alone.

preamplifier design

By testing a U822 divider, I discovered that the desired preamplifier should provide ample gain up to at least 2400 MHz and should have an output power limit of about +5 dBm. Naturally, it also would be nice to have wide bandwidth, low cost, small size and low power drain. Such a list of requirements would have been difficult to satisfy a few years ago, but monolythic silicon rf amplifiers that provide nearly all of these desired attributes are now available. They're small, have very wide bandwidth, and are less expensive than most low-noise rf transistors. Because they draw a fair amount of current, they do fall a bit short of our ideal, but only in terms of power drain. These "monolythic microwave integrated circuits" (MMICs) have been described recently in Amateur publications[2,3] and are available from stock at a number of distributors.

the MMIC

The MMICs described in References 2 and 3 are available from the manufacturer, Avantek, in four types. The data sheets for these devices list a number of operating characteristics, including the 1-dB compression point, which is the output power level where the gain has been reduced by 1 dB from the small-signal value. This compression point information is what we need to choose a device to limit near the +5dBm point, which the U822 divider requires for best operation. In fact, the MMIC data sheets contain curves of output compression point versus bias current, which can help us choose an operating point most appropriate for this application.

Of the four devices, the MSA03 seems best suited for use as the prescaler amplifier because it has an output compression point of about +5 dBm at 2000 MHz when operated at 25 to 30 mA bias. This compression point decreases with frequency, which matches the U822 operating window even better than if the compressed power level remained constant as the signal frequency increased. An MSA03 amplifier was assembled and tested for compressed power; the results are shown in **fig. 3**.

In addition to compressing input signals to the constant output power required at the U822 divider's input, the MMIC amplifier also provides gain to small signals, which would otherwise be below the operating range of the divider. Thus, if the preamplifier does its job properly, the dynamic range of the prescaler will be extended at both ends. The MSA03 will provide about 12-dB gain to small signals so that the bottom of the curve in **fig. 2** should be lowered by about this much. The top end of the curve will also be raised, but there's a limit to how high it can go; the MSA03 amplifier itself has a "never exceed" input power specification of 100 mW. Thus, with just one stage of amplification using the MSA03 we can expect a greater than 20-dB increase in dynamic range, which is enough to transform what otherwise would be a temperamental prescaler into a useful test device.

The output power level from the U822 is about −20 dBm when driving 50 ohms. If this level isn't sufficient to drive the frequency counter, a second MSA amplifier could be installed on the same board following the divider to increase the output power. A single MSA03 will bring the divider's output up to at least −8 dBm (90 mV RMS), which should drive all but the least sensitive frequency counters.

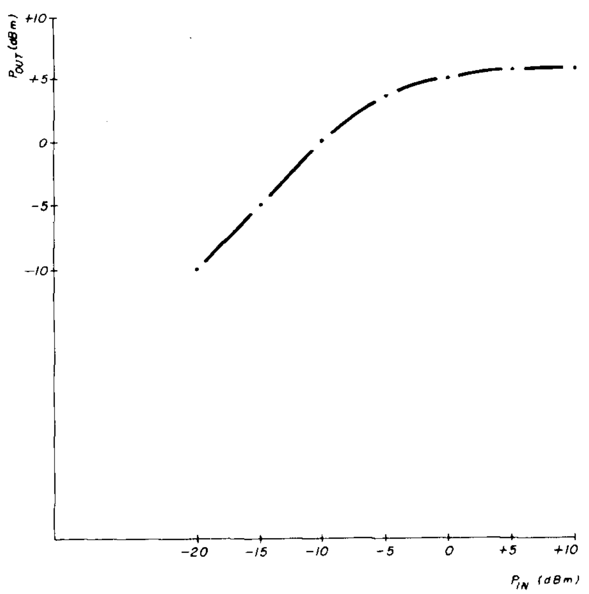

fig. 3. P_{OUT} vs. P_{IN} for the MSA03 at 2.0 GHz, 25-mA bias. The amplifier shows the expected limiting near +5 dBm.

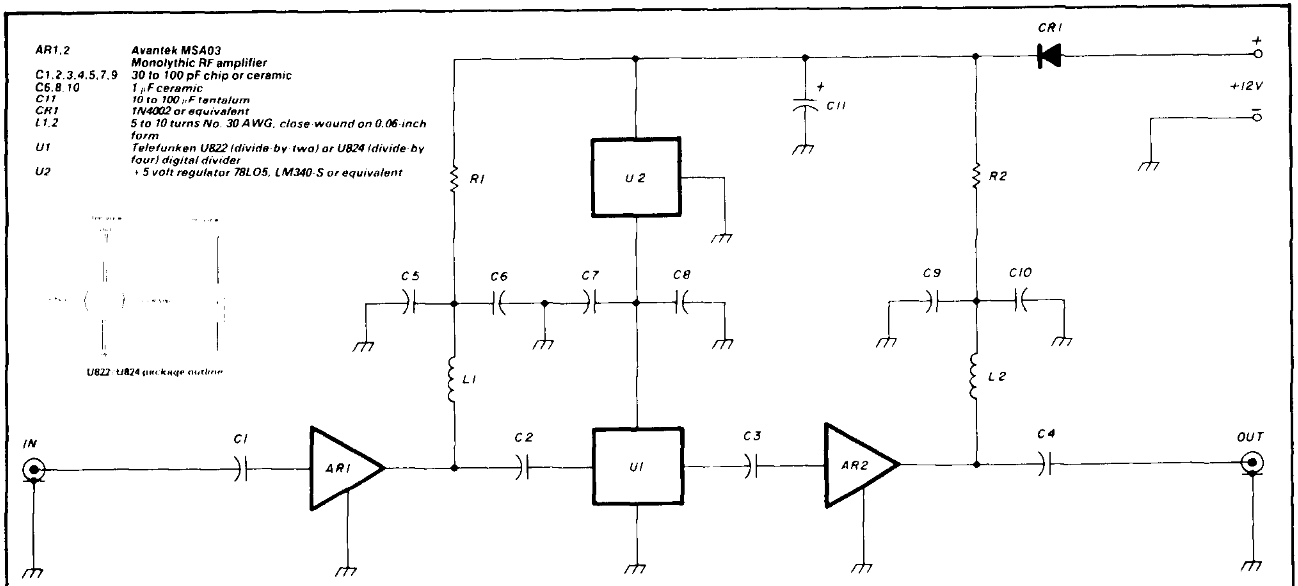

fig. 4. Prescaler schematic diagram.

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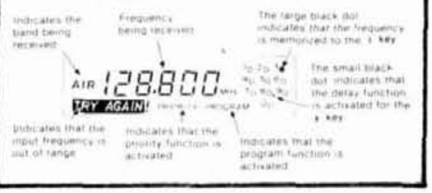
	MW	530 · 1600 kHz (531 · 1602 kHz)	10 kHz (9 kHz)
	LW	150 · 529 kHz (150 · 530 kHz)	1 kHz

7 Functions on LCD Display



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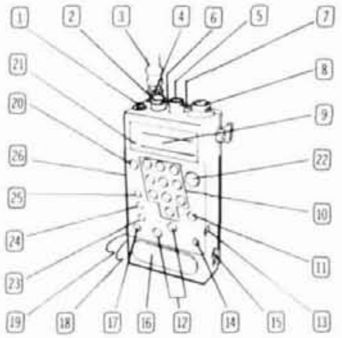

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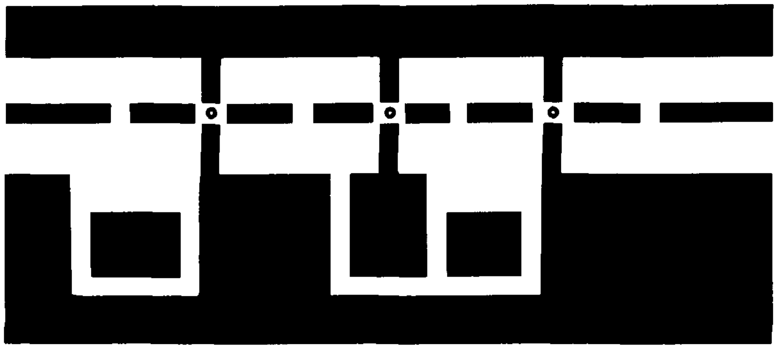

fig. 5. Full-size pc negative for the prescaler.

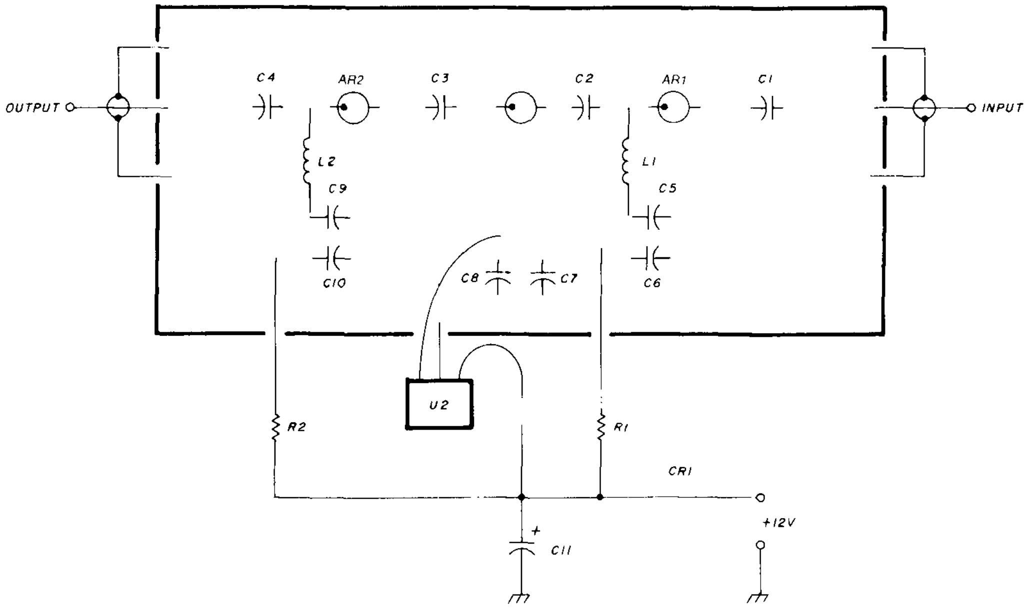

fig. 6. Component locations. Items shown off board are mounted on sidewall of enclosure.

prescaler operation

Figure 4 shows the schematic diagram of the prescaler. The rf signal enters at the left and is coupled to the MSA03 amplifier through a small capacitor. The capacitor can be a small mica type — but for more uniform results and flatter gain response, I recommend using a chip capacitor. Reference 2 describes the selection of capacitor type and value in detail. Any capacitance from about 30 to 300 pF is a fair choice here, and will work for the 1- to 2.5-GHz range. At the output of the MSA amplifier, a second capacitor of the same type is used to isolate the DC supply, which reaches the amplifier through a small, hand-wound choke. Resistor R1 biases the amplifier, and for a 12- to 15-volt supply 200 to 240 ohms is appropriate.

The U822 requires + 5 volt bias, which is just a bit too low to be used on the MSA amplifier. Rather than run two separate power supply leads to the prescaler, a small voltage regulator is used to drop the 12-volt to 15-volt input to the 5 volts needed by the divider. Because the divider draws only about 30 mA, a small voltage regulator IC such as the 78L05 can be used. No heatsink is required at this power level.

Following the divider a second rf amplifier buffers the divider's output and increases the divided output signal to a higher power level. The U822 provides about + 20 dBm output into 50 ohms. Because this level is too low to drive many frequency counters, another MSA03 amplifier brings the signal up to about −8 dBm. If the second amplifier isn't needed, it can be omitted. Install jumpers over the cuts in the microstripline to complete the circuit from C3 to the output connector. If AR2 isn't installed, then C4, C9, C10, R2, and L2 may also be removed.

At the right, the divide-by-two output leaves the output connector. The U822's output is direct-coupled, so a coupling capacitor is used to prevent unwanted biasing of the divider by external voltage sources.

construction

The prescaler is built on a circuit board that can be etched from the full-sized negative artwork shown in **fig. 5**. Alternatively, a prototype board can be made using the same artwork, and handcutting the traces with a sharp knife and peeling away the undesired pieces of copper. With either technique, leave the far side of the board as unbroken ground to form a ground plane for the microstrip circuit traces. Wrap the edges of the board with copper tape or thin brass shim stock. Solder both edges so that the top ground areas are well-connected to the bottom ground plane. The two ground leads from the MSA are run through the 0.15-inch hole in which the MSA amplifier is mounted. Then they're soldered to the ground plane on the far side of the circuit board. The output of the amplifier MMIC device is identified by a small bump on the top of the package next to the output lead.

The U822 divider is also mounted to the board in much the same way. A 0.2-inch hole is drilled in the board to clear the circular plastic package. The leads are then soldered flush to the traces, which connect them to the rest of the circuit. The U822 has four leads, as **fig. 6** shows. One lead each is used for the rf input, the divide-by-two output, ground, and +5 volt bias. The longest of the four leads is the output. The bias lead of the U822 should be well decoupled to ground. I used a chip capacitor, a small ceramic disk capacitor, and a tantalum slug capacitor. This combination, I hoped, would provide good RF decoupling at frequencies from a few Hz up to several GHz.

The biasing circuitry for the MSA and the voltage regulator are hooked up point-to-point along the edge of the circuit board and to the mounting points of the enclosure. Their locations are not critical if the rf amplifiers and the divider have been effectively decoupled on the board.

performance

Figure 7 shows the performance of the prescaler with its preamplifier in place. The improved dynamic range is markedly different from the operating window seen in **fig. 2**. With its preamplifier, the prescaler now has a much better input signal range, both above and below

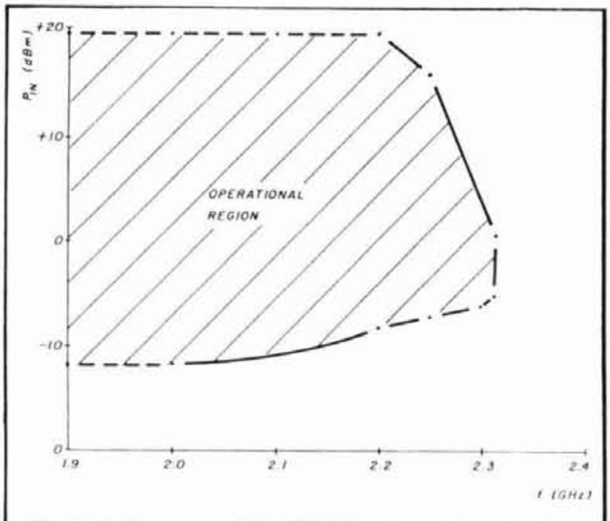

fig. 7. Performance of the U822 with MSA03. Dashed lines indicate limitations of the rf signal generator.

the levels which the divider alone could handle.

In recent years, digital integrated circuits have made it possible to build digital frequency counters for microwave frequencies. Just ten years ago, the fastest available counters operated at about 1200 MHz, but silicon bipolar dividers now on the market operate more than twice as fast. New Gallium Arsenide (GaAs) digital chips are in limited production, and although they're still too expensive for Amateur use, they promise yet another leap in performance in the near future.

references

1. Jerry Hinshaw, N6JH, "1.5-GHz Divide-by-four Prescaler," *ham radio*, December, 1978, page 84.
2. Jerry Hinshaw, N6JH, "Monolithic RF Amplifiers," *ham radio*, March, 1986, page 22.
3. B. Atkins, KA1GT, "Microwave Amplifiers," *QST*, January, 1986, page 78.
4. J. Browne, "GaAs IC Complements Budget 3-GHz Counter," *Microwaves and RF*, January, 1986, page 221.
5. JA6BI, "High Frequency Dividers," *CQ Ham Radio*, August, 1985, page 355 (in Japanese).

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rewinding transformers

Pages 89 and 90 of W6WTU's article, "Rewinding Transformers with CAD (December, 1986) were transposed. —TNX WB4UIV

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The address of the Journal of the Environmental Satellite Users' Group was shown incorrectly in the October article, "Get on SSTV with the C-64" (page 43). The correct address is 2512 Arch Street, Tampa, Florida 33607. (TNX WD4MRJ)

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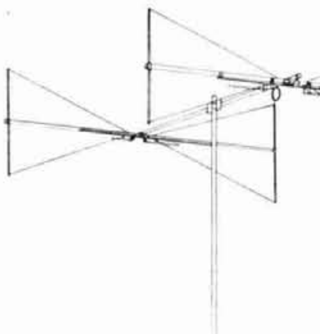

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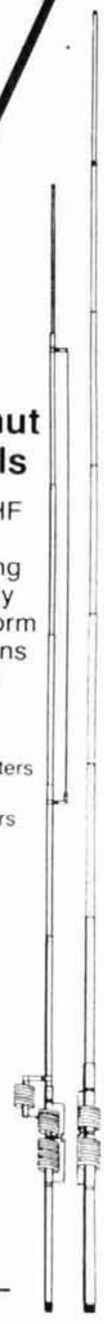

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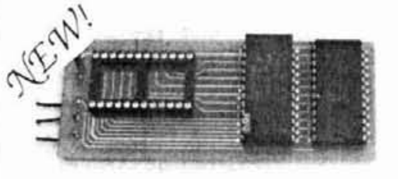

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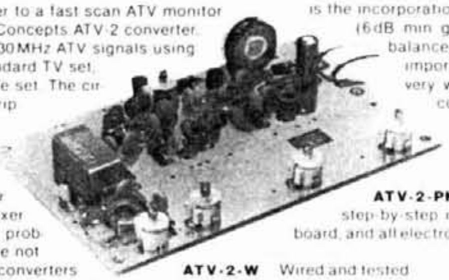

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X-band beacons

A practical guide to component selection, installation, and operation

On the low bands, distant signals are almost always available to aid in adjusting antennas, checking out equipment, and investigating propagation. This isn't so on the microwave bands, where contests may provide the only microwave signals you're likely to hear. By the time the contest arrives, however, it's much too late for extensive testing of any kind.

One way of solving this problem is through use of a beacon that provides an ever-present, stable (but distant) signal. Fortunately, microwave beacons aren't particularly difficult or expensive to build.

Part 97, section 97.87 of the FCC regulations provides for Amateur beacons. All frequencies above 450 MHz — and some below 450 MHz — are available for automatically controlled beacons. Although no special authorization is required, some form of control is necessary.

I've had a X-band (10 GHz) beacon operating from a 2000-foot mountain near Ventura, California, for several years (see **fig. 1**). Coastal southern California is its intended coverage area.

The heart of the beacon is a 140-mW Gunn diode source operating on 10.256 GHz. The Gunn diode is fm-modulated with the repeating Morse message: "WA6EJO/B Ventura X band beacon." Control is provided by the W6ORE remotely controlled station (**fig. 2**),[1] which simply turns the beacon's power supply on and off. Although this article pertains to building an X-band beacon, the same techniques can be applied to any microwave band where simple rf sources are available.

An X-band beacon consists of a signal source, an antenna, an IDer, a power supply, a weatherproof housing, and a control unit.

signal sources

A Gunn diode oscillator is a typical X-band source. The Gunn diode itself* is usually packaged in a small metal box or casting. There's a terminal for dc bias and an opening for the rf output. Pre-packaged Gunn diode oscillators used in intrusion alarms and police radars often appear on the surplus market.

The dc requirement ranges from about 5 volts to 15 volts, at a current level of tens to hundreds of milliamps, depending on the particular unit. This power should be well regulated because voltage fluctuations will result in fm-ing the frequency of the output (which comes in handy for modulation).

The power output is in the tens to hundreds of milliwatts — not levels capable of inducing rf burns, *but eye damage is a possibility*. Keep microwave sources, even weak ones, away from your head!

The frequency can usually be adjusted over a wide range, often hundreds of MHz, with a mechanical tuning screw. These are free-running, not crystal-controlled, oscillators. Nevertheless, they're surprisingly stable after a few minutes warm-up. Sources from intrusion alarms and speed radars are usually tuned to 10.525 GHz, slightly above the Amateur band.

The Gunn diode oscillator used in my beacon is a surplus police radar unit purchased from Lectronic Research Laboratories for $50.** While that may not seem to be a bargain — I have picked up Gunn oscillators at swap meets for $5 — the power output is quite high. The unit is rated at 100 mW and, when measured, produced 140 mW.

Equally usable are IMPATT (IMPact ionization Avalanche Transit Time) diode sources, which take more voltage (70 to 90 volts), and Dielectric Stabilized Oscillators (DSO). Klystrons are definitely passé. Solid-state sources are generally cheaper, longer lasting, and safer (no high voltage).

When purchasing surplus microwave hardware, it's

*Actually, the Gunn diode is not a true diode. It has no PN junction, but does have a designated anode and cathode.

**Lectronic Research Laboratories, Atlantic and Ferry Avenue, Camden, New Jersey 08104.

By Steve J. Noll, WA6EJO, TiC Scientific, 1288 Winford Avenue, Ventura, California 93004-2504

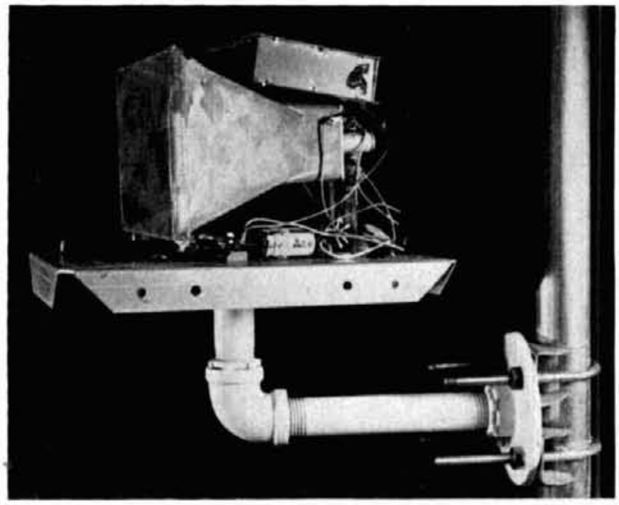

fig. 1. Beacon with cover removed.

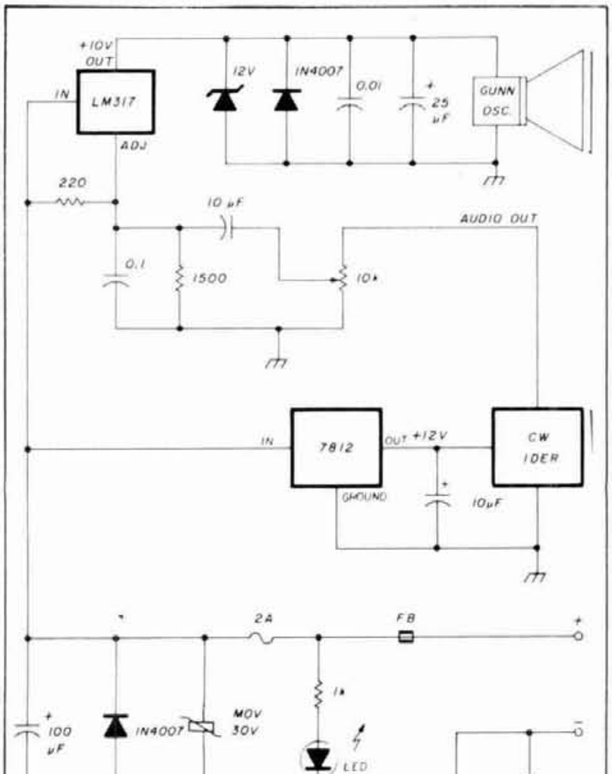

fig. 2. Beacon schematic.

important to make sure you're getting the correct frequency range. The designation "X-band" actually covers a very wide range of frequencies, from 5.2 GHz to 10.9 GHz, with several different sizes of waveguide available. Rectangular waveguide is the transmission line of choice because sources, antennas, and other hardware are usually built to mate with rectangular waveguide flanges.

The Amateur Radio Service portion of X-band is 10.0 GHz to 10.5 GHz, which includes the X_F and X_K sub-bands. The waveguide we are interested in measures 0.9 x 0.4 inches inside, and 1 x 1/2 inches outside. The designations for such guide are WR-90 (EIA) and RG-52/U (MIL). The flanges of interest are UG-39 and UG-40.

The waveguides for the frequencies just above and below the Amateur band differ only slightly in dimension; it's easy to pick the wrong one. When shopping at electronic swap meets, hamfests, or surplus stores, it's wise to carry a ruler or a waveguide flange of the correct dimensions for comparison.

Note that sources may actually have smaller rf output openings than the standard waveguide inside dimensions. In fact, the rf port may be just a round hole. Because of this, it's more important to judge surplus source frequency range by checking the spacing of the four No. 8 mounting holes at the flange corners. The spacing for UG-39 and UG-40 flange holes is 1-7/32 x 1-9/32 inches.

Let's say you've picked up a purported Gunn diode oscillator at the local swap meet or surplus emporium, but its voltage requirement isn't marked. Now what? Fortunately, it's not difficult to determine the optimum bias for a Gunn diode. An adjustable power supply, an attenuator, and a detector — or preferably, a power meter — are required.

Connect the source to the detector/power meter through the attenuator (10 or 20 dB, for protection). Run the supply voltage up, starting from 5 volts, and monitor the power output. It should peak somewhere between about 6 to 14 volts and then decline. *The peak is the operating point.*

I've applied this technique to three different X-band Gunn sources (**fig. 3**). A Solfan source started oscillating at 4 volts and had a broad peak at 8 volts with 8.5 mW out. A Racon source started oscillating at 4.5 volts and peaked at 9 volts with 30 mW out. A Greenray source started oscillating at 9 volts and peaked at 12 volts, with a 130-mW output.

A couple of important details: spurious low frequency oscillations can destroy a Gunn diode. (This can be prevented by connecting a 15- to 35-µF capacitor and a 0.01-µF capacitor across the diode.) Also, Gunn diodes can be damaged by reverse polarity. Usually the case of the Gunn oscillator is negative.

antennas

Although there are other kinds of microwave antennas, horns (**fig. 4**) are probably best for most beacon applications. They're commonly found on the surplus market, but if you can't find one, it's not difficult to make one from a short piece of brass waveguide, a brass flange, and some sheet brass (**figs. 5A, 5B**) available from hobby shops.* Horns are also reasonably efficient and don't require tuning.

Where to get waveguide and flanges? Check surplus stores and swap meets for miscellaneous waveguide assemblies that have salvageable parts. But avoid aluminum waveguide and brazed brass waveguide unless it's already in a usable form. Soldered brass waveguide and flanges are best because they can be taken apart with a torch. Another source is Lectonic Research, which sells brass flanges (in the $3 to $6 range) and waveguide (at about $4 per foot).

A horn is a directional antenna and essentially a flared, open waveguide. Short, small horns have wide, low-gain patterns; long, large-aperture horns have more gain and less beamwidth. Ideally, a microwave beacon should be positioned so that all users are situated in one direction from it. Power is hard to come by at X-band, so it's a shame to waste it on a wide-beamwidth antenna.

What sort of gain and beamwidth is available from horns? The small horn used on the Microwave Associates Gunnplexer transceiver, for example, measures 3 inches long and has an aperture measuring about 3 inches by 3-1/2 inches; the gain is approximately 17 dB, with a beamwidth of 30 degrees. The Microlab/FXR X638A, a large X-band horn, measures 15 inches long and has a 7-5/8 by 5-5/8 inch aperture; the gain is 22 dB, with a beamwidth of about 12 degrees. As you see, as gain rises, horns get longer.

identifying

Part 97.84d3 requires that beacons be identified at intervals not to exceed 1 minute. If ID is by voice, the word "beacon" must follow the call sign. If ID is by CW, the call sign must be followed by the fraction bar DN and the letters "BCN" or "B." Although speech synthesis and speech recording chips are available, it's probably still cheaper and better to identify with CW. Commercial CW IDers are available. GLB and Autocode** are two manufacturers of IDers in the $50 price range. An IDer can be built, of course, and few parts are required. The WB2BWJ IDer is quite popular.[2,3,4]

Although SSB is on the way, most 10-GHz stations still use fm because the popular Microwave Associates Gunnplexer was designed to work on fm. Therefore, fm modulation of the beacon is in order, and it's fortunately quite easy to accomplish. As noted, power supply fluctuations will fm the rf output of a Gunn diode. So all that needs to be done is to inject a little modulated CW audio into the diode via a coupling capacitor.

*See the RSGB *VHF-UHF Manual* for horn construction details.

**GLB Electronics, 151 Commerce Parkway, Buffalo, New York 14224; Autocode, P.O. Box 7773, Westlake Village, California 91359.

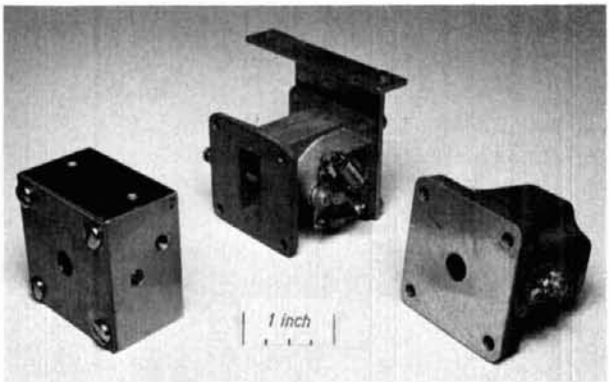

fig. 3. Surplus X-band Gunn Oscillators.

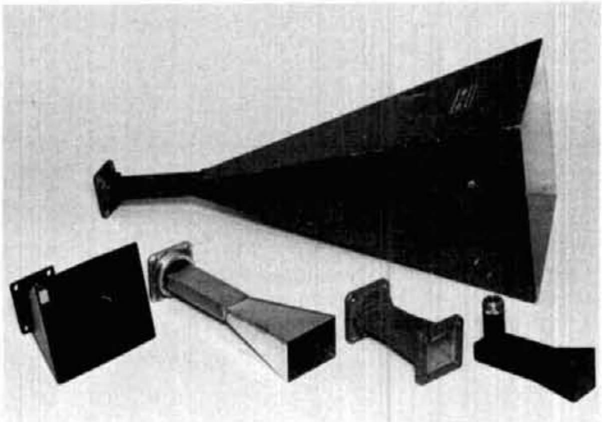

fig. 4. Examples of X-band horn antennas.

How much audio must be injected? That depends on the fm bandwidth of the receivers that will be monitoring the beacon. Probably the easiest way to determine the best amount is to adjust the IDer level while listening to the beacon output with a receiver typical of the type that will be monitoring the beacon.

In the case of my beacon, 100 mV peak-to-peak was required for a good signal as heard on a Microwave Associates Gunnplexer with a 3-dB-i-f bandwidth of 25 kHz. This voltage was measured at the Gunn diode. The IDer audio is actually coupled into the ADJ pin of the LM317 voltage regulator powering the Gunn diode.

power supply

Nothing's critical here. My beacon, including regulators, 140-mW rf source, IDer, and pilot light, draws a total of 400 mA from an unregulated 20-volt power supply. The unregulated supply is located in a cabinet, some 70 feet below the tower-mounted beacon. The supply consists of a 6-amp transformer, full-wave bridge rectifier, capacitive filtering, fuse protection of the line side, circuit breaker protection of the load side, and a solid-state relay for control. The raw dc is piped

up to the beacon via coax cable. The voltage regulators, a 7812 for the IDer and an LM317 for the Gunn diode, are located in the beacon housing.

Why not regulate the dc at the base of the tower? There are several reasons: voltage drop is one. The 20-volt supply allows for plenty of voltage drop in the trip up the tower. This also allows for more beacons to be added later by tee-ing power off the coax. Regulation right at the load also avoids hum and rf pickup that could occur through 70 feet of line.

lightning protection

Nothing but luck will save equipment actually struck by lightning. Serious damage from near strikes, however, can be avoided. A near strike took its toll on my beacon once and the result was blown fuses, a tripped circuit breaker, a blackened neon pilot light, a destroyed voltage regulator, and burned paint on the power supply. But there was no damage to the valuable parts, the IDer, or the Gunn diode! This fortunate outcome wasn't entirely attributable to chance. The beacon and its power supply were judiciously designed using fuses, Metal Oxide Varistors (MOVs), polarity protection diodes, ferrite beads, and surge-absorbing capacitors. The three terminal voltage regulators have an innate capacity for load protection. And using coax instead of a pair of open wires for supplying power helps reduce induced voltage. Design as much protection in as possible; it just might pay off!

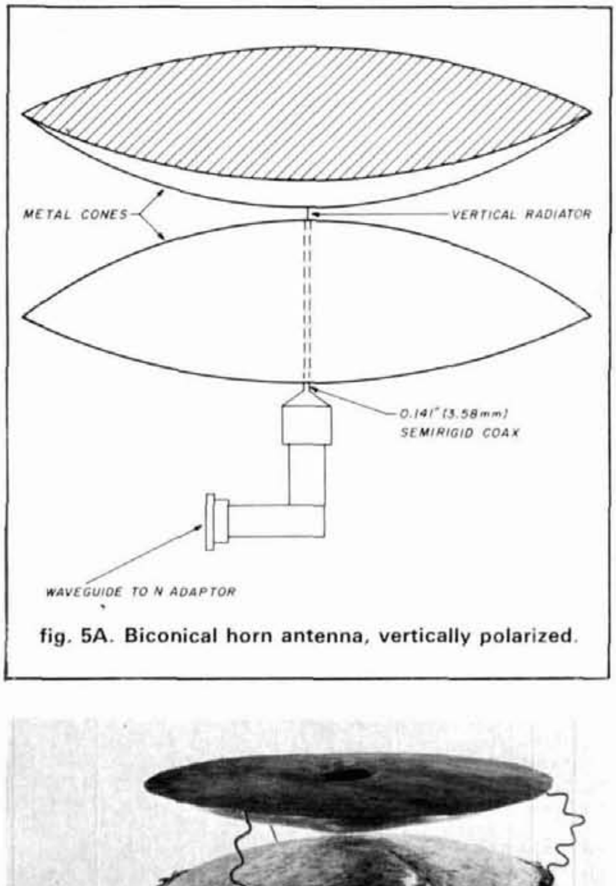

fig. 5A. Biconical horn antenna, vertically polarized.

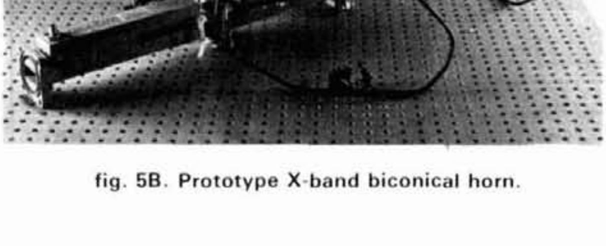

fig. 5B. Prototype X-band biconical horn.

beacon enclosure

Presumably the horn antenna, rf source, and IDer will be mounted on a tower or pole of some sort. All are small enough to fit inside an enclosure less than a half cubic foot in volume. The horn needs to "look" into the atmosphere through an rf-transparent window, so at least one wall of the enclosure has to be made from a suitable dielectric.

Finding an appropriate plastic box is no small feat. Sunlight can be quite destructive; it will disintegrate some plastics in a very short period of time. (For example, polyethylene trash bags left in sunlight will deteriorate in a few weeks. White nylon cable ties crumble in a few months.) Plastics often contain ultraviolet stabilizers to improve their sunlight resistance, but you can't tell by looking if a given piece of material contains UV stabilizers or microwave-absorbing additives.

Some have suggested testing the rf absorption of a material by placing it in a microwave oven, saying that if the material gets hot, it shouldn't be used. This sounds reasonable, but I really don't know how valid it is. Another test involves placing a piece of the proposed rf window material in front of a Gunnplexer and noting if much frequency "pulling" occurs, or if there's a change in mixer current caused by reflection. In the absence of any actual rf attenuation measurement capabilities, this method seems more reliable.

Some possible enclosures include plastic food storage containers, small plastic trash cans, computer diskette storage tubs, or wood or metal boxes with glass or Fiberglas™ windows. Styrofoam™-type materials might not be advisable because birds would be able to peck through them readily.

I was lucky to find a plastic box perfect for this application (**fig. 6**). It once housed a roof-mount Multipoint Distribution Service (MDS) 2-GHz receiver and antenna, so its microwave transparency and weather resistance were already proven. I further protected the box from sunlight by covering all sides except the one that the horn shot through with adhesive aluminum tape.

I covered the Gunn oscillator with building insulation to slow temperature changes, and thus, frequency

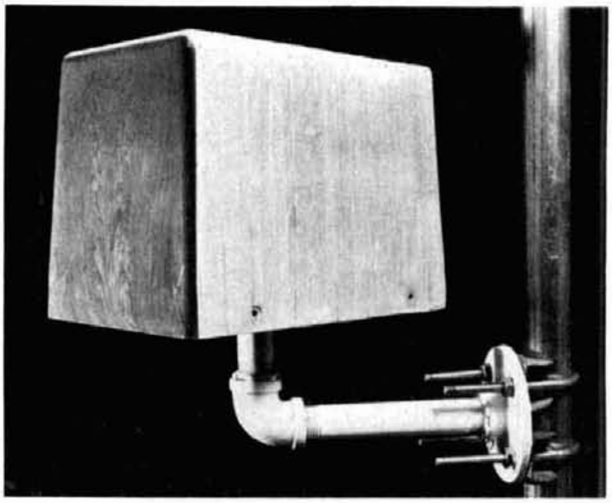

fig. 6. Beacon with cover in place.

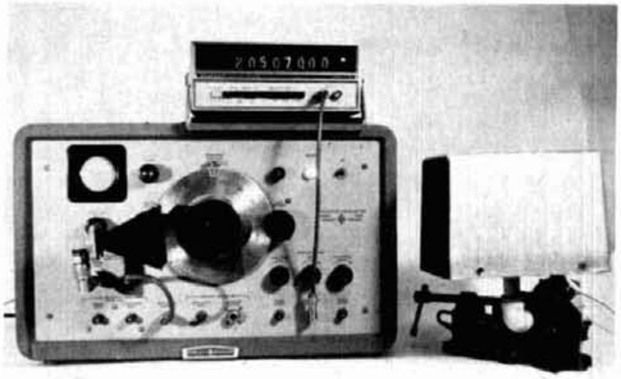

fig. 7. Measuring beacon frequency with an HP-540B transfer oscillator.

drifting. You can cover the horn opening with plastic food wrap (such as Saran Wrap™) to slow air migration-induced temperature changes. For perfectionists who want to provide active temperature control, several circuits are described in the *Gunnplexer Cookbook*.[5]

control circuitry

Part 97.87b says, "A station in beacon operation, either locally controlled or remotely controlled, may also be operated by automatic control when devices have been installed and procedures have been implemented to ensure compliance with the rules when the duty control operator is not present at a control point of the station."

One can't just park a beacon on a hilltop and forget about it; control is required. This would presumably mean simply being able to turn it on and off. Ideally, a beacon would be located at an existing repeater or remotely controlled station (Remote Base) site and share the control link.

My beacon, or more specifically, its power supply, is operated by the control link of a remotely controlled station. If a control receiver must be built for your beacon, remember that Part 97.86d allocates all frequencies above 220.5 MHz, except 431-433 MHz and 435-438 MHz, for controlling ("auxiliary operation").

choosing a frequency

The Amateur X-band covers 10.0 GHz to 10.5 GHz. Considering the possibility of drift, it would be wise to stay clear of the band edges. The rigs most likely to use the beacon, the Microwave Associates Gunnplexers, are usually operated around the middle of the band anyway.

How do you find the middle — or for that matter, *any* portion of the band? If you don't have access to a microwave frequency counter or wavemeter, one way is to use a Gunnplexer for a receiver and tune the beacon until it's heard. But how do we know where the Gunnplexer really is? You could build up a calibrator from a crystal oscillator and multiplier chain, hit a snap diode (an SRD) with a few hundred MHz of rf and generate a wee bit of X-band. Or, you could just hit a diode with a hundred mW or so of 146.52 MHz from a common 2-meter handheld.[6] The 70th harmonic will be 10.2564 GHz, close enough to the middle of the band.

Another affordable method of microwave frequency measurement involves using a surplus Hewlett-Packard 540B transfer oscillator (**fig. 7**). This instrument consists of a tunable 100- to 220-MHz oscillator, a diode mixer, and a small oscilloscope. The oscillator output and the signal to be measured are both applied to the diode mixer, which serves as a combination harmonic generator and mixer. The oscillator is tuned until a zero beat is observed on the oscilloscope. If we know, for example, that the source is somewhere between 10.1 GHz and 10.4 GHz, and tuning the 540B oscillator yields a zero beat at 205 MHz, the source is at 10,250.0 GHz (205 MHz x 50th harmonic). There are procedures given in the 540B manual for figuring the source frequency if the possible range is wider (approximate source frequency unknown). A frequency meter output is provided on the 540B for connection of a counter to obtain higher resolution than is provided by the oscillator dial. The source signal can be picked up by connecting a small horn antenna to the 540B mixer input with a waveguide to a type N adapter. The 540B will measure frequencies from 10 MHz to at least 12.4 GHz.

Remember, the packaging, and anything else near the front of the horn will "pull" the frequency somewhat. So whatever method is used for determining the beacon frequency, be sure that the final measurements are made with the beacon in its finished, packaged form.

expected range

How far away can you expect to hear an X-band beacon? Assuming a line-of-sight path, a 15-mW beacon, a Gunnplexer receiver with a very narrow (15 kHz) i-f, and small 17-dB horns on both beacon and Gunnplexer, you can expect a range of about 100 miles. With an 80-mW beacon and the same set-up, you can expect a range of about 200 miles. For a wide (200 kHz) i-f, 15-mW beacon, and two 17-dB horns, expect a range of about 30 miles, and about 60 miles for an 80-mW beacon.

If you use a 2-foot dish at the receiver and a 17-dB horn at the beacon, figure about 150 miles for a 15-mW beacon and wide i-f, 300 miles for an 80-mW beacon and wide i-f, 600 miles for a 15-mW beacon and narrow i-f, and a whopping 1200 miles with an 80-mW beacon and narrow i-f.

improvements

The best improvement you could make to the simple beacon presented here would be to increase the frequency stability. This would make the beacon not only an excellent tool for checking propagation, but also a frequency standard.

The easiest way to achieve better stability is through temperature control; proportional temperature control methods are discussed in the *Gunnplexer Cookbook*. [5] Better yet is to phase lock the Gunn oscillator to a crystal-controlled signal. Techniques for doing this with Gunnplexers, also described in the *Cookbook*, could probably be adapted to simple Gunn diode sources.

One might consider impressing telemetry on the beacon's signal. For example, it would be interesting to monitor the air temperature at the beacon site (as well as at the receive site) and see if there's any correlation between air temperature and signal strength. Ducting or inversions might be detected in this way. One possible method would be to connect an LM34 Fahrenheit temperature sensor IC* to a 566 voltage-controlled oscillator IC. The resulting temperature-dependent tone would be used to modulate the Gunn source between IDs. A frequency counter on the X-band receiver would measure the tone frequency and yield the corresponding temperature.

Another telemetry candidate is relative humidity. Humidity sensors haven't been commonly available, but now Mepco/Electra (Philips) makes one that changes capacitance with humidity.**

Still another option would be the ability to pipe the audio from the control link through the beacon. This would allow one-way X-band QSOs.

*Digi Key Corporation, P.O. Box 677, Thief River Falls, Minnesota 56701.

**Goldsmith Scientific Corporation, 720 East Industrial Park Drive, Manchester, New Hampshire 03103.

For better coverage, one might be tempted to install several Gunn sources on the same tower, each pointing in a different direction. Unfortunately, this is prohibited by 97.87a: "A station in beacon operation shall not concurrently operate on more than one frequency in the same amateur frequency band, from the same location."

Though it's not practical to get several free-running Gunn oscillators on exactly the same frequency, there may be other ways around this restriction. For example, each Gunn source could be served by a different IDer bearing the call of an Amateur responsible for that particular source. Or, each source could be switched on, IDed, and then switched off in succession so that none were operating concurrently.

operation

Although the 140-mW beacon is only 11 miles from my QTH, I've never been able to copy it there because of a small peak located in the middle of the path. It's estimated that the peak blocks the path by about 50 feet; even a Gunnplexer with a 2-1/2-foot dish won't pick up any knife-edging, although 1296-MHz signals over the same path are very strong. Other knife edge-dependent shots have been tried without success.

When the path is truly line-of-sight, the beacon signal is, of course, quite strong. It has even been picked up around town, while mobile! In this case, the receive antenna was a vertically polarized, omnidirectional gain biconical horn fashioned from two pizza pans; the flat pans were beaten into cones and mounted with their apexes almost touching. A tiny driven element between the apexes was connected to the Gunnplexer with a waveguide-to-coax adapter. The whole works — essentially a horn spun about the vertical axis — was then mounted on the top of a truck camper shell. (The biconical horn might make a good beacon antenna if an omnidirectional pattern is necessary.)

conclusion

A microwave beacon is a worthwhile project that can benefit many Amateurs. It isn't particularly difficult to build; perhaps the most difficult part is simply finding a site at which it can be installed. Might a beacon be just the catalyst you need to spark microwave activity in your area?

references

1. Steve Noll, WA6EJO, "Remotely Controlled Stations: A Look at A Successful Remote Base," *ham radio*, September, 1986, page 48.
2. Michael J. DiJulio, WB2BWJ, "Versatile CW Identifier," *ham radio*, October, 1980, pages 22-25.
3. Michael J. DiJulio, WB2BWJ, "An Improved Memory For the Versatile CW Identifier," *ham radio*, February, 1982, pages 24-26.
4. Michael J. DiJulio, WB2BWJ, "Short circuits," *ham radio*, February, 1982, page 70.
5. Bob Richardson, W4UCH, "Gunnplexer Cookbook," *Ham Radio Publishing Group*, Greenville, New Hampshire 03048 (Chapter 5)(out of print).
6. Steve Noll, WA6EJO, "X-band Calibrator", *ham radio*, April, 1981, page 44.

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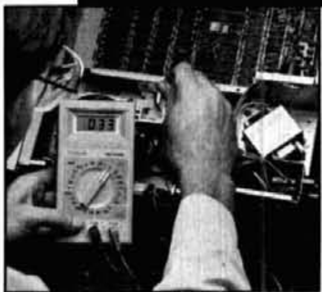

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top-down filter design

Structured programming guides ladder filter design using real components

The design and construction of filters is a topic of increasing importance to Radio Amateurs. Mathematical advances in filter theory — from the simple m-derived filters so common two decades ago to those of today — have been paralleled by an increasing sophistication in the design of Amateur equipment requiring such filters. This trend can be seen by comparing the mere two pages of filter design information in the 1957 edition of the *ARRL Radio Amateur's Handbook* to the multiple pages, complete with design tables and an extensive bibliography, in the 1986 *Handbook*.[1]

However, it's one thing to design such a filter and an entirely different thing to construct one that works, especially at radio frequencies. Filters are designed assuming purely resistive terminations with perfect inductors and capacitors. Real filters are built with lossy reactive components, often with reactive terminations, and always with additional "components" in the form of lead inductances and stray capacitances. Sometimes, also, a series "trap" is added in parallel with the output of a filter to remove a particularly troublesome signal. These factors, then, may cause the frequency response of a real filter to be considerably different from the desired design response.

This article describes a computer program which will calculate the frequency response of a filter made from *real* components. Many Amateurs now have access to personal computers and can therefore "measure" the response of a real filter without building it and without the laboratory equipment that would be necessary to actually measure the response. The program is particularly useful for evaluating the response of a filter which is not terminated in its design load, but instead in some other impedance — for example, a tuned circuit.

The program is designed to analyze ladder filters (**fig. 1**). Most common filters are of this form.

software design requires planning

It's a sad fact that most engineers and scientists are self-taught programmers. As such, they may not realize that a program must be "engineered" just as thoroughly as any hardware project. All too often, they may just start in writing code without having thought through the overall structure of the program. This is the software equivalent of starting the design of a receiver by calculating the values of resistors in an i-f amplifier.

Just as hardware design is approached from the overall to the specific — starting with block diagrams and desired stage characteristics — so must a program be designed from the outside inward. This is called "structured programming." Good programming techniques are important if the resulting programs are to be bug-free and robust. There are, alas, not many examples of this kind of software design in the Amateur literature, and many programs appearing in the Amateur literature are very poorly designed. The impetus to write this article came as much from a desire to help stamp out poor programming practices as a wish to share a very useful program.

This article, then, is a construction article. . . but it will be a program, not a piece of hardware, that is constructed.

The essence of structured programming is to describe the problem as clearly as possible. In this case, we want to analyze the attenuation vs. frequency response of a filter made with real components. The principal difficulty is that there is no simple way of characterizing a real component which is valid over a wide frequency range. Obviously, we can represent any component as a complicated, frequency-varying impedance. Such a representation is difficult to handle, and also presents the problem of somehow measuring real components in order to find out how they

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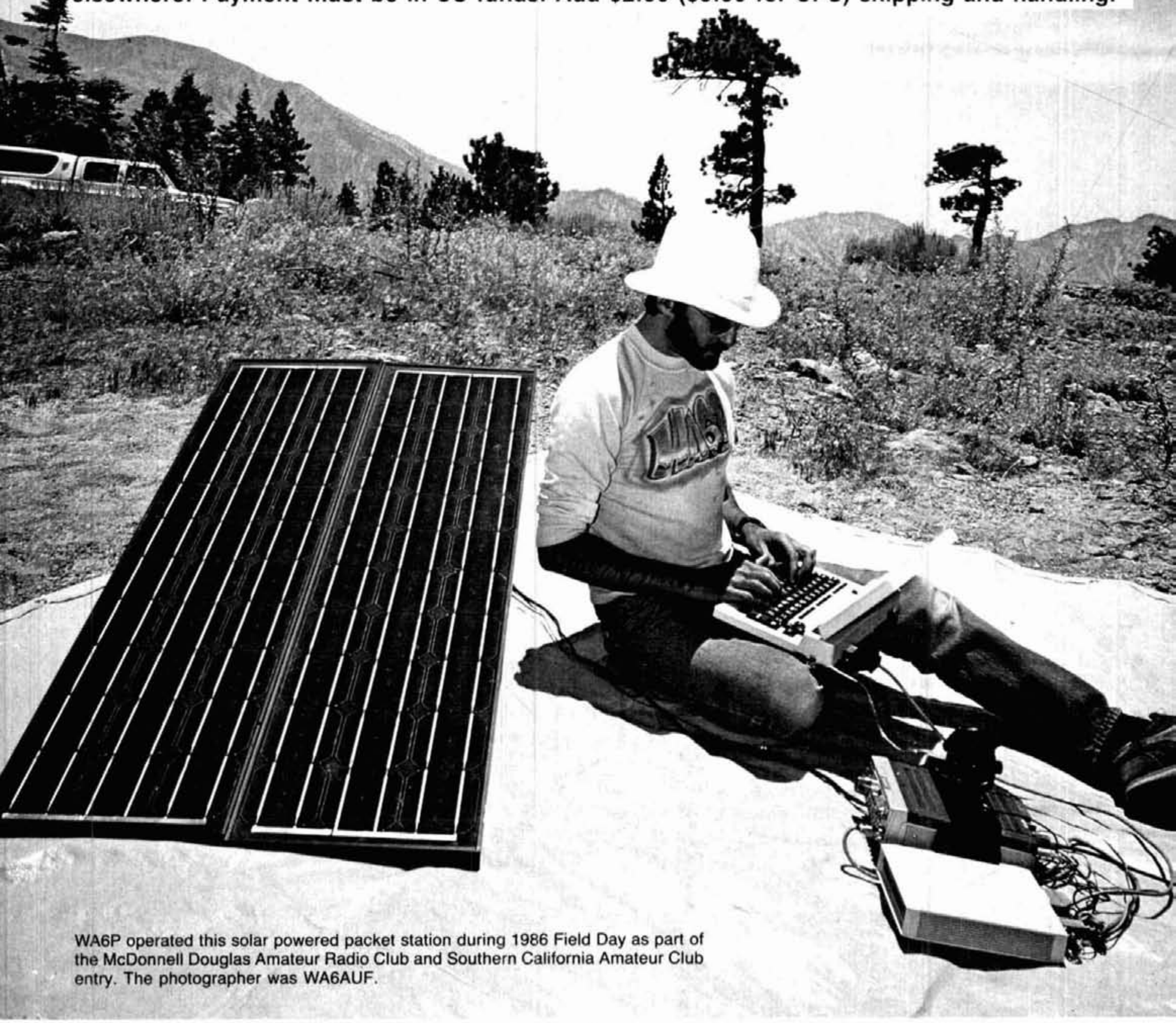

WA6P operated this solar powered packet station during 1986 Field Day as part of the McDonnell Douglas Amateur Radio Club and Southern California Amateur Club entry. The photographer was WA6AUF.

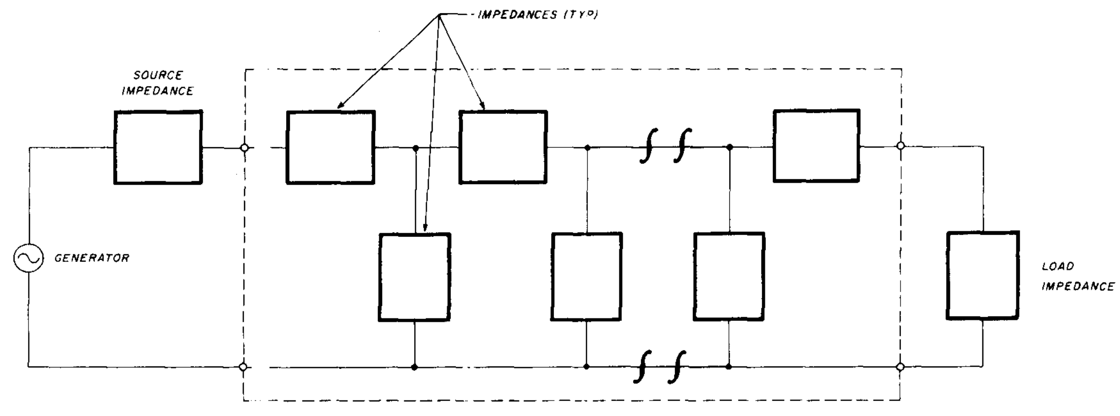

fig. 1. Block diagram of typical ladder filter.

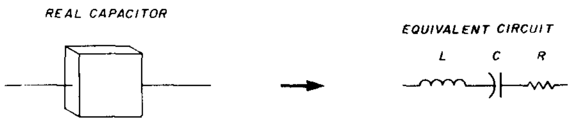

fig. 2. Equivalent circuit for a real capacitor.

Table I. The quantities needed to specify a real component.

Component	Quantities needed
Capacitor	Capacitance, lead inductance
Resistor	Resistance, lead inductance
Inductor	Inductance, Q, stray capacitance

vary with frequency. This approach is, in practice, unusable. The question is, how detailed should our model of a component be in order to give an adequate representation of its characteristics?

Consider a real capacitor, for example. The equivalent circuit of a real capacitor, as shown in **fig. 2**, can be represented by a series circuit consisting of a capacitor, an inductor, and a resistor. The problem arises because no single value for any of these components is completely valid for *all* frequencies.

Fortunately, for most real capacitors used in rf circuits (such as silver mica, polystyrene or small value NPO ceramic capacitors), the resistance value is close to zero and may be neglected. The inductance is due partly to the capacitor leads and partly to the internal construction of the capacitor, but can be fairly represented by just the lead inductance. We can therefore consider a real capacitor to consist of a capacitance in series with a lead inductance and have a model which is fairly good over a wide frequency range.

Similarly, real resistors have inductive and capacitive elements. However, the stray capacitance across a resistor may usually be neglected and a real resistor can be represented as a perfect resistance in series with a lead inductance.

The most troublesome component is a real inductor. Real inductors have easily measurable losses as well as a stray capacitance which may be significant. The loss term is normally very frequency-dependent; one way of describing it is to use the Q value of the inductor according to:

$$R = 2\pi fLQ$$

where R is the equivalent resistance *in parallel* with the inductance. Unfortunately, this is only a first-order approximation. However, for filter responses over just a few decades in frequency, it's reasonably valid and provides a basis for computation. A real inductor, then, will be specified by an inductance, a Q value (valid for the frequency range of the desired filter response) and a stray capacitance. Fortunately, all these values may be fairly easily determined for a real inductor — the inductance and Q value by means of a bridge and the stray capacitance by measuring the self-resonant frequency of the inductor with, for example, a grid dip meter.

To summarize, real components of capacitors, resistors, and inductors may be specified by the quantities shown in **table 1**.

The basic circuit which is analyzed is that shown in **fig. 1**, but where every box is represented by a series or parallel combination of components with each component being described by values as listed in **table 1**. The whole filter consists of a regular structure of these boxes, alternately in series and in shunt between the source and the load.

For any frequency, the basic method of calculating the filter attenuation vs. frequency response (the ratio of load to source voltage) is what Hayward has called the "tackhammer" approach.[2] Each element has

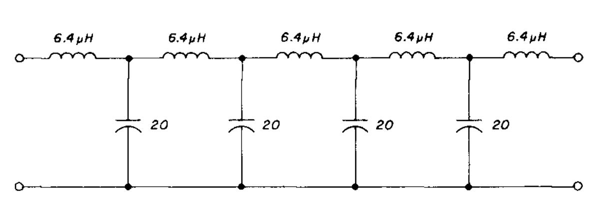

fig. 3. Circuit diagram of filter built and analyzed.

a total impedance which can be calculated for that frequency. Then, the total impedance seen by the source can be calculated by starting at the load end and working towards the source. Assuming a source voltage of 1, the current from the source can be calculated and, working back towards the load, the voltage at each node of the network and the current into the succeeding leg can be calculated. The voltage at the last node will be the voltage across the load and this value, divided by 1 volt, will be the filter response at that frequency.

This is obviously a very tedious technique because it must be done for a number of frequencies if the overall filter response is to be evaluated. However, it's admirably suited to computer calculations.

Now for the construction portion of this article: the calculations needed for the filter response are sufficiently long that using an interpreted language such as BASIC would result in unacceptably long execution times. (BASIC also doesn't lend itself to structured programming techniques.) Instead, I used a compiled version of PASCAL, which is particularly well suited to this type of program because the programmer may define new variable types. In this program, I used this feature to define complex numbers and operations used in the calculations and in the definition of component "types" used to describe the real components.

Structured programming starts at the most general level and define the overall program flow, leaving the details for last. This is directly analogous to the best way of designing hardware, which is to start at the general and work down to the specific. If you were designing a receiver, for example, you would first determine all the features desired and then draw a block diagram showing all the major functional blocks needed to produce them. The software equivalent to the hardware block diagram would be a general outline of the program as a whole. Flow charts are often used for this, but many people, including myself, prefer to use "pseudo code." This is a description of the program in cryptic English sentences, in which each sentence describes a portion of the program that does a single, definable operation. For the filter analysis program, the general steps are, first, housekeeping (setting up the program variables, initializing the arrays to be used, and opening any files necessary) and second, repetitively describing the desired filter, calculating the response, and displaying the results until you're ready to quit.

The pseudo code description of the program I first wrote was the following:

```
INITIALIZE
REPEAT
GET ALL THE PARAMETERS
DO THE CALCULATION
DISPLAY THE RESULTS
UNTIL DONE
```

Having the equivalent of a block diagram of the program, the next steps are to break each block (in this case, each sentence of pseudo code) successively into smaller and smaller pieces of pseudo code until each sentence is just a statement in the language being used. At this point, the program is complete.

Somewhere early on in this process, it's necessary to define the form of the data upon which the program will work. In this case, the data obviously consists of a description of the filter and the frequency limits of the calculations. So, part of the process of programming requires thinking carefully about how the data will be kept. Looking at **fig. 1** again, we see that there is a regular form to the shape of the filter. Starting at the source end, there are L-shaped sections consisting of a series section along the "top" and with a "leg" in shunt. The filter consists of a number of such pieces. The symmetry is broken only by the necessity of adding a source "element" in front of the filter and by having the last "leg" of the filter be the load element.

I chose, therefore, to describe the filter as an array of "arms" where each arm consisted of a "top" and "leg" pair of "elements." Each element could consist of a series or parallel combination of up to three "components." Each component would be either a resistor, inductor or capacitor and would be described by the values given in **table 1** for that particular kind of component.

Finally, having essentially written out the program in terms of operations on complex numbers, it was necessary only to write PASCAL code to describe how the operations were done. Normal good programming practices were followed throughout.

The object is to make the source code as readable as possible. The most common failing of beginning programmers is the omission of sufficient explanation in the source code to allow others to understand how the program works. Bear in mind that you're not really preparing these comments for others but rather, for yourself — next month or next year.

The program was written to handle ladder filters with up to nine "legs." Because frequency response is usually plotted on a logarithmic scale, the program

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- SWT-2 70 cm antenna tuner
- PG-2N extra DC cable
- PG-3B DC line noise filter
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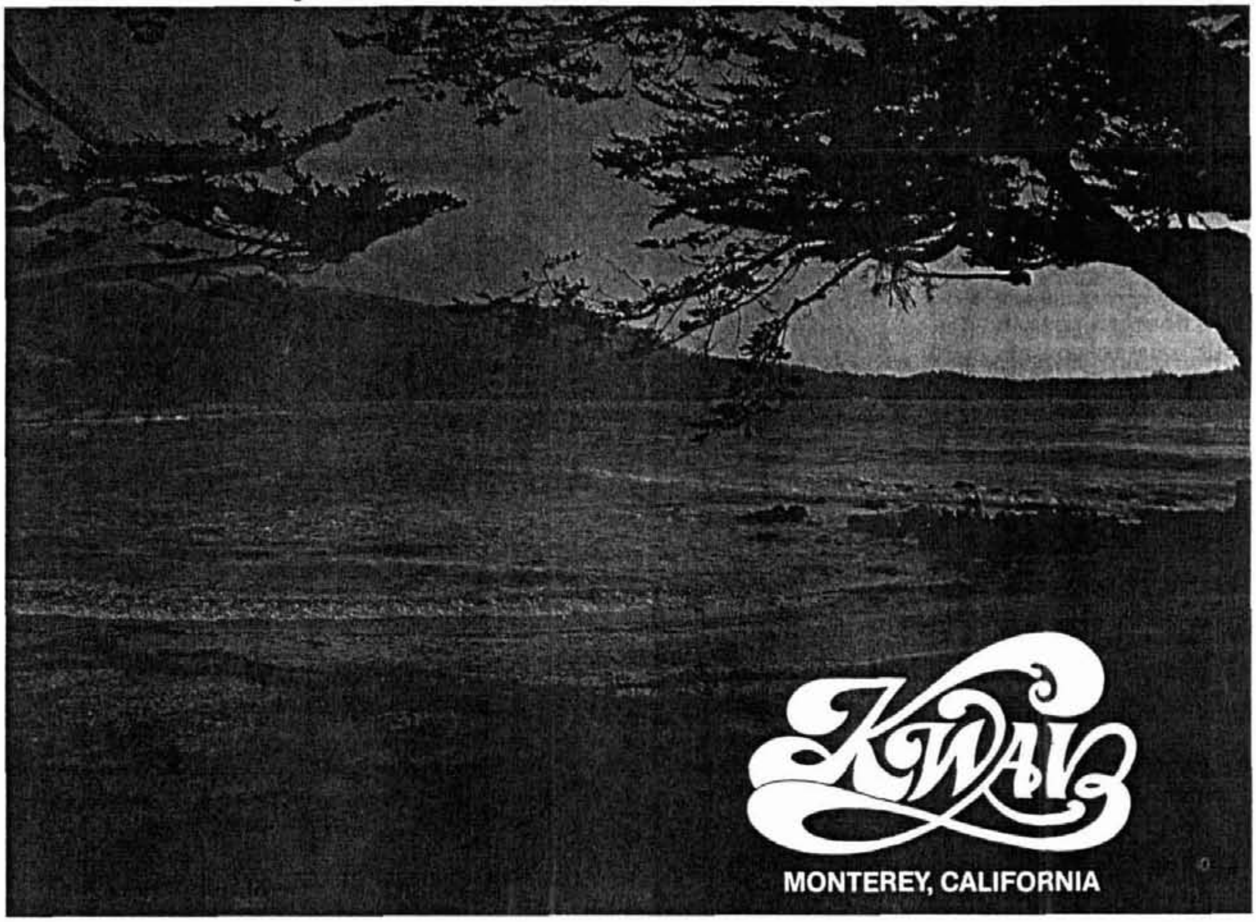

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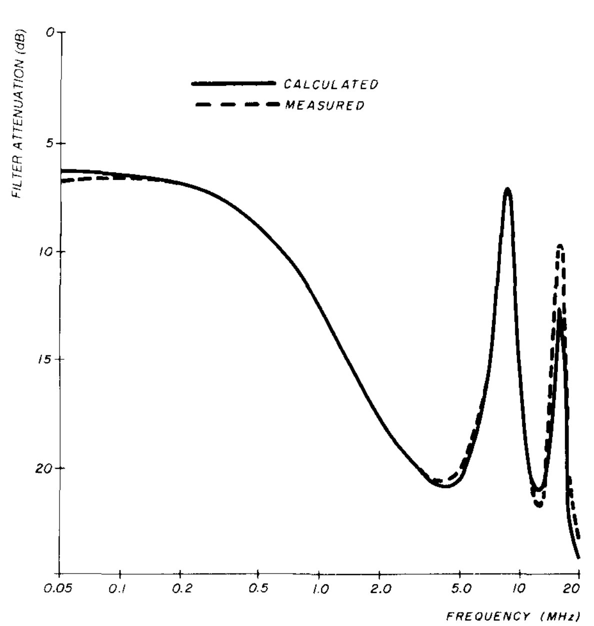

fig. 4. Comparison of measured and calculated filter response.

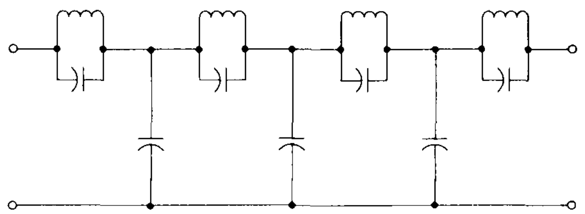

fig. 5. Circuit diagram of commercial low-pass filter.

was designed to calculate the filter response at 50 frequencies, evenly separated logarithmically, between any desired lower and upper frequency limits. Both the number of filter legs and the number of points in the frequency response can be altered in the source code and the program may be recompiled with those values instead of the ones used.

As a test for the program, a four-leg filter was constructed and its frequency response was measured on the workbench. The circuit diagram of the filter is shown in **fig. 3**. This "filter" is not a valid design, but was constructed from components on hand to see how closely the calculated filter response was to the measured one. The measured data were compared to the response calculated by the program.

Each inductor was an Ohmite Z-50 rf choke. At 7.9 MHz, the measured inductance was 6.4 μH with a Q of 100. These values were measured with a Boonton Q Meter. The parallel self-resonant frequency, measured with a grid dip meter, was 84 MHz. This corresponds to a parallel stray capacitance of 0.56 pF. The capacitors were all 20-pF, 5 percent silver-mica capacitors, each with lead lengths of about 1/4 inch in total. Using the rule of thumb that No. 20 straight wire has an inductance of 20 nH per inch, the lead inductance was estimated to be 5 nH for each capacitor.

The filter termination was a coaxial 50-ohm load and the voltage across it was measured with an HP 411A rf millivoltmeter. The program was run with lower and upper frequency limits of 0.05 and 20 MHz, respectively, and the filter response was measured at the same frequencies used in the program. For frequencies below 1 MHz, the signal generator used was a AN/URM 25D with its output passed through a 20-dB 50-ohm pad to make the output impedance 50 ohms resistive. Above 1 MHz, a Wavetek Model 3000 signal generator was used. The source and load elements were single 50-ohm resistors with zero lead inductance. As is evident in **fig. 4**, there is excellent agreement between the measured and calculated frequency responses. The disagreement between measured and calculated responses is greatest at frequencies where the filter attenuation is high and is probably attributable to measurement errors.

It's worth noting that the filter responses given by this program are all about 6 dB below what might be expected from a cursory glance at the setup. That is because, normally, filter response is given as the ratio of output to input voltage to the filter, whereas in this program the response is given as the ratio of filter output voltage to the internal "generator" source voltage. I did this because I wanted to be able to specify a source impedance which was not just purely resistive. For purely resistive sources and load *which are equal*, just add 6 dB to the program's values to get the numbers that are usually used.

As compiled, the program will handle ladder filters with up to nine legs. Although this may seem excessive, it will allow the calculation of the frequency response for many networks that may have far fewer legs. Consider the filter circuit shown in **fig. 5.** In some commercially-built versions of networks like this that I've seen, the parallel resonant circuit consisted of a small inductor and capacitor in the middle of a rather large shielded compartment with rather long leads going to the feedthrough capacitors which were in the partitions between compartments. In reality, these long leads have an inductive reactance which may be appreciable at higher frequencies. The actual circuit would be that shown in **fig. 6**.

This filter may be made into a ladder filter of the type used by the program by assuming that there are very large resistances to ground between the parallel sections and the series resistances, as shown in **fig. 7.** If values of, say, 100 megohms are assigned to these resistors, the calculated response of the filter won't be affected by them and will closely approximate the

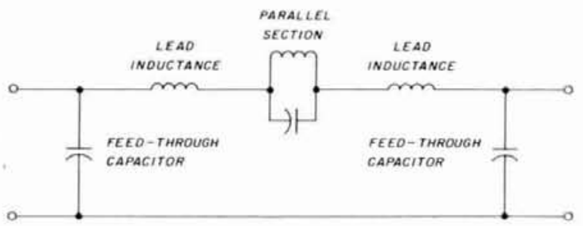

fig. 6. Equivalent circuit of one section of filter.

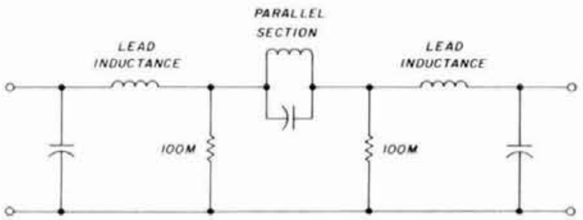

fig. 7. Filter section redrawn to be suitable for program analysis.

actual frequency response of the filter, as constructed.

A program like this allows you to predict, accurately, what the response for a real filter will likely be. I recently built a high-power (600-Watt) 6-meter amplifier. Using a spectrum analyzer, I noticed that there was a significant fourth harmonic output at 200 MHz. The problem turned out to be caused by excessive harmonic generation in the 25-Watt driver — a run-of-the-mill semiconductor, broadband amplifier. The simplest remedy seemed to be to put a low-pass filter between the driver and the final amplifier. I chose a pre-calculated standard-value capacitor (svc) design with a 3-dB corner frequency of 75.16 MHz.[2] This filter is a 7-element Chebyshev design; the schematic diagram is shown in **fig. 8**.

The program was first run for this filter with the assumption that the source and load were 50 ohm resistive, that inductors would have a *Q* of 100 throughout the desired range, and that the capacitors would have a lead inductance of 5 nH. The calculated filter response, very similar to the theoretical response for perfect components, is shown in **fig. 9** as a solid line. However, the load provided to the filter by the amplifier isn't purely resistive because there's a tuned circuit in the transformer-coupled grid portion of the amplifier circuit. Indeed, the input to the amplifier is more like a 50-ohm resistance in parallel with a parallel tuned circuit. Assuming that this tuned circuit would be something like a 0.1 μH inductor in parallel with 100 pF, the calculated filter response with this load is shown as the dashed line in **fig. 9** and deviates considerably from the theoretical response of the filter. Just out of curiosity, I also calculated the re-

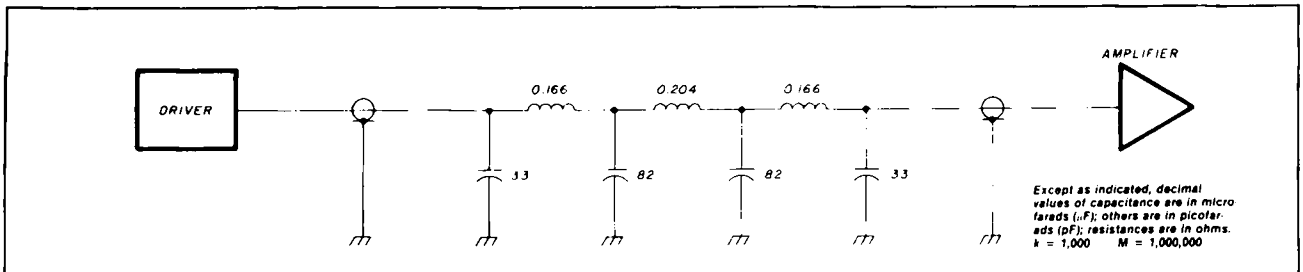

fig. 8. Low-pass filter.

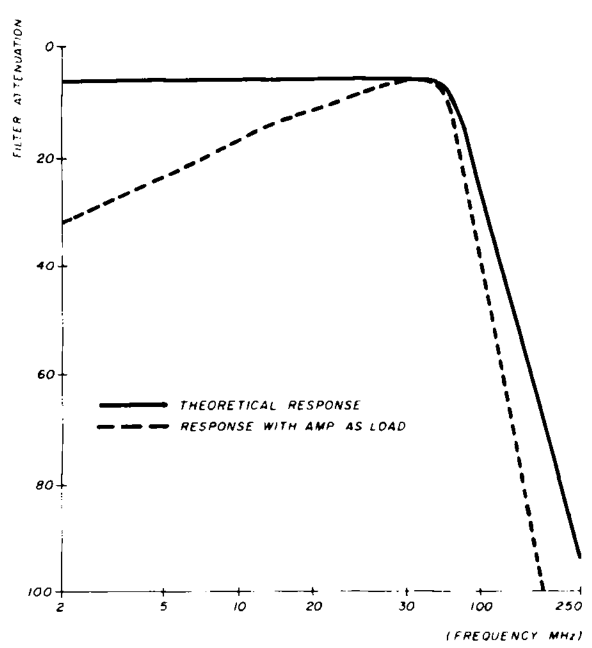

fig. 9. Response of filter no. 19 with standard load and with amplifier as a load.

sponse of the filter into the same load (the amplifier), but with a filter in which the last 33 pF capacitor was replaced with a series trap at 200 MHz (a 0.1 μH inductor in series with 6 pF). The response at 200 MHz, however, wasn't significantly affected by this "modification" to the filter, probably because the response was already down some 100 dB. Note that because of stray coupling and leakage, the practical ultimate stop-band attenuation will be less than 100 dB.

The point of all this is that the response of a filter in a real application may differ considerably from the theoretical response. This program allows one to "measure" a real filter response in a real situation.

It's also useful in examining various "what if" scenarios, in that it allows you to see what effect component tolerances have on filter response. You can observe the effects of "cut and try" solutions where you might, for example, replace a series section with a trap to remove a particularly troublesome unwanted signal. You can see what effect various load impedances have on the frequency response.

getting the program

Photocopies of the program listing (Turbo PASCAL), which is too long to reproduce here, are available from the author for an SASE and one IRC or a 68-cent Canadian stamp. Diskettes including the program source code and executable files are available directly from the author for $15 (U.S.) or $20 (Canadian), on either CP/M 8-inch SSSD diskettes, Apple II CP/M diskettes, or in an IBM PC version on IBM PC-DOS diskettes. (Both an 8087 version and a non-8087 version of the executable program are included on the IBM PC diskette. The 8087 version runs considerably faster than the non-8087 version.)

The source code was originally written in a version of PASCAL called PASCAL MT +, marketed by Digital Research; source code for this version of PASCAL is included on the diskettes. The source code alone, modified to be compatible with DEC PASCAL on a VAX, is also available as VAX files on 8-inch RX01 diskette format for the same price.

The compiled and linked version of the program on the diskettes handles filters with up to nine legs and gives 50 points in the frequency response. Both these numbers may be changed and the program recompiled if necessary. The attenuation vs. frequency response is given in dB and the phase angles are in degrees.

references

1. Filter No. 19, Table 11, page 2-42, *1986 ARRL Handbook*, American Radio Relay League, Newington, Connecticut, 1985.

2. W. H. Hayward, W6ZOI, *Introduction to Radio Frequency Design*, Prentice-Hall, 1982.

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ham radio TECHNIQUES

Bill Orr W6SAI

"white noise": technology bites back

When I received my ham license in 1934 I quickly got on the air with a three-tube receiver and a one-tube transmitter. The only problem was finding the band. It took me a week to make reasonably sure I was in the 20-meter band. After much confusion, I finally had two pencil marks on the dials of my receiver and transmitter. If my signal seemed to be near the marks, there was a good chance I was inside the band.

Today my transceiver reads out to 10 Hz in its flashing digits. Quite a change from the dear, dead days of 1934! But there's a price to pay for progress, and this price is becoming apparent — especially to Amateurs living in metropolitan areas where there are many stations per square mile. The price is white noise interference (phase noise).

What is white noise interference? I can tell you this: if you have it, you know it!

Just as white light is made up of light of many different wavelengths, "white noise" is made up of an infinite number of frequencies. Theoretically, white noise goes "from dc to daylight" with infinite amplitude. If you listen to it on a receiver, it covers an extremely wide band and sounds like a sizzling, frying background noise.* When it's relatively weak, it sounds like a steady hiss. For the record, the *1986 ARRL Handbook* defines "phase noise" (which is a form of white noise) as "residual random variation of the phase difference between the synthesizer output and a perfect sine wave of the same frequency."

A representation of white noise is shown in **fig. 1**. In this hypothetical situation, the operating frequency of a signal is measured along the x-axis (frequency) and signal amplitude is measured along the y-axis. This drawing is of the white noise of a representative transmitter-exciter having a PLL (phase-lock-loop) frequency control system.[1] The desired output signal is the tall "spike" at the center frequency. Below the signal, and on both sides of it, are sidebands (the noise "pedestal"), which gradually decrease in amplitude with distance from the desired signal. At some remote frequency, the noise sidebands disappear into the noise floor of the receiving system.

Spectral impurity, or phase noise, can be measured with reference to the noise floor or to the amplitude of the desired signal. It is commonly specified in terms of strength in a given bandwidth, measured a certain frequency from the main carrier. While spectral impurity is not specified for Amateur equipment, it is often given for commercial or miltary gear; the AN/PRC-117 transmitter, for example, has a noise limit of −162 dB/Hz, referenced to the carrier (dBc) at frequencies greater than ±10 percent from the carrier.

A popular microwave signal generator has a specification or phase noise of greater than −185 dBc (referenced to carrier) at 10-kHz spacing from the carrier

These specifications imply a certain difficulty in measurement, since the measuring equipment is working with a signal ratio of much greater than 100 dB! Measurements of this type aren't done in the ham shack, or even in a reasonably well-equipped lab! They're not something a ham can easily check out and quantify on a late Saturday morning when the band is dead.

Nevertheless, white noise interference is becoming quite bothersome in areas of intense ham activity, particularly during contests. Unfortunately white noise generated in a PLL-type exciter is passed through a linear amplifier and boosted along with the desired signal.

on-the-air effects

An easily-recognized symptom of white noise is a rushing sound adjacent to a strong carrier. Let me give you an example. Tests were run between my station and a local Amateur, about 3 miles away. We aimed our beams at each other one morning when the band was "flat." My friend's signal was 30 dB over S9 on my receiver. As he sent slow dashes, I tuned back and forth on each side of his signal. I instantly noticed a hissing sound that coincided with the transmitted dashes. Five kHz off the test frequency the hissing dashes were S5; 10 kHz away, the dashes were S2; 15 kHz away, the dashes were just above the noise level. We didn't try adding the linear amplifier to the tests because we wanted to examine only the exciter.

We now reversed the tests. My friend listened to my transceiver as I keyed it slowly. Sure enough, the same white noise was heard, even though the transmitters were of differ

*On the lower HF bands it can be easily masked by atmospheric noise when an antenna is connected to a receiver. — Ed.

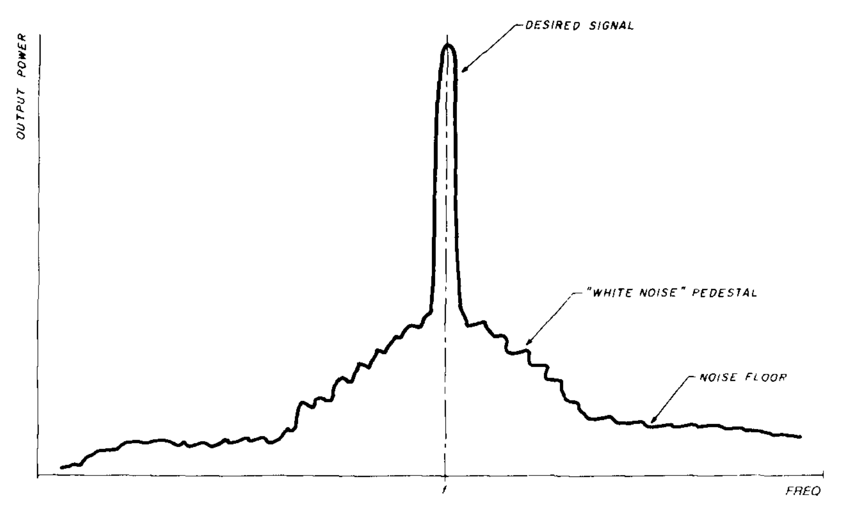

fig. 1. "White noise" generated by PLL frequency control device.

ent manufacture. I next cut out my external VFO (a PLL device) and cut in the internal VFO, which did not use PLL. I could thus test one frequency generation scheme against another at the push of a button. Using the internal VFO, the white noise disappeared immediately! My carrier was squeaky-clean right up to my S9 plus 30-dB signal with no apparent sideband noise.

As an afterthought, my friend switched on his linear amplifier and keyed the transmitter. Alas, the hissing noise came up over an S-unit and was now apparent over nearly 100 kHz on each side of the main carrier.

What was the culprit? Most communications specialists believe the problem lies in the synthesizer technique, but instances have occurred in which white noise was generated in the solid-state final amplifiers of some equipment. It could also be mixing noise in some of the transmitter stages.

Amateurs in the western states well remember when a Voice of America transmitter operating on 21460 kHz switched over from crystal control to a frequency synthesizer. The whole top end of the 21-MHz band was obliterated by white noise, which was reported by Amateurs in South America as being over S9! The problem was finally resolved when the synthesizer was removed from service.

Talking to close friends who have some expertise in the subject indicates that transmitted white noise varies not only from make to make, but model to model, and from unit to unit of PLL-controlled transmitters. Thus no specific make or model transmitter can be cited as being the main cause of the difficulty. The problem is much more complex than that.

the solution?

The solution lies in the design of the synthesizer, as well as the lead dress and filtering. What is required is the establishment of ground rules that define the amount of white noise acceptable for a given transmitted power level — just as in military gear. The problem of receiver overload seemed formidable a decade ago, but over the past few years it has been solved by the efforts of the equipment manufacturers. As to white noise, let's hope the same path will be followed. The first order of business is to recognize the problem; the next is to ascertain its magnitude. Does it affect only a few Amateurs? Or is it a more widespread problem, the cause of which has simply not yet been revealed to the general body of operators? I'll appreciate any comments that Amateurs may have regarding this subtle problem.

160-meter DX season — back again!

Hooray! The blasting summer static has dropped off in the Northern Hemisphere and Happy Days Are Here Again on 160 meters. Shown in **fig. 2** is a top-loaded vertical antenna used by some operators who are trying to be loud even though they live on small lots. In most cases, it's made of wire and slung between two trees. The 40-foot vertical wire is attached to the midpoint of an 80-foot wire which serves as the top loading structure. The antenna is worked against ground, and resonated to the operating frequency by means of the series-connected rotary inductor. The feedpoint resistance depends upon the ground resistance, as is the case with any Marconi-type antenna. With a ground system consisting of a ground rod, or connection to the cold water pipe system of the dwelling, plus two or three quarter-wave radials, the feedpoint resistance will run about 20 ohms. A simple L-network may be required between the coax feed line and transmitter to drop the SWR to a low enough value to permit an easy match to today's modern solid-state equipment.

With regard to the ground system for a 160-meter Marconi-type antenna, Mitch, KB6FPW, has some interesting experiences to relate. He erected an inverted-L antenna (imagine the antenna of **fig. 2** with half the top wire removed). The wire was cut to a total length of 3/8 wavelength at 1.9 MHz. Most of the wire was in the horizontal plane.

His first rf measurements, using water pipe grounds, showed a feedpoint resistance of 100 ohms. Addition of a 4-foot ground rod and a quarter-wave radial wire, wrapped around the perimeter of a fence and terminated in another 4-foot ground rod, brought the feedpoint resistance down to about 50 ohms. Mitch next added several extra radials of various lengths and a third ground rod. The feedpoint resistance dropped to 40 ohms. A second quarter-wave radial wrapped

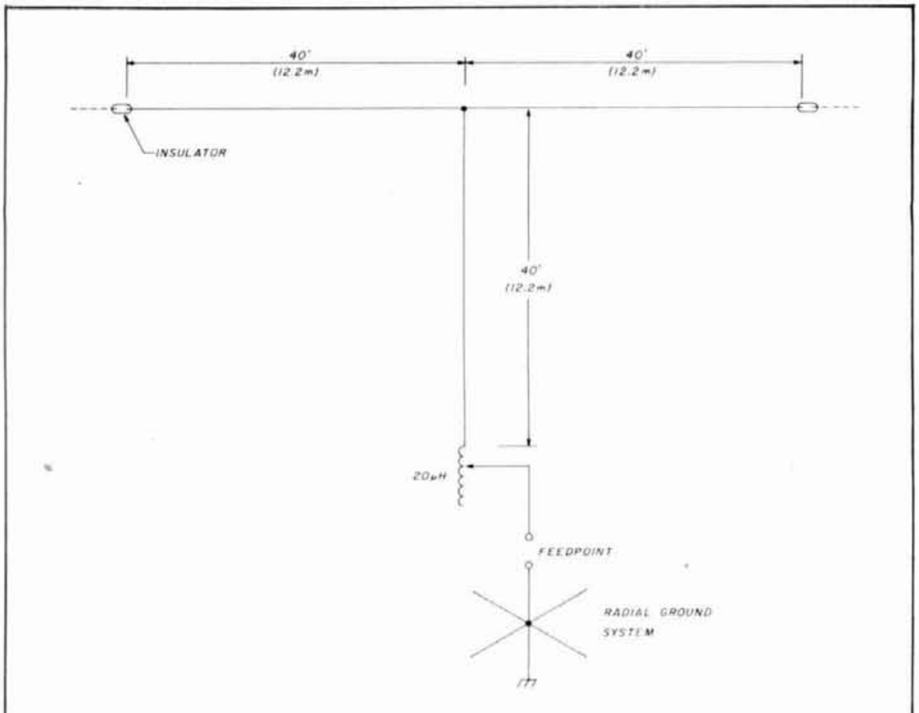

fig. 2. Compact T-antenna for 160 meter operation.

around the house didn't seem to make an appreciable difference. Mitch figured he had reached the point of diminishing returns, and there the experiment ended.

Mitch says, "There is a common misconception about ground radials. It's often said that a quarter-wave radial looks like a low impedance at the input end. If a short circuit (to ground) was applied to the far end of the radial, a high impedance would be reflected back to the input end. In free space this may be true, but when the radial is brought in close proximity to the ground, significant coupling exists — enough to change the character of the radial. Terminating a quarter-wave radial, laid close to the earth, with a ground rod at the outer end does not reflect a high impedance back to the input end. Instead, it improves the efficiency of the radial and actually lowers its impedance.

"Electrically short radials depend upon proximity with the earth. I have performed experiments on 1750 meters with a 100-foot radial. When the wire was held clear of the ground (at about 4 or 5 feet elevation), the radial current was unmeasureable with a 100-mA rf ammeter. As the radial was lowered to the earth, the radial current climbed to a maximum figure of 8.5 mA."

Mitch, by the way, is conducting experimental VLF transmissions using the identifier MEL on 170.626 kHz.

feedback from the field?

Great interest is expressed by newcomers to the 160-meter band: "What antenna should I use?" "What do the outstanding signals on the band use for antennas?" I'd like to hear from readers who have 160-meter antennas that work, and that may not be the common variety shown in all the handbooks. If you have an interesting antenna, write to me at: EIMAC, 301 Industrial Way, San Carlos, California 94070. Many thanks!

references

1. Doug DeMaw, W1FB, and Wes Hayward, W7ZOI, "Modern Receivers and Transceivers: What Ails Them?," *QST*, January, 1983, page 12.

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VHF/UHF WORLD

Joe Reisert W1JR

microwave and millimeter-wave update

Time really flies. Would you believe this month's column marks the beginning of the fourth year for "VHF/UHF World?" I'd like to thank those of you who have sent in such nice comments and ideas for future columns.

When I first started this column, I had about 15 possible topics outlined. Even though three years have gone by, that list is as long as ever. I'm always looking for constructive suggestions. Any ideas about subjects that need to be addressed or amplified? Just drop me a note. Your letters are always appreciated — even if I don't have time to answer them all.

About half of last year's columns were primarily oriented towards microwave and millimeter-wave subjects. This year I expect to continue in that vein. I hope I can keep the column well enough in balance so that all readers will be satisfied!

microwave and millimeter-wave update

North Americans were pioneers on the microwave and millimeter-wave bands, first with pulse and then "polaplexers."[1] However, in recent years we fell behind, especially in respect to our European colleagues. Most of the activity and DX records on these frequencies are presently held by Europeans. Even the "Gunnplexers" manufactured in the United States are being used in Europe to set new worldwide DX records!

We reviewed the general topic of microwaves in the January, 1986, column,[1] looking at available frequencies, DX records, microwave receivers, transmitters, antennas, feedlines, and schemes for getting on the frequencies above 70 cm (450 MHz). Little did I know that 1986 would be such an explosive year for microwave and millimeter-wave growth in North America. Although none of the worldwide DX records held outside North America were reclaimed in 1986, many of the North American DX records were broken.

For starters, the 33-cm (903 MHz) DX record was extended — but this was to be expected because this band had been available to Amateurs for less than a year. K3YTL and W1JR held the record for just under one day (June 15, 1986); then K1WHS and K3YTL snatched the record! I expect that there will be several 33-cm DX extensions per year for the next several years as gear improves and activity increases.

The North American 23-cm (1296 MHz) tropo DX record was broken this past summer when KH6HME and WB6NMT spanned the Pacific. This record still stands worldwide and will be very difficult to extend much further!

Soon after the DX records were published in the January, 1986 column, the 13-cm (2304 MHz) North American tropo DX record was broken when W4ODW and WB5LUA caught one of those great openings that occur in the Gulf area early each year. They extended this DX record by about 40 miles.

The North Texas Microwave Society, after a real onslaught on the 13-cm band in 1985, decided to push higher in 1986 and challenge the 16-year DX record on the 9-cm (3456 MHz) band. It didn't take them very long; less than three months after they activated this band, one of the longest-standing North American DX records fell when WA5TNY/5 (portable) worked W7CNK/5, a fixed station in Oklahoma City, Oklahoma, for a new North American DX record of 221 miles. The QSO first took place on cw and then on two-way SSB.

The 6-cm (5650 MHz) North American DX record is now under fire by a hotbed of activity centered in northeastern Oklahoma. It looks as if this 9-year old DX record will soon be broken. Some one-way contacts have already exceeded the present 267-mile DX record on this band.

Finally, in the Pacific northwest, one of the first regions of the world to develop microwave activity and set DX records, the 12-mm (24 GHz) North American DX record has recently been extended by over 50 percent to 115 miles by WA3RMX/7 and WB7UNU/7. This record is rather unusual in that it was accomplished not only with very low power (20 milliwatts maximum), but with narrowband modulation. First the record was set on cw and then continued using two-way SSB — perhaps the highest frequency where two-way SSB communications has ever been used by Amateurs, and perhaps even commercial interests as well.

Yes, 1986 was an exciting year for microwave and millimeter-wave activity, especially in North America. At long last it looks as if North Americans are again going to be in the forefront of activity and development on one of our highest frequency allocations.

To show the latest North American and worldwide VHF and above DX records, I've revised the tables published in references 1 and 2. **Table 1**

1. This table shows the latest claimed North American DX records on the frequencies above 6 meters. Note that the records are shown alphabetically by propagation modes. (Updated October 12, 1986.)

Frequency	Record	Date	Prop. Mode	DX	
50 MHz	Note 2			miles	(km)
144 MHz	KA1ZE-WB0DRL	86-02-08	Aurora	1347	(2167)
	KH6GRU-WA6JRA	73-07-29	Ducting	2591	(4169)
	VE1UT-VK5MC	84-04-07	EME	10,985	(17676)
	W4EQR-W7HAH	81-07-09	Es	1881	(3027)
	W5HUQ/4-W5UN	83-07-25	FAI	1229	(1977)
	K5UR-KP4EKG	85-12-13	MS	1960	(3153)
	KP4EOR-LU5DJZ	78-02-12	TE	3933	(6328)
	K1RJH-K5WXZ	68-10-08	Tropo	1465	(2358)
220 MHz	W3IY/4-WB5LUA	82-07-14	Aurora	1145	(1842)
	KH6UK-W6NLZ	59-06-22	Ducting	2550	(4087)
	K1WHS-KH6BFZ	83-11-17	EME	5058	(8139)
	K1WHS-KOALL	85-08-12	MS	1274	(2049)
	KP4EOR-LU7DJZ	83-03-09	TE	3670	(5906)
	VE3EMS-WB5LUA	82-09-28	Tropo	1181	(1901)
432 MHz	W3IP-WB5LUA	86-02-08	Aurora	1182	(1901)
	KD6R-KH6IAA/P	80-07-28	Ducting	2550	(4103)
	K2UYH-VK6ZT	83-01-29	EME	11,567	(18612)
	W2AZL-W0LER	72-08-12	MS	1020	(1641)
	WA2LTM-WB5LUA	79-09-10	Tropo	1310	(2108)
903 MHz	K1WHS-K3YTL	86-06-16	Tropo	310	(498)
1296 MHz	KH6HME-WB6NMT	86-08-13	Ducting	2528	(4068)
	K2UYH-VK5MC	81-12-06	EME	10,562	(16995)
	W4WSR-WA5TKU	85-06-03	Tropo	1112	(1790)
2304 MHz	PA0SSB-W6YFK	81-04-05	EME	5491	(8836)
	W4ODW-WB5LUA	86-02-20	Tropo	628	(1003)
3456 MHz	WA5TNY/5-W7CNK/5	86-08-03	Tropo	222	(357)
5760 MHz	K5FUD-K5PJR	77-09-20	Tropo	267	(430)
10.368 GHz	WA4GHK/4-WD4NGG	84-08-07	Ducting	297	(478)
	W7JIP/7-W7LHL/7	60-07-31	LOS	265	(426)
24.192 GHz	WA3RMX/7-WB7UNU/7	86-08-23	LOS	115.5	(186)
48 GHz	W2SZ/1-WA2AAU/1	84-09-08	LOS	0.3	(0.5)
76-149 GHz	None reported				
474 THz	K6MEP-WA6EJO	79-06-09	LOS	15	(24)

Note 1. The records are listed alphabetically by mode. Ducting is suspected where the path is mostly over water. No efforts are made to separate out ducting on overland paths so they're grouped under tropo.
Note 2. Six-meter records were left off since the primary mode is often hard to distinguish. Also long-path QSOs have been reported during solar cycles 19 and 21 which exceed 12433 miles (20004 km).

shows the latest North American DX records on the bands above 50 MHz. **Table 2** shows the equivalent updated worldwide DX records. **Table 3** shows the worldwide EME DX records. Will the data in **Table 1** become obsolete before the end of 1987? I'll bet on it!

why the increased activity?

1986 was a banner year for the microwave and millimeter-wave bands primarily because North American microwave enthusiasts gathered together, organizing societies and conferences and pooling their interests and resources. New DX records were also on their minds. Until recently, the modulation for most North American microwave and millimeter-wave operation was fm or cw using a keyed multiplier chain. Fm requires a good signal-to-noise ratio and moderate to wide bandwidth. Keyed multipliers aren't always that stable, especially if operated in remote locations such as mountaintops.

For reliable communications, and especially DX, you need good frequency stability in the transmitter as well as in the receiver. Narrow bandwidth modulations such as cw and SSB are preferred. Also important are low noise figure receivers, reasonable transmitted output power, moderate- to high-gain low-noise antennas, and low insertion loss feedlines. All these factors had to be addressed if real progress was to be forthcoming.

The same Amateurs who recently activated the microwave bands were also spurred on by the desire to use some of the new state-of-the-art technology that has recently become so affordable. After designing and building this new equipment, they organized mobile stations to travel to DX locations and to aid in activating new "grids" for the ARRL VUCC (VHF/UHF Century Club) award.

equipment considerations

If you want to take advantage of cw and SSB with its improved higher signal-to-noise ratio, you must pay close attention to frequency stability. Receiver/transmitter frequency stability objectives can best be met on the microwave/millimeter-wave bands by using solid-state up/down converters or transverters.

Many homebrew as well as commercial designs are now on the market. Modern solid-state transceivers are now available through 1300 MHz and are often used as the transmit/receive i-f for these same converters/transverters. The combination of

2. This table shows the latest claimed worldwide terrestrial DX records for the Amateur bands above 6 meters.

Frequency	Record Holder	Date/QSO	Prop. Mode	DX miles	DX (km)
50 MHz	Note 1.				
70 MHz	GW4ASR/P-5B4CY	81-06-07	Es	2153	(3465)
144 MHz	I4EAT-ZS3B	79-03-30	TE	4884	(7860)
220 MHz	KP4EOR-LU7DJZ	83-03-09	TE	3670	(5906)
432 MHz	KD6R-KH6IAA/P	80-07-28	Tropo duct	2550	(4103)
903 MHz	K1WHS-K3YTL	86-06-16	Tropo	310	(498)
1296 MHz	KH6HME-WB6NMT	86-08-13	Tropo duct	2528	(4068)
2304 MHz	VK5QR-VK6WG/P	78-02-17	Tropo duct	1170	(1883)
3456 MHz	VK5QR-VK6WG	86-01-25	ducting	1171	(1885)
5760 MHz	G3ZEZ-SM6HYG	83-07-12	ducting	610	(981)
10 GHz	I0SNY/EA9-I0YLI/IE9	83-07-08	ducting	1032	(1660)
24 GHz	I3SOY/3, IW3EHQ/3-I4BER/6, I4CHY/6	84-04-25	LOS	180	(289)
47 GHz	HB9AMH/P-HB9MIN/P	85-01-13	LOS	31.7	(51)
75 GHz	HB9AGE/P-HB9MIN/P	85-12-30	LOS	0.3	(0.5)
474 THz	K6MEP-WA6EJO	79-06-09	LOS	15	(24)

Note:
1. Six meters has been left blank on this listing because long-path QSOs (those exceeding 12440 miles or 20016 km) have been reported during solar cycles 19 and 21.

3. This table shows the latest claimed worldwide EME DX records.

Band	Record Holder	Date/QSO	Prop. Mode	DX miles	DX (km)
50 MHz	K6MYC-K8MMM	84-07-24	EME	2127	(3422)
144 MHz	K6MYC/KH6-ZS6ALE	83-02-18	EME	12088	(19450)
220 MHz	K1WHS-KH6BFZ	83-11-17	EME	5058	(8139)
432 MHz	F9FT-ZL3AAD	80-04-18	EME	11679	(18793)
903 MHz	none reported				
1296 MHz	PA0SSB-ZL3AAD	83-06-13	EME	11595	(18657)
2304 MHz	PA0SSB-W6YFK	81-04-05	EME	5491	(8836)
3300 MHz and above: None reported.					

a stable solid-state converter/transverter and i-f will produce stable operation on CW and SSB. It also permits moderate to narrow i-f bandwidth and its commensurately better signal-to-noise ratio is especially desirable for receiving weak signals. Finally, this combination will usually be more reliable and small to moderate in size, making it a good choice for portable operations, especially from high elevations free of local obstructions.

conversion schemes

Before you start to design and build microwave and millimeter-wave gear — especially if you want to advance the state of the art — you should first develop an overall plan of attack. Foremost in that plan is choosing the frequency conversion scheme, which is very important because it affects cost, complexity, performance, and future flexibility.

The first step is to identify the generally accepted weak-signal microwave operating frequencies. Those for 13-cm and above were set up many years ago as multiples of 1152 MHz, as discussed in reference 1. These frequencies, as well as the generally accepted frequencies on the lower microwave bands, are shown in **table 4**.

Note that since the microwave frequency plans were originally established, some slight modifications have been made to accommodate EME. EME operation is now centered around this frequency with a guard band of at least ±50 kHz. In North America it is now standard operating practice to use the frequency 100 kHz above the old operating or EME frequency for the terrestrial cw/SSB calling as shown on

4. Typical North American weak-signal microwave operating and calling frequencies for EME and terrestrial operation.

Band (cm)	EME center frequency (MHz)	Weak-signal calling frequency (MHz)
33	903.0	903.1
23	1296.0	1296.1
13	2304.0	2304.1
9	3456.0	3456.1
6	5760.0	5760.1
3	10368.0	10368.1

table 4. Calling frequencies are great for finding activity, especially in areas where activity is low.

Next, if possible, choose a conversion scheme that will allow at least 15-20 dB of image rejection with simple filtering. If a low-frequency i-f is chosen (for example, 28 or 50 MHz), the rf filtering ahead of the first mixer will be more stringent, since the image frequency will be close to the rf frequency. This usually requires a narrow bandwidth filter, possibly with more than one pole. This type of bandpass filter is often more difficult to tune and may have higher insertion loss than a simple one-pole type.

Different i-f and LO (local oscillator) schemes are in use on the microwave bands, as discussed in reference 1. Nowadays a 2-meter i-f is most popular for the 23- and 13-cm bands. Therefore, an 1152- and 2160-MHz LO would be required for 1296- and 2304-MHz transverter operation, respectively, as shown in **figs. 1A** and **1B**.

Interestingly enough, if you use these schemes, you can get on 3456 MHz almost for free. Simply mix the output of your 1296-MHz transmitter with the 2160-MHz LO and voila! — you have 3456 MHz, as shown in **fig. 1C**. This is the scheme used by many of the operators now on 9 cm.[3]

If you use this scheme and a TVRO-type (3.7-4.2 GHz) preamplifier, you get sufficient image and LO rejection for free. This is true because the image frequency is 864 MHz and the LO is 2160 MHz, well below the cutoff frequency of the waveguide typically used on TVRO-type preamplifiers.

Paul Shuch, N6TX, recently extended this technique to the 6- and 3-cm (10,368 MHz) bands.[4] His approach is more or less an offshoot of the 1152-MHz multiplier scheme described in reference 1.

Basically it goes like this. If you multiply the 1152-MHz LO three times and mix it with 2304 MHz, you get 5760 MHz (**fig. 1D**). Now if you also multiply the same 1152-MHz LO seven times and mix it with 2304 MHz, you get 10,368 MHz (**fig. 1E**).

Furthermore, if you don't care about the lower microwave bands, just multiply the 1152-MHz LO seven times and mix it with 2304 MHz. You'll get both 5760 and 10,368 MHz from a typical mixer. If an image rejection mixer is used, you'll have instant separation of the two desired outputs (**fig. 1F**).[5]

These conversion techniques all have their advantages and disadvantages, depending on the bands you want to work and the gear you have. If the frequencies specified in **table 4** are maintained, fewer LOs will be required to get on the microwave bands. This is significant because frequency instability is one of the biggest impediments to reliable microwave and millimeter-wave communications.

For over a decade 3-cm ("X" band) GunnPlexers have been in use. Various i-fs (such as 30, 50, and 88-108 MHz) have been used. The majority of stations in North America now seem to favor 30 MHz. The two most popular frequencies chosen for this scheme are 10,250 and 10,280 MHz, well away from the weak-signal calling frequency.

mixer design

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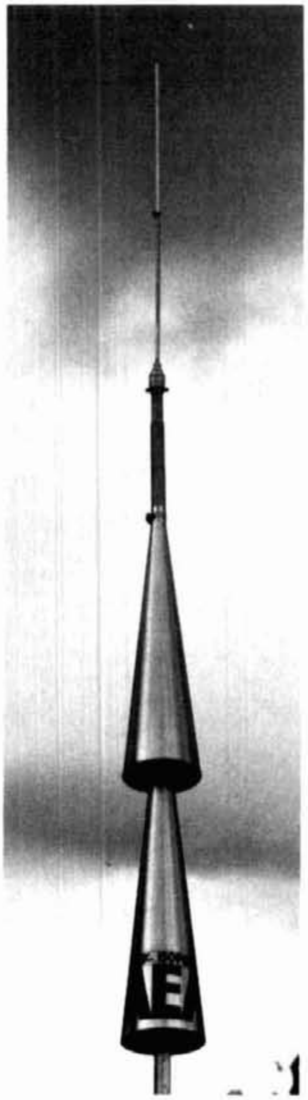

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IsoPole Specifications

Model	144	220	440
Freq. Coverage (Mhz)	135-160	210-230	415-465
2.1 VSWR bandwidth	)12Mhz @ 146Mhz	)15Mhz @ 220Mhz	)22Mhz @ 435Mhz
Power Rating	1 kw	1 kw	1 kw
Gain**	3 dbd	3 dbd	3 dbd
Radiating Element Length	125.5" (3.2m)	79.25" (2m)	46" (1.2m)
Amateur Net Price	$49.95	$49.95	$69.95

**dbd — db gain over a dipole in free space

149

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use of DBMs (double-balanced mixers) for up/down converters.[6] I feel even more strongly that, if available, they should be used in the microwave region. DBMs have fewer spurious outputs and usually are matched to 50 ohms at all ports, so they're easy to use with standard 50-ohm filters and amplifiers.

Many suppliers manufacture DBMs for the VHF/UHF bands, but the choices narrow as you go above 1 GHz, especially if price is any consideration — as it always is for us Amateurs! Once again, we're helped by the TVRO business, which has generated some reasonably priced DBMs that cover both the 9- and 13-cm bands.

Table 5 shows typical specifications of some reasonably priced (less than $100) DBMs that are usable through 4.2 GHz. Be careful in your selection, because the upper limit of the i-f is not always high enough for some of the higher i-f conversion schemes just discussed.

Until moderately priced DBMs are available above 4.2 GHz, Amateurs will probably have to use single-balanced or single-ended mixers for the upper microwave and millimeter-wave bands. At 3 cm and above, waveguide mixers are readily available on the surplus market. Even some of the police radar detection mixers may be adaptable to Amateur operation.

Finally, don't overlook GaAsFETs as mixers. They may be more difficult to use than DBMs and may require additional filtering or tuning, but they can be much less expensive than DBMs. Single-gate GaAsFETs are usable, but the dual-gate types are a natural for mixers because the LO can be injected directly into the second gate. Furthermore, GaAsFET mixers often have conversion gain and hence require less follow on gain, an especially important consideration in transmitter applications.

local oscillators

Local oscillators are a subject unto themselves. Many circuits have been published; the most successful ones used on the microwave bands have been those that started with a fifth or seventh overtone crystal oscillator operating in the 90-125 MHz region followed by a transistor multiplier.[5,6]

Often a 96-MHz oscillator is multiplied 12 times to 1152 MHz as just discussed. Transistor or diode multipliers can be used if a high frequency (for example, 2160 MHz) is desired.[7,8] For the most critical applications, especially for the upper microwave and millimeter-wave bands, oven-stabilized oscillators may be preferred.

Recently several packaged oscillator/multipliers appeared on the surplus market; often they can be retuned to the Amateur bands. Some even use internal phase-locked oscillators. Several commercial sources are now available to the Amateur (more on this later), so I won't dwell on this subject at this time.

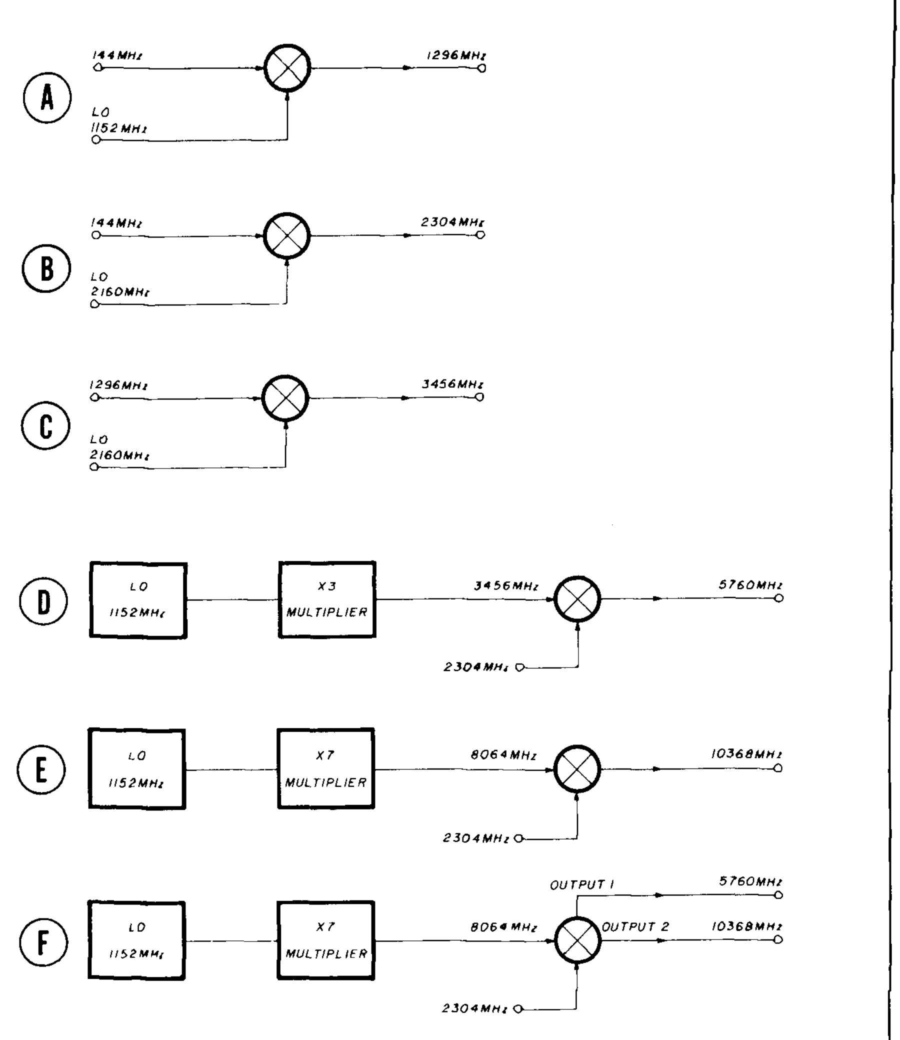

fig. 1. These are some of the popular or recommended conversion schemes for getting on the Amateur microwave bands. In all cases, the frequencies shown will place you near the most common operating frequencies listed in table 4. (See text for explanation of figs. 1A through 1F.)

low-noise preamplifiers

Only a decade ago receivers using crystal mixers in the front end were in common use. They still are used today in GunnPlexers. Receivers with a mixer as the first active stage frequently have noise figures of 8-10 dB or even higher!

If you want to take advantage of cw and SSB communications, you should design your receiver accordingly. Low noise figure preamplifiers and designs are now quite plentiful, especially since

Table 5: Some recommended "standard level" (5 milliwatts LO) DBMs that will work on the microwave frequencies and cost less than $100.00.

Part No.	Supplier	rf/LO freq GHz	i-f freq GHz	Conv.loss typ.dB	Price ea.	Notes
DBM-500	Vari-L Company	1.7-4.2	DC-1.5	7.5	95.00	w/SMA connectors
DBM-1120	Vari-L Company	1-2	DC-0.8	5	85.00	w/SMA connectors
PAM-42	Mini-Circuits	2-4.2	DC-1.3	7-8	26.95	module
SRA-5	Mini-Circuits	.05-1.5	DC-0.6	7-8	21.95	relay can
ZAM-42	Mini-Circuits	1.5-4.2	DC-0.5	7-8	39.95	w/SMA connectors
ZFM-4212	Mini Circuits	2-4.2	DC 1.3	7-8	39.95	w/SMA connectors

low-cost GaAsFETs became available.[9] Low-cost GaAsFETs can now yield noise figures under 2 dB through 25 GHz, which is more than sufficient for terrestrial communications!

TVRO preamplifiers without modifications seem to work quite well on the 9-cm Amateur band and deliver 40-55 dB of gain with a typical noise figure of 1.5 dB. All they require is a waveguide-to-coax transition on the input and dc power applied directly to the unit or through the feedline if so configured. They're often available at flea markets for less than $30!

transmitter amplifiers

CW or SSB with narrow bandwidth i-fs and good frequency stability make microwave and millimeter-wave DX very feasible using low power (less than 1 watt), as discussed previously. The use of a low-level upconverter with a DBM is becoming very popular even in the microwave region.[10] The rf output power available from a "standard" level DBM is typically in the 10-100 μwatt region. Therefore, this approach normally requires 25-50 dB of gain to reach a reasonable transmitter output power level.

Inexpensive gain (at $2-4 per device) is now readily attainable by the use of MMICs (monolithic microwave integrated circuits). Many devices are available up through at least 6 GHz, with output powers approaching 100 milliwatts.[7,11] The MMIC will probably be the workhorse for power levels below 100 milliwatts.

GaAsFETs are particularly attractive for transmitter applications since they're low in cost and have high gain. Even the small-signal types can usually deliver 10-100 milliwatts of output power.

Microwave class C power bipolar transistors and GaAsFETs — especially the "internally" matched types — are also usable, especially if only cw operation is contemplated. They are less costly than linear types with higher power levels (5 to 10 watts or more).

Linear types of bipolar and GaAsFETs that can deliver 2 to 5 watts are also available. These devices are expensive ($100 to $300), but offer considerable performance and size advantages when compared to conventional power generation techniques. Prices of these devices are constantly dropping.

One of the real sleeper bargains is the TWT (Traveling Wave Tube). Expensive only if it's purchased new, it provides very high gain (typically 25-40 dB), usually over an octave of bandwidth into 50 ohms -- without external tuning! Two-to 4-GHz TWTs are quite common and cover two Amateur microwave bands for the price of one!

Available through 25 GHz and usually moderate in size (typically only 6 to 12 inches long), TWTs are generally linear amplifiers. Transmitter-type TWTs that deliver up to 100 watts of output power at 10 GHz are also available!

TWTs do require several different voltages, often up to or above 1000 volts, with a positive ground. They can be used for portable operation if 115 VAC is available either locally or from a small gasoline generator or a dc-to-ac inverter.

Don't overlook receiver-type TWTs, which also have high gain and typically deliver 1-10 milliwatts of maximum output power, more than adequate for low-power operation. However, they're not recommended for front ends on receivers because they usually have 5-10 dB noise figures.

TWTs have been used in satellites and point-to-point microwave links for many years. However, the trend is to use solid-state amplifiers because they require only a few low voltages and are very compact. Furthermore, some of the TWTs used by telephone companies are being replaced by solid-state-amplifiers. As a result, TWTs are finding their way into the Amateur surplus market, especially for the 6- and 9-cm Amateur bands.

Below 3.5 GHz, the ubiquitous 2C39/7289 vacuum tube family is still usable. Twenty-five to 50 watts output per tube has been reported on 13 cm. Power klystrons that deliver hundreds of watts are also available for the microwave frequencies if you're fortunate enough to locate them, but that's another ball game.

antennas and transmission lines

Antenna designs have also come a long way in recent years. The principal workhorse of the microwave bands is the parabolic dish, although the loop Yagi has been used as high as 10 GHz.[12,13,14]

The real bargains are the used or surplus UHF TV and TVRO dishes. Channel Master makes a 7-foot UHF TV dish which, when covered with proper screening, works well up through 13 cm.[13,15]

Feeding dishes isn't too complicated for terrestrial work. Two 3-pound coffee cans soldered together using a quarter-wave probe works well at 23 cm.[15] A similar arrangement using a one-pound coffee can will cover 13-cm[15] while a Campbell's soup can makes a good feed on 9 cm.[7]

Recently scalar feeds such as the TVRO "Chaparral"™ type are being used. They seem to work well on the lower F/D (0.35-0.4) dishes.[12,13] When this feed is used on the larger diameter (6 foot minimum) dishes on the 9-cm Amateur band, the overall gain seems to be very near the expected value.

Feedlines are always a problem on the microwave bands. Low dielectric foam or air dielectric Heliax™ used in the shortest possible length are recommended.[16] The popular trend on the microwave bands is to use antenna-mounted preamplifiers and to locate the transmitter as close to the antenna feed as possible. This is increasingly more feasible when solid-state devices are used in the transmitter. Low-loss waveguide feedline is recommended on 10 GHz and above.

commercial gear

As previously mentioned, there are now commercial converters, transverters, and LOs available for all the Amateur bands through 13 cm. SSB Electronics uses a very interesting packaging concept. Each of their subsystems is a separate module. For instance, for a transverter you buy a separate LO with dual outputs, receive downconverter, and transmit upconverter. The LO for a 13-cm setup is a compact unit that puts out a stable 3-5 milliwatts of power at 2160 MHz for about $100. This unit can be adapted to the 9-cm scheme mentioned earlier.

Recently SSB Electronics announced a 3-cm (10,368 MHz) transverter that sports a 2.5-dB maximum receiver noise figure and over 150 milliwatts of output on CW or SSB. A 144-MHz i-f is used. The filtering required is obtained by the use of several dielectric resonators that have very high *Q* and low insertion loss. At less than $500 for the basic transverter, this should be a natural for weak-signal "X" band enthusiasts.

*Transverters Unlimited, Hans Peters, VE3CRU, Box 6286 Station A, Toronto, Ontario, Canada M5W 1P3.

propagation

This subject was discussed in detail earlier.[2,17] It's quite obvious from the details already discussed on new North American DX records that the microwave and millimeter-wave Amateur enthusiasts are taking advantage of many of the radio propagation opportunities available to them. Once again this proves that these are very worthwhile frequencies, quite capable of supporting radio propagation well beyond the line of sight!

summary

This month's column was primarily aimed at updating all the recent happenings on the microwave and millimeter-wave bands and in particular the recent record breaking DX contacts. It's great to see such activity and advancement of the state of the art.

Some of the latest techniques and devices that are presently being used were also discussed. It's good to see that Amateurs are really taking advantage of the new low- to moderately-priced solid-state devices, and nice to see Amateurs benefit from the UHF and TVRO businesses. It's no longer very difficult to build or operate gear on our highest Amateur bands.

Important VHF/UHF Events:

January 3:	*Predicted peak of the Quadrantids Meteor Shower at 1830 UTC.*
January 10-12:	*ARRL VHF Sweepstakes Contest*
January 28:	*EME perigee*
February 25:	*EME perigee*

references

1. Joe Reisert, W1JR, "VHF/UHF World: Amateur Microwave Bands," *ham radio*, January, 1986, page 44.
2. Joe Reisert, W1JR, "VHF/UHF World: Microwave and Millimeter-Wave Propagation: Part 1", *ham radio*, July, 1986, page 82.
3. Rick Fogle, WA5TNY, "3456 MHz Operation," *Proceedings of the 1986 Central States VHF Conference*, St. Louis, Missouri, July, 1986.
4. Paul Shuch, N6TX, "A Five-Band Microwave Transverter," *Proceedings of the Microwave Update 86 Conference*, Estes Park, Colorado, August, 1986.
5. Joe Reisert, W1JR, "Getting Started on 13 and 23 cm", *Proceedings of the 1985 1296/2304 MHz Conference, Estes Park, Colorado, September, 1985.*
6. *Joe Reisert, W1JR, "VHF/UHF World: VHF/UHF Receivers," ham radio*, March, 1984, page 42.
7. Al Ward, WB5LUA, "MMIC Update/Cascading

MMIC's," *Proceedings of the Microwave Update 86 Conference*, Estes Park, Colorado, August, 1986.

8. Richard L. Campbell, KK7B, "A Clean Microwave Local Oscillator," *Proceedings of the 1985 1296/2304 MHz Conference*, Estes Park, Colorado, August, 1985.

9. Joe Reisert, W1JR, "VHF/UHF World: Low-Noise GaAsFET Technology," *ham radio*, December, 1984, page 99.

10. Joe Reisert, W1JR, "VHF/UHF World: VHF/UHF Exciters," *ham radio*, April, 1984, page 84.

11. Joe Reisert, W1JR, "VHF/UHF World: Broadband Amplifiers in Receiver Design," *ham radio*, November, 1986, page 91.

12. Joe Reisert, W1JR, "VHF/UHF World: Reflector Antennas — Part 1," *ham radio*, February, 1986, page 51.

13. Joe Reisert, W1JR, "VHF/UHF World: Reflector Antennas — Part 2," *ham radio*, March, 1986, page 68.

14. Joe Reisert, W1JR, "VHF/UHF World: Designing and Building Loop Yagis," *ham radio*, September, 1986, page 56.

15. Gerald Handley, WA5DBY, "The Care and Feeding of a 7-Foot Dish," *Proceedings of the 1985 1296/2304 MHz Conference*, Estes Park, Colorado.

16. Joe Reisert, W1JR, "VHF/UHF World: Transmission Lines," *ham radio*, October, 1986, page 83.

17. Joe Reisert, W1JR, "VHF/UHF World: Microwave and Millimeter-Wave Propagation — Part 2, *ham radio*, August, 1986, page 69.

ham radio

NE5205 wideband amplifier

There is an error in Mike Gruchalla's article, "NE5205 Wideband Amplifier" (September, 1986, page 30). In the last few sentences of the section on performance (page 38), the 20-dB return loss is stated as being related to an impedance within 0.5 ohm of 50 ohms. This is incorrect. The port-one impedance Z_1 is given in terms of the S-parameter S_{11} by:

$$Z_1 = Z_0 \frac{(1 + S_{11})}{(1 - S_{11})}$$

The display of S_{11} in dB indicates the magnitude of the ratio of the reflected power from and the incident power to port 1. That ratio is equal to the magnitude of S_{11} squared. A 20-dB return loss is a power ratio of 1/100, which implies that the *magnitude* of S_{11} is 0.1. The two value extremes that will result in real (i.e., non-complex) values for load impedance are +0.1 and −0.1. Using the equation above and a 50-ohm characteristic impedance, the impedance corresponding to a return loss of 20 dB could be as high as 1.22 Z_0, or 61 ohms, and as low as 0.82 Z_0, or 41 ohms. So, the 20-dB return loss represents a port impedance within about 10 ohms of 50 ohms, and not 0.5 ohms as stated in the article. (TNX W3NQN — Ed.)

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0508G	50-54	170	1	6	15
0510	50-54	170	10	-	-
0510G	50-54	170	10	6	15
1410	144-148	160	10	-	-
1410G	144-148	160	10	6	15
1412	144-148	160	30	-	-
1412G	144-148	160	30	6	15
2210	220-225	130	10	-	-
2210G	220-225	130	10	7	12
2212	220-225	130	30	-	-
2212G	220-225	130	30	7	12
4410	420-450	100	10	-	-
4410G	420-450	100	10	11	12
4412	420-450	100	30	-	-
4412G	420-450	100	30	11	12

1 Models with G suffix have GaAs FET preamps. Non-G suffix units have no preamp.
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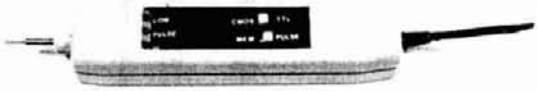

a deluxe logic probe

Accurate logic probe detects high frequencies and pulses

Plenty of good logic probe circuits have already been described in print. Unfortunately, a review of their schematics shows that each lacks something — either speed, accuracy, flexibility, or protective devices. Increasing use of microprocessors, PLL synthesizers and digital signal processing circuitry makes the need for an improved probe obvious.

The logic probe shown in **fig. 1** represents an attempt to overcome problems with existing circuits and produce a device which is simple in design and easy to construct, yet powerful and inexpensive.

circuit description

To protect the probe from an accidental reverse voltage connection, a diode is included in series with the power supply (**fig. 2**). The 1N270, a germanium diode, has a lower forward voltage drop than a silicon diode and has a peak reverse breakdown voltage of about 100 volts. The LM330T-5.0 is a low-voltage dropout voltage regulator which provides a regulated 5.0 volts output with an input as low as 5.6 volts.[1] In addition, this regulator has an approximately linear voltage output drop as the input supply voltage falls below 5.6 volts. For instance, with this device connected to a 5-volt TTL supply, its output would still be approximately 4.3 volts. The combined effects of the diode and voltage regulator are such that when the probe is connected to any supply above 6.0 volts (CMOS) the regulated output voltage V_{REG} will be 5.0 volts. When the probe is connected to any TTL supply, the voltage at V_{REG} will be about 4 volts, which is acceptable. In fact, I've found that the probe still works with an input supply voltage down around 4 volts. The 60-μF capacitor is necessary for proper regulation and should be a tantalum.

To protect the input from accidental negative or high voltage, I've used a technique similar to that used to protect CMOS gate inputs. The 2.2 k (3 watt) resistor provides current limiting when either the lower 1N914 diode conducts (negative input) or when the top 1N914 diode conducts (positive input greater than supply). The 0.068-μF ceramic capacitor provides an ac bypass for pulses.

To allow high-speed pulse detection, I've separated the pulse and level detection functions. This was necessary because most comparators have a response time far below that of most modern logic operating frequencies and therefore would reduce or miss high frequency pulses.[2] At the input, a 100-pF ceramic capacitor couples pulse signals into an MC74HC04 CMOS inverter.[3] The MC74HC04 is a HEX high-speed CMOS inverter which has an operating speed similar to that of LSTTL. In addition to low power consumption typical of CMOS, this device can be powered from

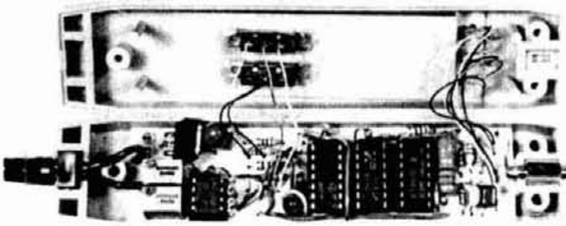

fig. 1. Deluxe logic probe.

M. Wilde, 7708-181 Street, Edmonton, Alberta, Canada T5T-127

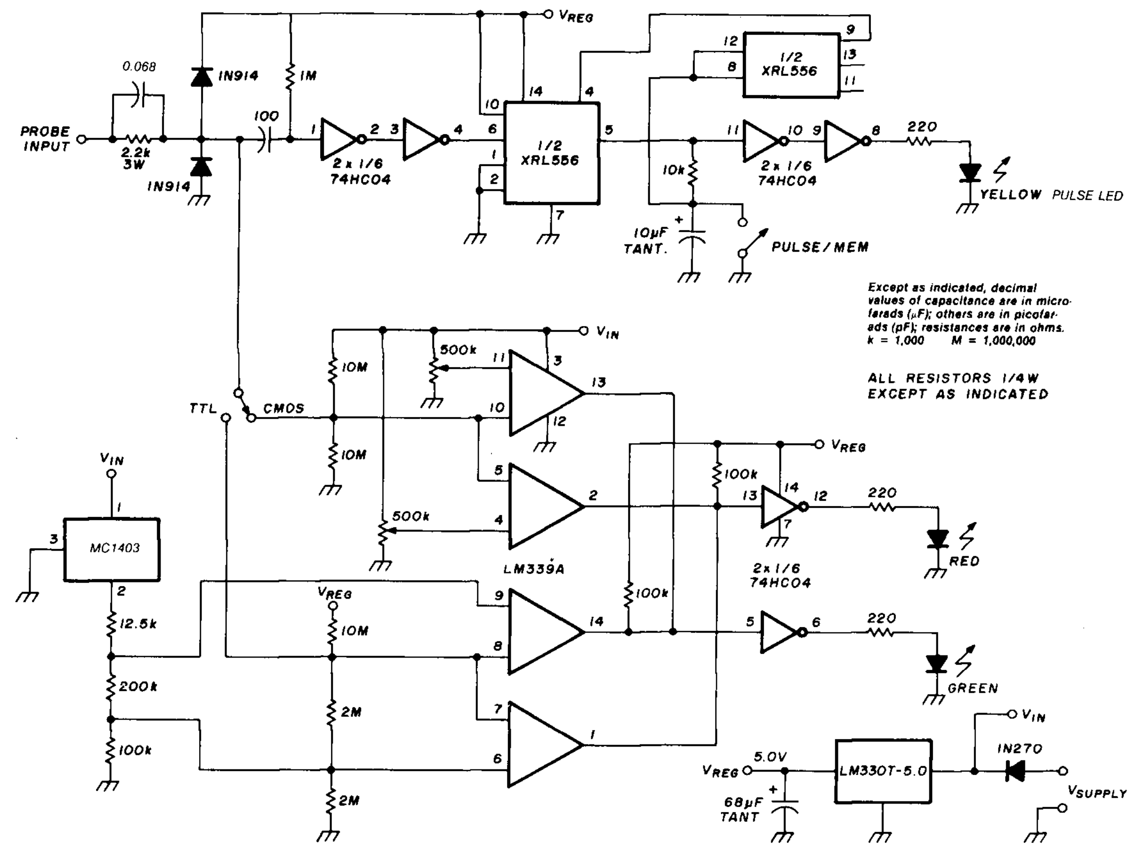

fig. 2. Logic probe schematic.

a wide range of supply voltages — 2 to 6 volts. This is useful because of the approximately 1-volt drop across the probe power supply. The 1-megohm resistor connected from the input to V_{REG} is a pullup resistor used to prevent the CMOS input from floating and erroneously triggering. The incoming pulses are put through two inverters which buffer the original pulse and square up the waveshape.

The pulse trigger and display use an XRL556 dual timer.[4] The first timer is a negative edge-triggered Set/Reset flip-flop, and the second a comparator/flip-flop. When a negative edge first appears at the input of timer 1 (pin 6), a flip-flop is set and its output goes high. This causes the pulse LED to turn on and the 10-μF capacitor to begin charging toward the supply voltage. When the voltage on this capacitor reaches 0.66 V_{REG}, the second timer turns on, resetting the flip-flop in timer 1. Now the pulse LED is turned off, and the 10-μF capacitor begins to discharge toward ground. The flip-flop in timer 1 remains reset until the decreasing voltage on the capacitor reaches 0.33 V_{REG}. At this point, timer 2's output goes low and timer 1 is ready for retriggering. Two timers provide a fixed on and off time, which will cause the pulse LED to flash on and off (at about 1 Hz) when repetitively triggered, thereby providing a pulsing display for a pulsing input. By shorting out the 10-μF capacitor, timer 2 is never allowed to reset timer 1, which provides memory.

logic level detection

Logic level detection is accomplished by two separate window detectors with their outputs ORed together. A National Semiconductor LM339 quad, single-supply comparator, which has open collector outputs is used.[5]

Two 500-k, 10-turn trim pots set to 70 percent and 30 percent of the supply voltage are used to set the CMOS thresholds. Using a 10-turn pot allows an accurate and stable setting, with the possibility of resetting these ranges to, say, 80 percent and 20 percent if it's ever necessary to detect a narrower range. Two 10-megohm resistors in series from the supply to ground hold the CMOS window comparator input to 0.5 volts V_{IN}. This keeps the logic level output LEDs off when there's no input signal. Large value resistances were chosen to reduce power consumption and provide a high input impedance.

For the TTL window detector, I used the combination of a 10-megohm resistor and two 2-megohm resistors to keep this window input at a nominal 1.1 volts (remember the approximate 1-volt drop across the

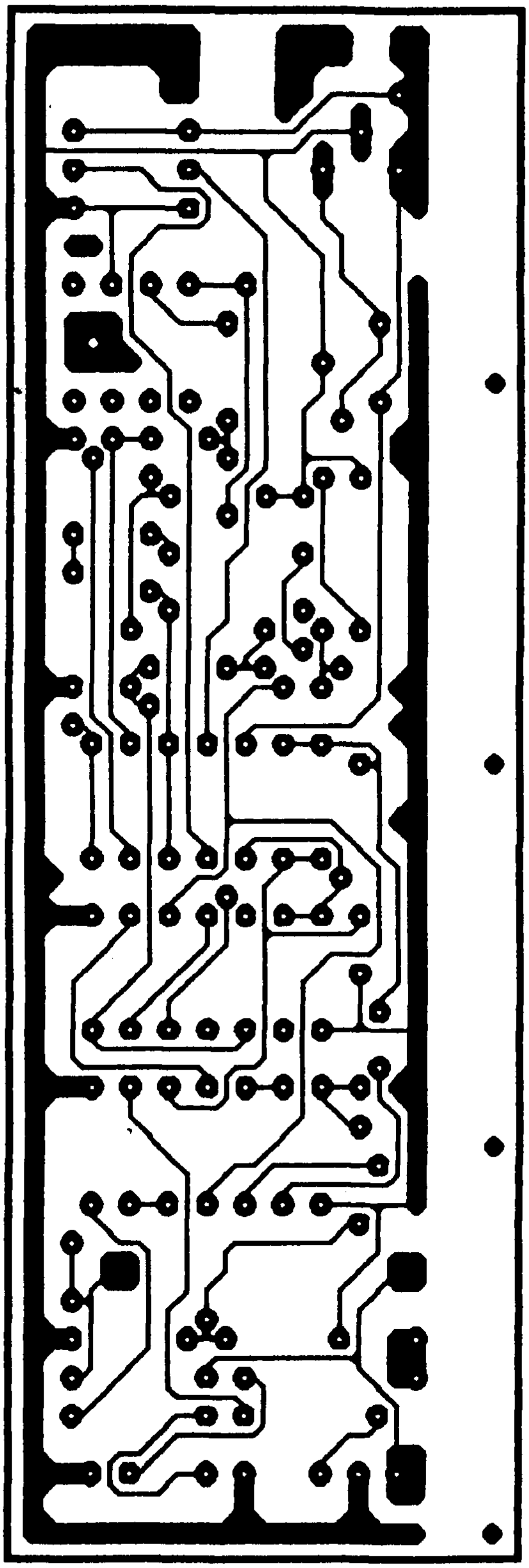

fig. 3A. Logic probe pc board artwork, shown 2x actual size.

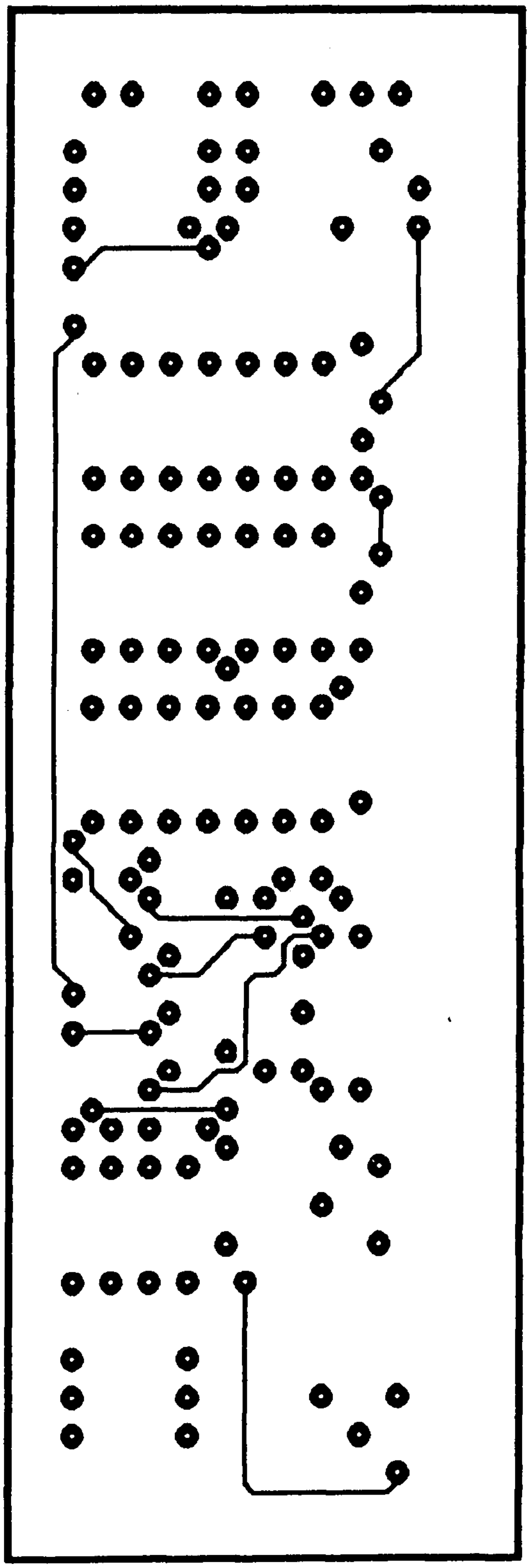

fig. 3B. Reverse side (component side) pc artwork, shown 2x actual size.

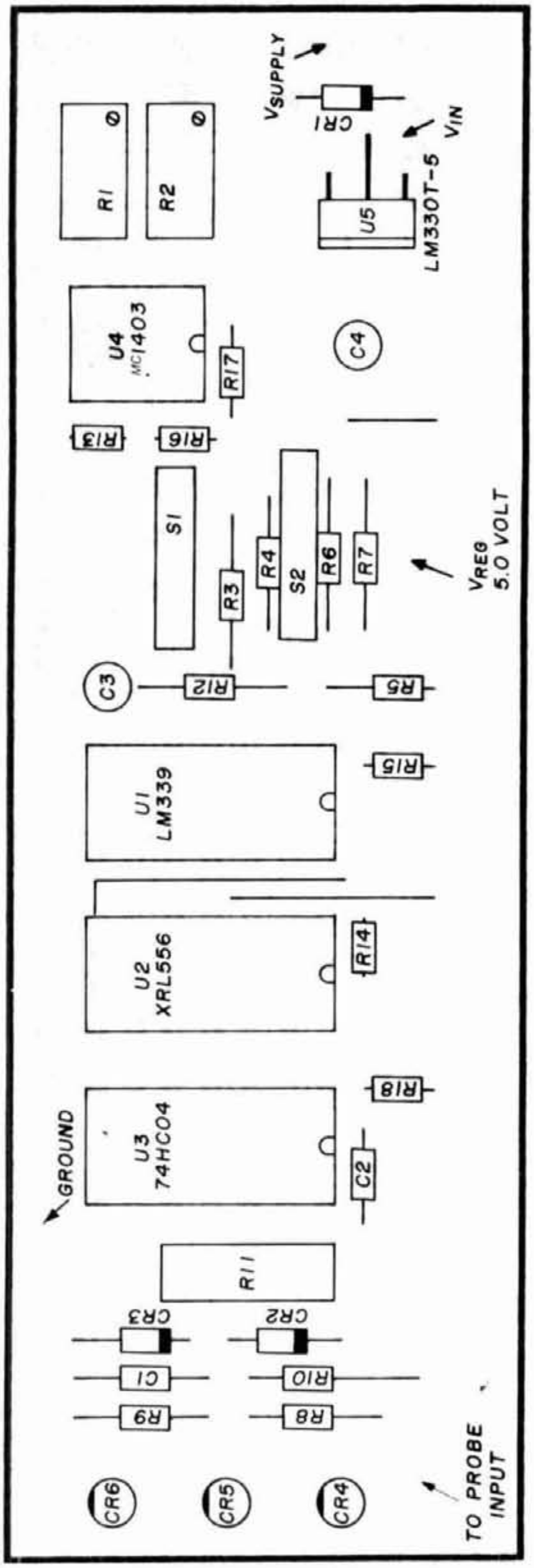

fig. 3C. Component placement diagram showing pattern of 3A, 2x actual size.

C1	*0.068 μF ceramic chip*
C2	*100 pF ceramic*
C3	*10 μF tantalum, 10 volts*
C4	*68 μF tantalum, 16 volts*
CR1	*IN270*
CR2,3	*IN914*
CR4	*LED Miniature Green*
CR5	*LED Miniature Yellow*
CR6	*LED Miniature Red*
R1,R2	*500 k, 10-turn (potentiometer)*
R3,R4,R5	*10-Megohm, 1/4-watt*
R6,R7	*2-Megohm, 1/4-watt*
R8,R9,R10	*220-ohm, 1/4-watt*
R11	*2.2 k, 3-watt*
R12	*10-k, 1/4-watt*
R13,R14,R15	*100-k, 1%, 1/4-watt*
R16	*200-k, 1%*
R17	*12.4-k, 1%*
R18	*1-Megohm*
S1,S2	*Miniature slide switch*
U1	*LM339N*
U2	*XRL556CP*
U3	*SN74HC04N*
U4	*LM 1403*
U5	*LM 330T-5.0*

supply). The logic thresholds themselves are set by a voltage divider network connected to an MC1403 precision voltage reference IC.[6] The MC1403 provides a stable temperature-compensated 2.5 volts output and operates at a supply voltage range of 4.5 to 40 volts. Because of this lower voltage limit, this device must be connected to V_{IN} and not V_{REG}, because the additional 0.6 volt drop would be too much. The resistor combination shown in **fig. 2** provides 0.8- and 2.4-volt references for the TTL window detector.

calibration and assembly

The only calibration required for this probe is to set the CMOS logic levels on the multi-turn pots. This is easily done by connecting the probe to a 10-volt supply and adjusting the pots until they provide 7 volts and 3 volts at pins 11 and 4, respectively, of the LM339.

I've tried to measure the maximum frequency and minimum pulse width this probe is capable of detecting, but the probe is capable of detecting higher speed pulses than my test equipment will provide. With my test equipment I've found that the probe will at least work up to 20 MHz (square wave input) and detect pulses as narrow as 20 nanoseconds. This is sufficient for most work currently being done, but still isn't the limit of the probe.

The slow response time of the comparators (LM339) results in the green and red LEDs turning on and a

flashing pulse LED for square wave inputs under about 2 MHz. For square waves over about 5 MHz, however, the green and red LEDs will be off (because of the slow comparators), but the pulse LED will still flash. Although I initially thought this was a shortcoming, others have suggested that this is actually useful because it provides a rough indication of speed. The probe will indicate a true pulse and logic level condition for all narrow pulses because one logic level is present for most of the time.

The pc board, which measures approximately 1 x 4 inches, fits nicely into a logic probe case available from Global Specialties.* The case comes with a probe tip and power cord, but the holes for the switches have to be drilled and a label made (if desired). The prototype used sockets for all ICs; this causes some height problems, however, and I recommend leaving them out.

The pc board artwork is reproduced in **fig. 3A**. **Figure 3B** illustrates the reverse side (component side) hole diagram as well as a computer-generated jumper placement. Point-to-point wiring is recommended for this side. **Figure 3C** details component placement using the same pattern shown in **fig. 3A**.

references

1. LM330T-5.0 data sheet, National Semiconductors.
2. J. Rozenthal, "Improved Logic Probe," *ham radio*, April, 1983, page 91.
3. SN74HC04N data sheet, Motorola.
4. XRL556CP data sheet, EXAR.
5. LM339N data sheet, National Semiconductors.
6. LM1403 data sheet, Motorola.

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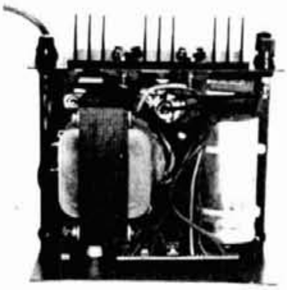

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RS-A SERIES

MODEL RS-7A

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

RS-M SERIES

MODEL RS-35M

• Switchable volt and Amp meter

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

VS-M SERIES

MODEL VS-20M

- Separate Volt and Amp Meters
- Output Voltage adjustable from 2-15 volts
- Current limit adjustable from 1.5 amps to Full Load

MODEL	Continuous Duty (Amps) @13.8VDC	@10VDC	@5VDC	ICS* (Amps) @13.8V	Size (IN) H x W x D	Shipping Wt (lbs)
VS-20M	16	9	4	20	5 x 9 x 10½	20
VS-35M	25	15	7	35	5 x 11 x 11	29
VS-50M	37	22	10	50	6 x 13¾ x 11	46

RS-S SERIES

MODEL RS-12S

• Built in speaker

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

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modifying microphones

Adapt yesterday's microphones for use with modern rigs

Although modern transceivers are designed to accommodate low-Z, hand-held microphones, some of us prefer desk-type units to handhelds. We'd like to use a prized older microphone but know it just won't match the new transceiver. Older microphones *can* be modified, however; this article describes some simple modifications and a special preamplifier that may be added if necessary.

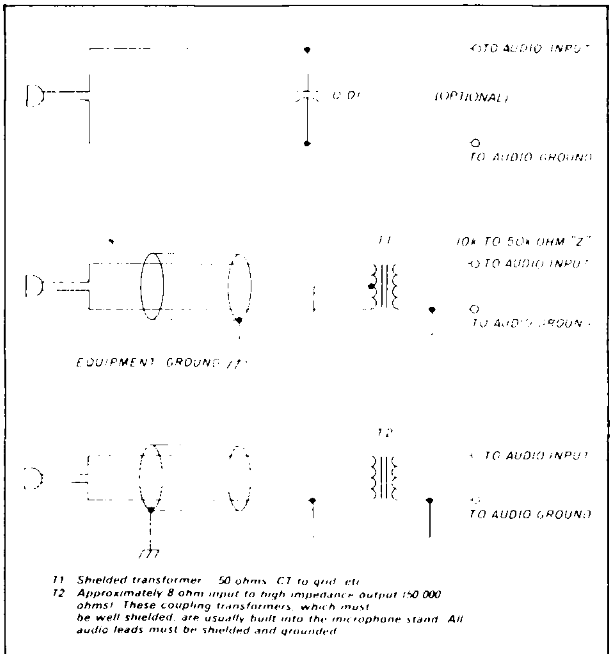


fig. 1. (A), Crystal microphone, approximately 50,000-ohm "Z"; (B), dynamic microphone, 50 ohms, Western Electric 600 broadcast types, etc.; (C), dynamic microphone, 8-500 ohms, into 10,000 to 50,000 ohm "Z."

Most modern rigs use low-Z impedance microphones, usually around 500 ohms. Because you can run a lower-Z unit into a higher Z-input and lose only gain, it isn't necessary to "match" the impedance, provided you have adequate microphone gain. No changes are necessary unless you want to use, for example, a Western Electric 50-ohm broadcast microphone with a 430S. In this sort of arrangement, it would be necessary to use a matching step-up transformer as shown in **fig. 1**.

Other low-Z microphones may also be used in this manner. Some manufacturers enclose the transformer and the 50- kilohm microphone in the same unit. Under these circumstances, the transformer must be magnetically shielded and preferably located in the base of the microphone stand. I found this system satisfactory for rigs that have adequate microphone gain; others may require an additional outboard preamplifier. Some manufacturers provide such units. As a rule, though, lower-output microphones are a better choice.

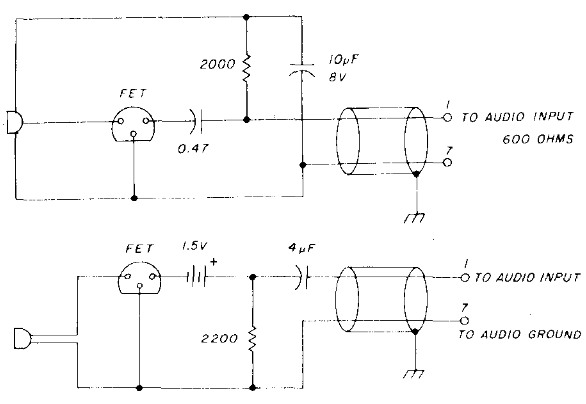
Crystal microphones can be used only into a high impedance input of 50 kilohms or more. An Astatic D104, for example, may be shunted at the microphone terminals with a 0.01μF capacitor to equalize the audio output.

Condenser Electret microphones (CEM), widely used by ICOM and other manufacturers, usually employ a transistor preamplifier built into the microphone capsule. This requires that preamplifier power be supplied. Generally a small battery is incorporated into the base of the stand, or, as in the Radio Shack 33-1058 tie clip that I use, a built in mercury cell is incorporated within the microphone case. No on/off switch is required because the life of the battery is equal to its shelf life. The IC-HM12, for example, obtains its preamp voltage from the transmitter (eg., IC 735, 745, 751), via the same terminal (No. 1) that carries the audio from the preamp. (See **figs 2 and 3**.)

The output impedance of these units is 600 ohms, at a level above that of an unamplified dynamic micro

By A.G. Sheffield, VE7CB/W6, Tri-Palms Estates, 32-291 Merion Drive, Thousand Palms, California 92276

phone. It should be noted that equipment designed for CEM microphone inputs will not have sufficient gain unless a preamplifier is added. Using the RS 33-1058 capsule, the circuit shown in **fig. 3** is more than adequate.

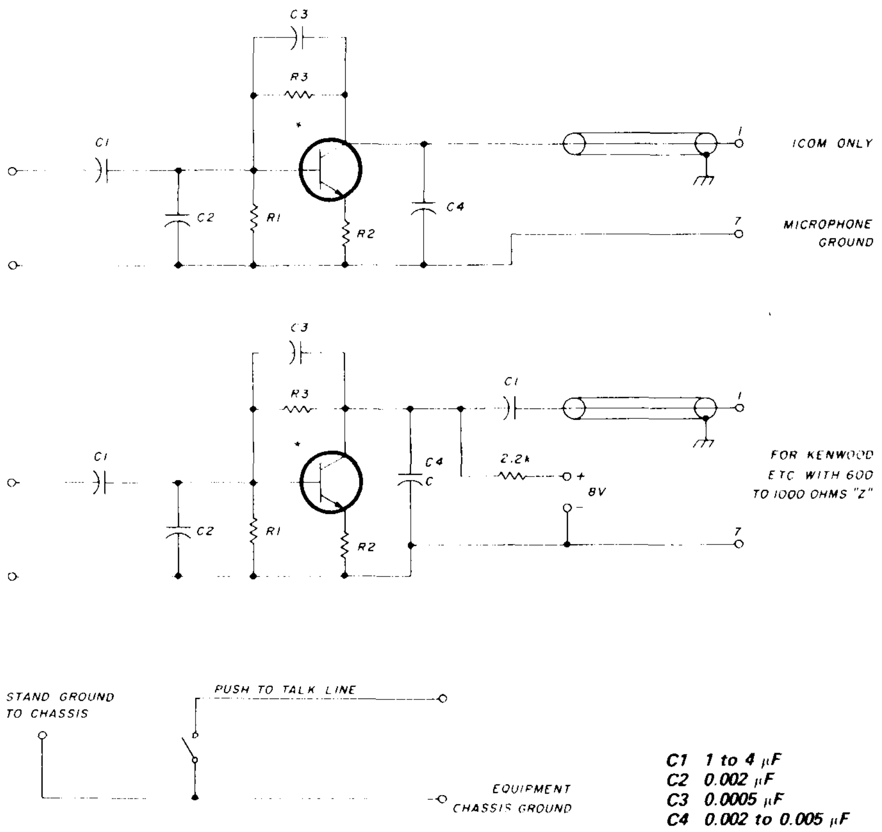


These units have 600-ohm output Z, use an amplifier built into the microphone capsule, and must have a battery supply included. All audio leads must be shielded, with the shield grounded to the chassis ground. The push to talk switch must also use the equipment ground.

fig. 2. Condenser Electret microphones employing built-in preamplifier circuits.

providing more gain

The preamplifier was constructed on a 1 X 2-inch piece of insulating board, with holes punched through for each component lead. It was wired directly into the microphone output and transceiver input via the microphone cord, directly from the base of the desk unit. (Note that the preamp termination must match your rig's input Z. Also, if a common audio and voltage line isn't used — as in the ICOM series — a battery for the preamp will be necessary.) Matching to 600 ohms is enhanced by using a larger transistor than normal and operating it at a lower level. I have used a 2N3053, 2N1304, 2N2430 satisfactorily in this application, with no hiss or distortion noticeable at full gain. It's very important that the audio line to the microphone plug be an insulated shielded wire and that the microphone and preamp ground be kept insulated and separate from the chassis ground. Pin 1 is audio, pin 8 is equipment ground, and pin 7 is audio ground.



C1 1 to 4 µF
C2 0.002 µF
C3 0.0005 µF
C4 0.002 to 0.005 µF
R1 22k
R2 100 ohms (optional)
R3 220k

**Radio Shack 33-1058*

fig. 3. Microphone preamplifier circuits that can be used with ICOM and Kenwood transceivers.

This grounding method is essential in order to prevent hum and RF feedback. I wrap the microphone capsule with clear plastic tape to insulate it from the stand clamp. There should be no continuity path between the capsule and microphone stand; if there is, severe RF feedback will be evident.

For operation on SSB, it's especially important that the frequency response from 300 to 3000 Hz be flat and free of spurious peaks. Speech limiters and processing will level off these peaks somewhat, but it's at this point that the distortion inherent in such designs becomes apparent. Clipping produces square waves and harmonics within the audio range and is therefore not desirable. Response can be tailored to suit by reducing C1 for less bass and increasing the value of C2 for less highs. If full gain is required, remove emitter resistor R3. In my case, with the 745, the microphone gain is equal to the HM12's with the resistor left in. It is higher, but still within usable limits with the resitor out.

This low-cost, conventional design is the result of many hours testing different microphones and preamplifiers. Through its use, increased operating comfort — plus good voice quality and clean audio, with no spurs or splatter — can be achieved.

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109	121	133	145	157	169	181	193	205	217	229	241	253	265	277	289	301	313	325	337	349
110	122	134	146	158	170	182	194	206	218	230	242	254	266	278	290	302	314	326	338	350
111	123	135	147	159	171	183	195	207	219	231	243	255	267	279	291	303	315	327	339	
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PRACTICALLY SPEAKING ... Joe Carr K4IPV

"function generator" circuits: part 2

Last month we discussed using textbook integrator circuits as low-pass filters, for generating quadrature sine wave signals, and for generating triangle waves out of square waves. This month, we'll look at some practical circuits, keeping in mind that there's a serious difference between textbook circuits and real, on-the-workbench ones.

a practical integrator

Almost all textbooks on linear integrated circuits or operational amplifiers include the circuit shown in **fig. 1**. This circuit produces an output voltage that is related to the integral of the input signal and the gain ($-1/R1C1$).

The nature of the integrator is that it produces an output voltage that is the time-average of the input voltage. There's only one problem with the traditional circuit: with real operational amplifiers, it often doesn't work! But unfortunately, some articles and books don't tell you what the problem is and how to deal with it. When I first started building integrators several years ago I discovered the problem the hard way.

The main problem in practical integrators is that the dc offset voltage normally present at the output of real operational amplifiers charges capacitor C1, and thereby soon saturates the op-amp. The output voltage starts rising immediately after power is applied and soon is off scale.

One method used to cancel the effects of offset is to use an operational amplifier that has a very low offset potential and no input bias current (or very little). For low-cost applications, the CA-3140 BiMOS op-amp (which uses MOSFET input transistors) is a good choice. Devices of the 741 family are almost useless for integrator service except for periodic signals with no dc offset.

Another procedure is to connect a resistor across the integrator capacitor in order to keep the dc from building up (**fig. 2**). This is especially useful for integrators that see periodic input signals. The rule of thumb is to make the shunt resistor (R2) very much larger than R1. In the test case, I used a 470-k input resistor and a 10-Megohm shunt resistor, which worked quite nicely.

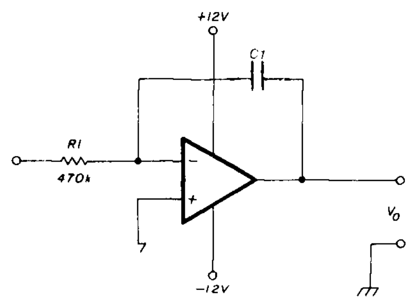


fig. 1. Basic integrator circuit uses op amp and single resistor/capacitor combination.

Finally, we may also have to use an offset null potentiometer in some circuits. In my test case, with 400-Hz sine, square, and triangle wave input signals, the potentiometer was not needed. Other cases, however, may require a counter offset provided by R3. Although the values of the resistors in this network are dependent upon the application, most of the time a 5-k value for R3, and 10 to 27-k for R4 and R5 will suffice. Make R6 equal to R1 for starters; it can be increased or decreased as needed after the circuit is tested.

To adjust the potentiometer, short the input of the integrator (making $V_{in} = 0$). Adjust R3 for a potential of zero volts at point "A." Momentarily close S1 to force the output voltage to zero. If the output voltage rises to either positive or negative values after S1 is opened, adjust R3 to cause the rate of increase to slow down to zero. Again close S1 and see if the output voltage changes. Repeat the procedure until the output voltage remains at zero following every closing of S1.

In normal operation, switch S1 is used to reset the integrator after it performs an operation. It is used in some instruments where a value is calculated, but is only occasionally needed in cases where an integrator sees a periodic signal with no dc offset component. For slow circuits, the switch can be a relay, while in faster circuits it can be a CMOS electronic switch with an "on" channel resistance very much lower than R1. Keep in mind that this switch dumps the charge in capacitor C1, so the CMOS switch selected must be able to withstand the charge in the capacitor without burning up.

sawtooth generator circuit

Not long ago, when I was building Science Workshop's "Poor Man's Spectrum Analyzer," decribed by W4UCH in a recent *ham radio* article,[1] I needed a sawtooth generator circuit from an oscilloscope. But W4UCH had used a 30-year old Heathkit, and modern oscilloscopes don't have a sawtooth output. (Mine is a modern triggered sweep model with "X-Y" capability.) Although I eventually

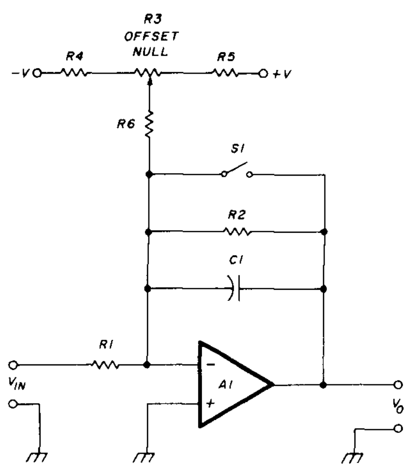
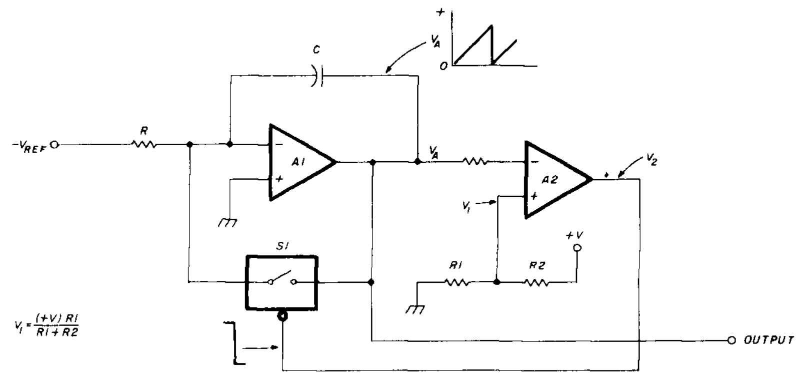
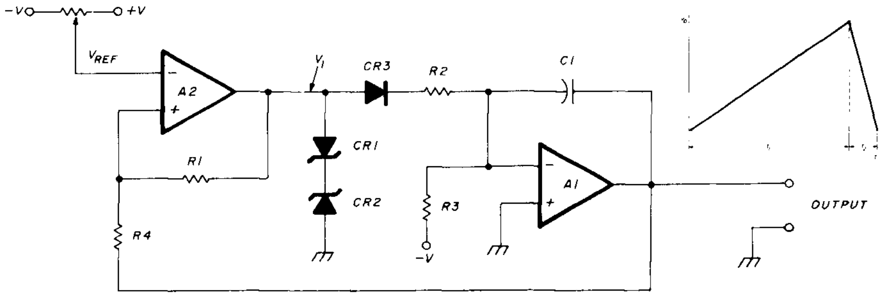


fig. 2. Use of resistor R2, in parallel with C1 prevents input offset voltages from saturating the op-amp.



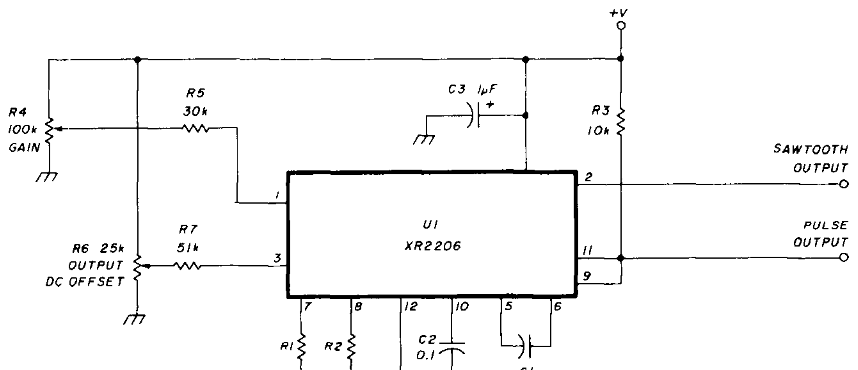
$$V_1 = \frac{(+V)\,R1}{R1 + R2}$$

fig. 3. Integrator and comparator combine to form sawtooth generator.



$$T_1 \simeq \frac{2V_1\,R3\,C1}{(-V)} \qquad R2 \ll R3 \qquad R1 = R4$$

fig. 4. Sawtooth generator's decay time is function of R2/R3 ratio.



$$F = \frac{2}{C1}\left[\frac{1}{R1 + R2}\right]$$

$$\text{DUTY CYCLE} = \frac{R1}{R1 + R2}$$

fig. 5. Circuit built around XR-2206 chip provides sawtooth and short pulse waveforms.

bought the Science Workshop sweep board described in W4UCH's article, I decided to look into sawtooth generator circuits. Because they're based on the integrator circuit, I decided to include them here.

Figure 3 shows one attempt at designing a sawtooth circuit. It consists of an integrator (A1) followed by a voltage comparator; the output of the comparator drives the control input on an electronic switch (which is active-LOW). At turn-on, the charge in capacitor C is zero, so voltage V_A is zero. Because voltage V1 is positive, the output of the comparator (V2) is positive. Under this circumstance the control line of S1 is inactive, so S1 is open.

At turn-on, the stable reference voltage $-V_{REF}$ causes the output of the integrator to increase. At the point where $V_A = V1$, the output of A2 drops LOW, forcing S1 to close. This discharges C, forcing the output voltage V_A down to zero.

Figure 4 was derived from a circuit given in one of Graeme's classic op-amp books.[2] The ramp generator circuit is the integrator formed with A1, C1, and R3 (being driven by V–). The output voltage rises until it reaches the threshold of comparator A2. That comparator uses positive feedback and a reference voltage V_{REF} provided by a potentiometer. The trip threshold is V_{REF} + V1 (which is set to 0.7 volts greater than the zener voltage of CR1/CR2, assuming that these diodes are identical). When the output voltage hits the threshold voltage, the comparator output snaps positive and forward biases diode CR3. If resistor R2 is very much less than R3, then C1 will discharge very rapidly, resulting in the classical sawtooth waveshape (see **fig. 4** inset). The reset time, T2, will be very much shorter than the period, T1, if R2 < < R3.

Another means of generating a sawtooth waveform is to use a special function generator chip such as the Exar XR-2206.* The XR-2206 is capable of generating sine/square wave/triangle waveforms; it is used to generate a sawtooth and a short duty cycle pulse in the circuit in **fig. 5**.

The frequency of this sawtooth generator circuit is set by resistors R1 and R2, plus capacitor C2:

$$F = \frac{2}{C1(R1 + R2)}$$

where: F is in Hz, C1 is in Farads, and R1 and R2 are in ohms. The duty cycle is:

$$\frac{R1}{R1 + R2}$$

Jameco** makes a circuit board "function generator" kit for less than $20 that creates the sine wave, square wave, and triangle wave signals. It can be easily modified for sawtooth applications.

references

1. Bob Richardson, W4UCH, "A Low-Cost Spectrum Analyzer with Kilobuck Features," *ham radio*, September, 1986, page 82.
2. Jerald G. Graeme, "Designing With Operational Amplifiers: Applications Alternatives," McGraw-Hill Book Company, New York, 1977, pages 159-162.

*Dick Smith Electronics, P.O. Box 8012, Redwood City, CA 94063-8021. Order part No. Z6820 ($3.95).
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open-wire line for 2 meters

Low-loss, inexpensive VHF "cable"

It's a well-known fact that transmission line losses increase with the frequency of operation. Coax and open-wire line manufacturers supply data to permit users to select the proper transmission line for a given frequency. The data is usually in the form of dB loss per 100 feet, specified at discrete frequencies or by means of a curve expressed in dB loss per 100 feet versus frequency. Typical transmission line attenuation losses are shown in **table 1**.

line loss and cost considerations

For any frequency, it's possible to find a line that provides the lowest losses to the antenna system. For frequencies below 30 MHz, losses are not a problem unless line lengths are great — for example, over 300 feet at 30 MHz. At that frequency, RG8/U may produce a 3-dB loss over the line length, which represents one-half the power being lost in the coax line.

There's also a relationship between transmission line loss and cost, which is nonlinear. For a given frequency, cost versus line loss is an inverse function; that is, the lower the loss, the higher the cost. At 145 MHz, we have the choice of several readily-available transmission lines (**table 1**). The table also shows the market cost of each type as determined from recent magazine advertisements. Some of the transmission line costs are high, especially for long runs.

I'm interested in both minimum line loss and minimum costs. Reference 1 describes such lines for operation below 30 MHz in lengths of approximately 500 feet. Those lines are open four-wire transmission lines of 200 ohms impedance, which can be converted to 50 ohms with 4:1 baluns at the high frequencies. Open two-wire lines of 200 ohms impedance become impractical because of the very close spacing (less than 0.1 inch) required.

running the line

When it came time to consider the location of a 2-meter beam to pick up the Carolina DX Association repeater at a distance of approximately 50 miles, the closest tower was an 80-footer 120 feet from the operating position.

It has been my practice to bury coax cable from the house to the base of the antenna tower and run the coax up the tower. That practice was appropriate for low-frequency antennas in lengths of less than 200 feet. An alternative method would be to run a support line of steel cable between the house and the tower, securing the coax to the support line. Either way is acceptable; it's simply a matter of esthetics.

choosing the line

To run the coax underground and up the tower to the 50-foot level would require approximately 190 feet of transmission line. A suitable transmission line to produce an attenuation less than 2 dB for the total length would be one of the hard-line types.

Because of my successful experience with the four-

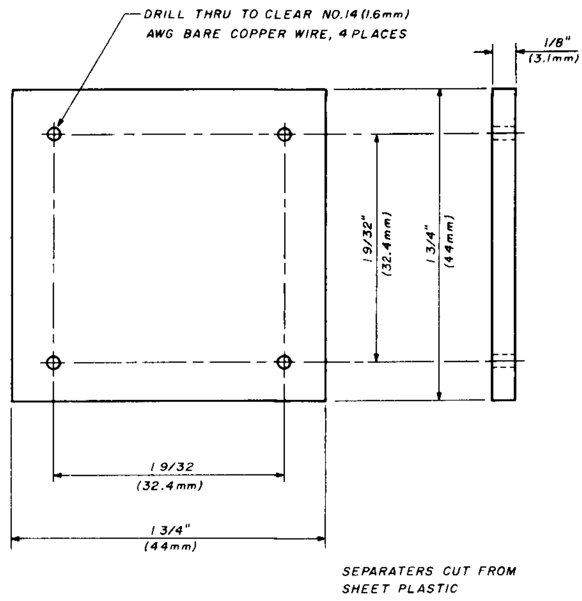


fig. 1. Dimensions of plastic spreaders for four-wire, 200-ohm transmission line.

By Henry G. Elwell, Jr., N4UH, Rt. 2, Box 20G, Cleveland, North Carolina 27013

Table 1. Attenuation as a function of transmission line length.

Cable Type	Impedance (ohms)	dB/100 ft (150 MHz)	Avg cost/100 ft (dollars)
RG213/U	50	2.3	30.00
RG8X	52	3.5	15.00
RG58/U	52	6.0	12.00
Aluminum (1/2 inch)	50	1.2	79.00
Heliax, (1/2 inch)	50	0.9	179.00
Heliax, (7/8-inch)	50	0.5	399.00
Four-conductor, open-wire	200	0.6	46.00

Notes:
1. Coax-type cables do not include connector cost.
2. The cost of the four-conductor open-wire line includes $36.00 for 400 feet of No. 14 copper wire plus an additional $10.00 for homemade spreaders and baluns.
3. The loss for the 200-ohm line is calculated from **eq 5** of reference 1.

wire, 200-ohm transmission line, I decided to use it for the straight-line, 120-foot run to the 2-meter antenna. Since I wanted as short a run as possible, the transmission line would be supported at the ends with no intervening support poles. That decision meant that the line would require good separation along its length as well as proper end supports.

building the line

Four 120-foot lengths of No. 14 copper wire were measured, and about a dozen square plastic spreaders made by W2IRC (**fig. 1**) were slipped on one end. That end was tied to a tree. The remaining spreaders were slipped on the other end, and the line pulled tight and secured. The spreaders were finally separated by a distance of 3 feet, with each hole encapsulated with silicone rubber to retain each spreader at its selected location. The transmission line was left undisturbed; after a few days, I found they were properly secured.

I used a special four-wire, 200-ohm terminating block, available from W2ER,* at each end. One was attached to the house and the other to the tower. Meanwhile, because commercial baluns for 145 MHz appeared to be unavailable, I made two 4:1 baluns. I decided small cores would be adequate for the amount of power to be used (25 watts maximum), so I wound Amidon iron-core type T94-12 cores as shown in **fig. 2** and soldered them to the cross-connected four-wire line at each end. Then I mounted a coax receptacle on the tower terminating block for ease of

*Marshall Etter, W2ER, 16 Fairlane Drive, East Quoque, New York 11942.

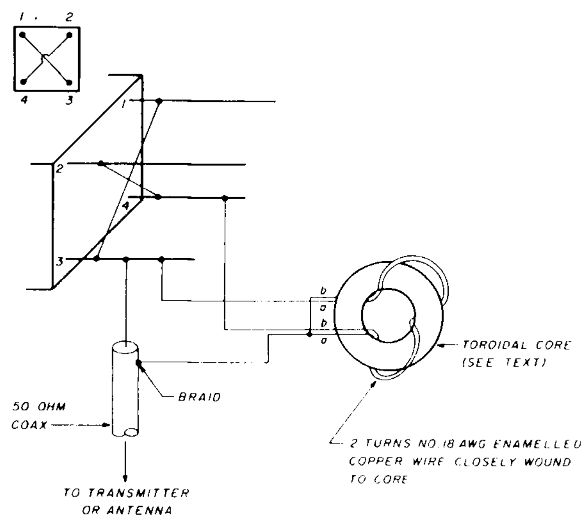


fig. 2. Connections of 50-ohm coax and 4:1 balun to four-wire 200-ohm transmission line, cross connected.

assembly and wrapped the baluns in tape for minimal weather protection.

final assembly

I connected one end of the transmission line under the eaves, then ran the line to the transmitter using a 15-foot piece of RG8/U coax. I connected the other end to the 80-foot tower at the 50-foot level, then added a noninductive, 50-ohm resistor across the coax connector at the tower. The VSWR of the line measured 1:1.

This whole exercise came about because of the prodding of N4ZC, who wanted me to be able to access the Carolina DX Association repeater located near the North Carolina/South Carolina border. His final exhortation included an offer to install the 10-element beam for me. With that kind of an offer, who could refuse?

N4ZC installed the beam at the 50-foot level, connected the 6-foot length of coax, and inquired whether the Carolina DX repeater could be accessed from the height. I raced into the house, raised the repeater, then ran outdoors again to report success!

Before this system was installed, I couldn't hear any signals at all from the Carolina DX Association repeater; now, operation over the less-than-ideal 50-mile path is satisfactory. And although the VSWR on the antenna system becomes very high during heavy rain storms, operation into other North Carolina repeaters has improved tremendously.

references

1. Henry G. Elwell, Jr., N4UH, "Long Transmission Lines for Optimum Antenna Location," *ham radio*, October, 1980.

ham radio

the weekender

the weekender: aural VCO provides relative metering

frequencies, however, conventional varicap diodes aren't effective. Instead, transistor Q5 and the 1000-ohm resistor form the variable element needed for controlling the frequency of our VCO by limiting the charging current flowing into the 0.15 μF timing capacitor according to the forward bias being applied to Q5.

As the voltage on pins 2 and 6 of U1 reach 2/3 Vcc (about 6 volts with a 9-volt supply) the timer will fire and pin 3 will be pulled low. Pin 7, an open collector output, goes low and begins to discharge the timing capacitor — through the 3.3-kilohm resistor. The discharge time provided by this resistor assures a reasonable, although asymmetrical, waveform for the aural

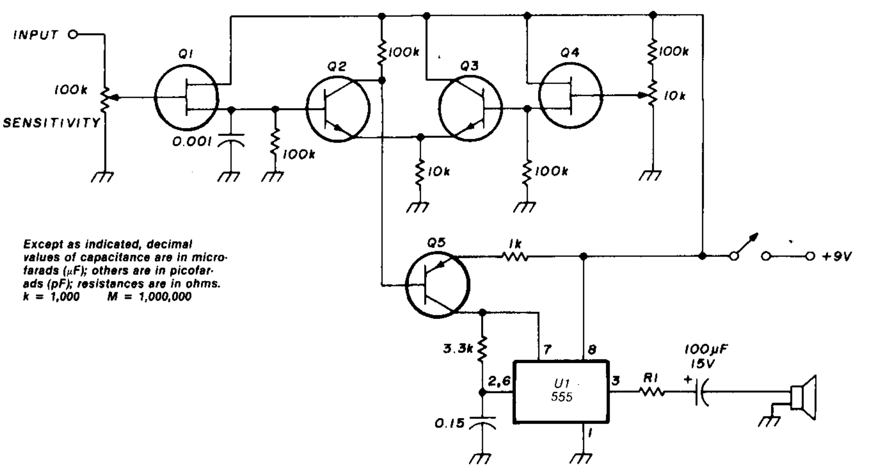


fig. 1. Aural VCO schematic parts values not shown are discussed in the text.

Being an avid 2-meter foxhunter, I'm always willing to try out any new gadget that might serve that end. This article describes a circuit, shared with me by Don Lewis, KF6GQ, for an RF sniffer which produces a tone that rises in frequency as the signal gets stronger. Ideas for a number of useful Amateur applications will be discussed.

how it works

Figure 1 shows the schematic for the aural VCO. The heart of the circuit is a 555 timer used as an RC audio oscillator. The frequency is determined by the RC values; increasing the value of resistance or capacitance lowers the frequency, while decreasing either has the opposite effect. In an HF VCO design, a varicap diode would be used as the variable element controlling the frequency of oscillation; at audible

By Peter J. Bertini, K1ZJH, 20 Patsun Road, Somers, Connecticut 06071

signal generated by U1. At 1/3 Vcc the internal flip-flop resets, the output on pin 3 goes high, the open collector output on pin 7 floats, and the timing cycle begins again.

Transistor Q5, a PNP device, is used in a common collector configuration. Forward bias occurs as the base is driven towards ground. Transistors Q1 and Q4 form a differential amplifier. The quiescent bias for Q5 is set by the 10-kilohm pot's setting the bias at one of the differential amp inputs. The input signal, applied to the remaining differential amp input, in turn controls the forward bias of Q5. As the input voltage rises, transistor Q5 is driven further into conduction, reducing the RC time constant and thus increasing the frequency of the tone.

adjusting and using the VCO

The tone level is set through the value of R1, the resistor in series with the pin 3 output of U1 and the speaker. Battery life will be greatly reduced if too small a resistor is used for R1. Depending on the audio level needed, 47 to 1000 ohms will serve here. The 555 can source or sink upwards of 200 mA and will easily drive speakers with 8 to 45 ohms impedance. With no input signal the zero-set pot is adjusted for the desired resting tone. A steady click-click-click (similar to the sound of a Geiger counter) marks the lowest frequency that should be set. At this point any signal applied to Q1 will proportionally increase the tone frequency.

construction

Because layout is not critical, perfboard with 0.1-inch centers may be used for component mounting; all of the parts are available "off-the-shelf" from your nearest electronics distributor or Radio Shack. A 2N2222, 2N3904, or similar small-signal NPN device may be used for Q2 and Q3. A 2N2907, 2N3906, or similar small-signal PNP transistor will serve for Q5. Q1 and Q4 are N-channel JFETs; an MPF102, 2N5485, 2N5486, or 2N5487 will work well, although the pinch-off voltage rating, if too low, may limit the range of the device. Feel free to use junkbox parts if they're available; the circuit is forgiving of part substitutions.

putting the VCO to work

Figure 2 shows the VCO being used as a sensitive 2-meter field strength meter. Combined with a hand-held DF antenna, the meter lets you leave your vehicle and find a hidden transmitter within easy walking distance.

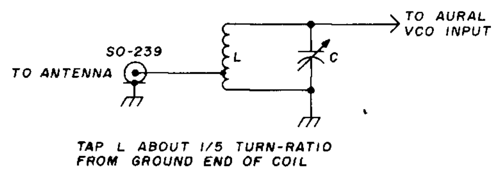


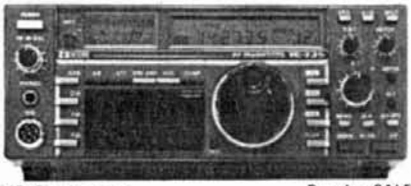
fig. 2. Using the aural VCO as an indicating device for a field-strength meter. The values for L and C should resonate at the frequency desired.

In a recent article I showed a simple external metering and attenuator for 2-meter FM transceivers.[1] Connecting this aural VCO to the signal-strength metering circuits allows you to orient your directional antenna without having to watch the S-meter — certainly a feature conducive to safe driving. Sightless or mobile HF operators might find that the aural VCO could replace the meter movement used for SWR bridges or relative output indication to facilitate antenna tuner or radio tuneup.

reference

1. Peter J. Bertini, K1ZJH, "The Foxbox: A Direction-Finding Tool," *ham radio*, October, 1985, page 25.

ham radio



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an IF sweep generator

Versatile unit tests and aligns LC, crystal and mechanical filters

How would you like to have a versatile piece of test gear that could be used to align LC, crystal, or mechanical filters as well as to provide fm discriminator alignment? The generator described in this article can be set to a center frequency of 455 kHz and frequency modulated at any desired deviation up to ± 40 kHz. The sweep rate of 25 Hz is suitable for checking filters such as the Murata CFS series and for fm discriminator alignment. A 2-Hz rate is used for checking narrow-bandwidth crystal and mechanical filters. Linearity of sweep is excellent. A crystal diode detector is built in. A dc-coupled scope and a frequency counter are needed for calibration and display.

circuit operation

Referring to the schematic (**fig. 1**), U1, Q1, Q2 and associated components make up the rate and ramp generator. U1 is connected in the conventional astable circuit, but with the addition of CR4 and CR5 silicon diodes.

Photo 1. BP1 is labeled IN. Connect to input filter under test. BP3 is labeled OUT. Connect to output of filter under test.

Positive going pulses about 5 microseconds long occur at the output, pin 3, at 40-millisecond intervals (fast rate) and at about 480-millisecond intervals (slow rate).

Assume that at turn-on, C1 is at zero voltage. Q2 is turned off and C9 in the 555 timer circuit is also at zero voltage. C1 begins to charge through constant current generator Q1. A linear voltage ramp appears at Q2 collector. When U1 times out, a short positive pulse is coupled to Q2 base through R3. It turns Q2 on, which rapidly discharges C1, and the cycle is repeated at the rate selected by S1. Ramp voltage is applied to the gate of Q3, which is used as an inverting buffer and for dc-level shifting. Q3 drain is directly connected to modulation input pin 5 of U2, an LM566 function generator. It is a voltage-controlled oscillator, which outputs approximately square waves at pin 3 (not used here) and more or less triangular waves at pin 4. The changing voltage at pin 5 frequency modulates the output at pin 4, which is applied to the unit under test. Output from that unit is detected and filtered by CR3 and associated components, and a dc voltage proportional to this output is supplied to the scope vertical amplifier at J3.

The scope horizontal amplifier is connected to J1. The ramp voltage sweeps the trace left to right and the detected output voltage deflects the trace vertically. Thus the display can trace out the passband of a filter or the characteristic S-curve of an fm demodulator.

component selection

Capacitors C1 and C2 should be tantalum. C4 is polystyrene; an NPO ceramic would probably serve as well.

R1 in the constant-current generator limits charging current to C1, and its value may need to be changed to allow C1 to be charged to about 4 volts during the 40--millisecond period of the 25-Hz sweep rate. When in the 2-Hz mode, C1 will charge to about 8.5 volts. Neither value of voltage is critical.

Q2 must be a fast-switching type, capable of handling the high peak current that flows when C1 is discharged. Its duty cycle is very low. The 2N2222A used here has

By Bob Griffith, W2ZUC, 476 Keenan Avenue, Fort Myers, Florida 33907

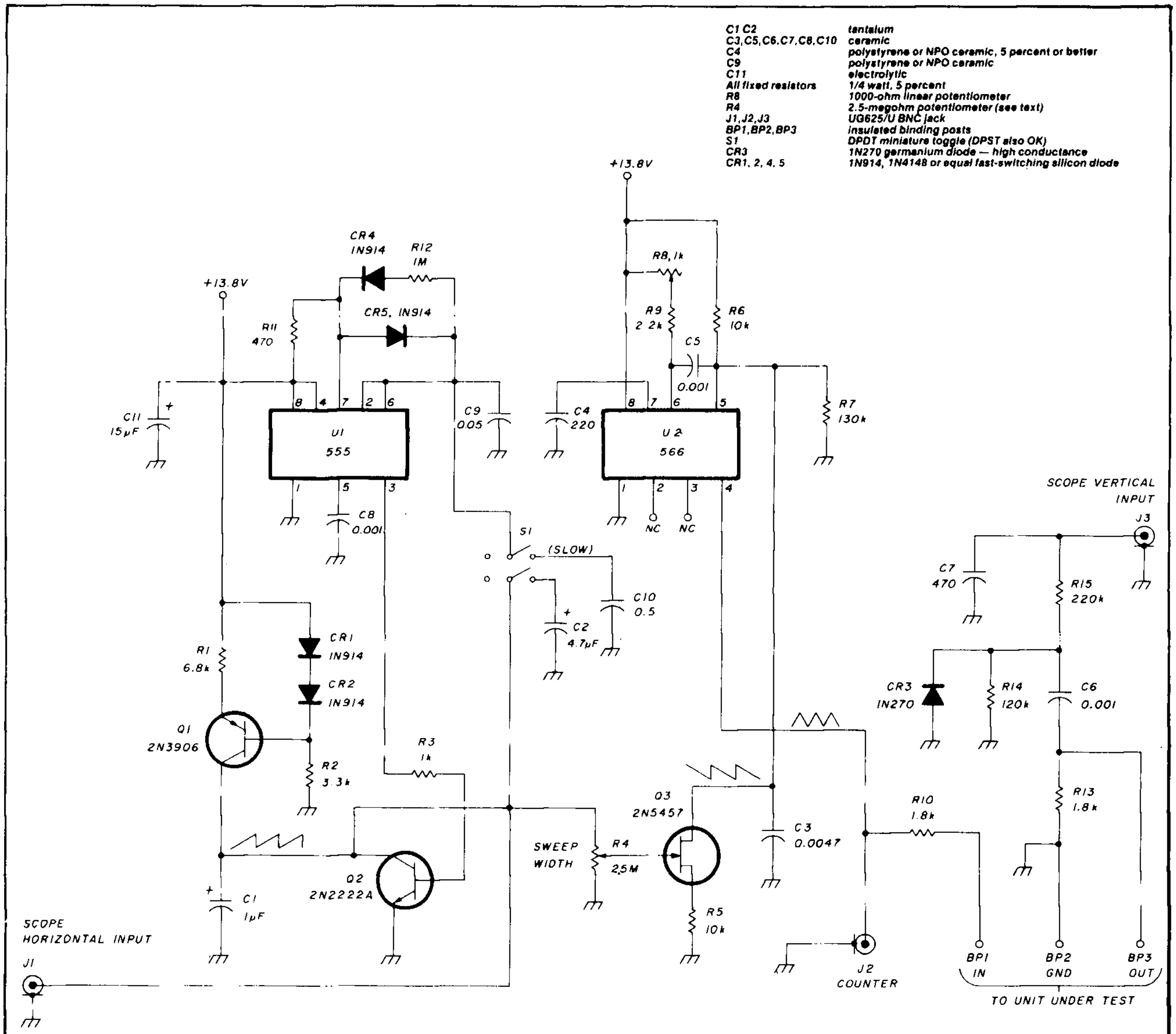

fig. 1. Schematic for the sweep generator.

survived many hours of operation. R3, the 1-kilohm resistor in series with Q2 base, is near the maximum value that allows the collector to be driven close to ground.

It's possible that U1 may fail to output the desired 5-microsecond pulse. If so, increase R11 to 1-kilohm, which will lengthen the pulse but won't upset operation.

Sweep width control R4 is a 2.5-megohm potentiometer. It may be replaced by a 1-megohm potentiometer in series with a 1-megohm fixed resistor to Q2 collector. The full ramp voltage isn't needed (or usable) at the gate of Q3.

Q3 is a readily available JFET. However, the spread in characteristics is broad, and it may be necessary to try more than one in this circuit. The selection can be made by setting up the test circuit of **fig. 2.** Pick a transistor that draws enough current to make the drain voltage approximately 12.0 volts and source voltage about 0.8

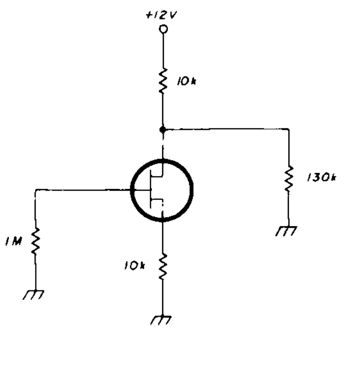

fig. 2. Circuit for testing the 2N5457 inverting buffer.

volts. The value of the 130-kilohm resistor can be varied ±20 percent if necessary.

U2 center frequency is determined by R8, R9, and C4. R9 is near the recommended 2-kilohm lower limit for the 566. When the sweep is zero, the output frequency can be varied from 350 kHz to 486 kHz. The upper frequency limit of the chip is 1 MHz, but any lower range can be obtained by increasing the values of R and C in the timing circuit.

The inverted ramp voltage supplied to U2, pin 5 from Q3 drain causes the VCO frequency change. Sensitivity is high; from a resting voltage of 12.0 volts, a drop of 0.1 volts to 11.9 volts increases the frequency about 22 kHz. Thus the output frequency at pin 4 increases during the ramp cycle, and the display is from left to right for increasing frequency.

Resting voltage at U2 pin 5 should be close to 12.0 volts for a 13.8-volt supply to obtain best linearity of sweep frequency. Total current drawn is 48 mA. An on-card 12-volt regulator can be used. If so, adjust the value of R7 to bias pin 5 at 10.5 volts. Closely regulated voltage isn't necessary, but it must be well filtered. The ramp generator and U2 are sensitive to hum voltages. For that reason, an external power supply is used.

construction

All the components except width control R4, center frequency control R8, S1 with C2 and C10, and the binding posts and jacks are on a single-sided board measuring 1.5 by 5 inches. I don't have a layout for it; I make lines and pads using dental burrs in a a high-speed grinder. Perf board should be acceptable.

The controls, switch, three binding posts, and three UG-625/U BNC jacks are mounted on an aluminum panel measuring 3.5 by 6 inches. The board is held to the panel by two small angle brackets. A short two-conductor cable with a two-contact male connector passes through a hole in the phenolic box, which measures 3.8 by 6.3 by 2 inches. No high frequencies are involved, but there are some high-impedance points and good insulation is needed.

initial checkout

Connect a counter to J2 and connect the scope DC vertical input to J1. Turn sweep width control R4 fully counter-clockwise and set center frequency control R8 fully clockwise. Set S1 to fast and apply well-filtered 13.8 volts to the power connector. The frequency should be about 486 kHz. Turn the center frequency control fully counter-clockwise. The frequency should be about 350 kHz. If the upper frequency is below about 475 kHz, you can shunt R9 with a fixed resistor from 22 kilohms upward, or try a slightly smaller value of capacitor at C4. The upper limit isn't critical, but it must be high enough to allow setting of the frequency at the upper point of a filter under test, which will be explained later.

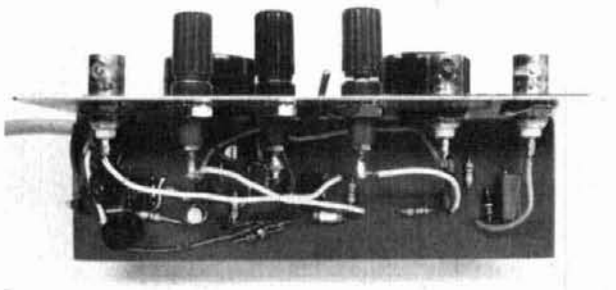

Photo 2. Bottom view of circuit board. The 555 timer is at left. Q2 and Q1 are next to the right. Q3 is near the front of the board between BP1 and BP2. The 566 is near the center of the board. Detector and associated components are at the right end.

Check the ramp voltage. It should be a very linear sawtooth having a period of approximately 40 milliseconds and a peak amplitude of about 4 volts. If no signal is here, check Q1 for short or open circuit and check Q2 base for a positive-going pulse. If it's missing, check the 555 timer. Set S1 to slow. The sawtooth amplitude should be about 8.5 volts and the period near 480 milliseconds.

This procedure assumes that you have a scope with a calibrated sweep. If not, the counter should work on the 25-Hz rate, and the 2-Hz rate can be estimated by visual check against a sweep second hand. Neither rate is really critical. If you don't intend to check very narrow filters, the slow rate and switch can be eliminated.

Disconnect the counter and connect the scope probe to J2. Turn the sweep width control to about 10 o'clock. Triangular waves about 3 volts peak-to-peak above a 5-volt DC level should appear. Successive waves should appear to move left and right at the repetition rate of the ramp voltage. If little or no movement can be seen, check for a signal at the gate of Q3 and at its drain. If there's a normal signal at the gate but no inverted signal at the drain, check the dc bias at the drain and at pin 5 of the 566.

Connect a jumper from BP1 to BP3 (binding posts). Connect the scope dc horizontal input to J1 and vertical input to J3. Turn the sweep width control to minimum. Vary the center frequency control through its range and observe the trace on the scope face. It should be a straight line at 400 to 500 millivolts above ground. Turn up the width control. Output at J3 should not change except near maximum sweep.

calibration and use

Connect the input of the filter to be tested to BP1, ground to BP2, and the output of the filter to BP3. Set the center frequency and width controls to obtain a display that looks like an inverted U. Check both sweep rates. If there's a noticeable difference in the trace shape, use the slower rate. Increase the sweep width and note

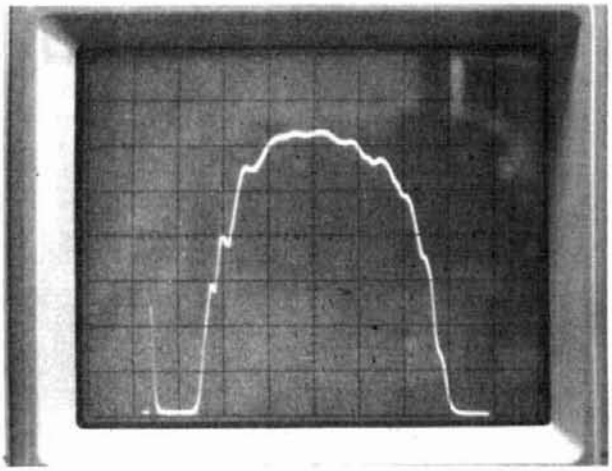

Photo 3. Scope display of passband of Murata CFS455E filter. Each horizontal division is 0.5 volts. Each vertical division is 50 mV. Sweep rate is 25 Hz. The 6dB points are at 446 and 466 kHz. The pip at left of trace is not a spurious response of the filter. It is display of retrace during the negative going portion of the ramp voltage, since there is no blanking during that interval.

that the trace moves to the left. This is normal. Restore to center by adjustment of the center frequency control.

Reconnect the counter to J2. Position the trace so that a point near the middle of the passband is at some easily noted height — for example, six divisions above the zero-volt baseline. Reduce the sweep to zero and adjust the center frequency control for six divisions in height of the now-straight horizontal line. Read the frequency from the counter. This is the frequency for approximately the center of the filter. Now readjust the center frequency control for three divisions in height at both low and high-frequency ends of the passband. Read the counter again. These frequencies are at the 6-dB points for that filter. Symmetry and ripple within the passband are easily seen on the display.

It's impossible to determine the 60-dB points accurately on a filter passband using the simple diode detector in this unit. An idea of the skirt selectivity and presence of nearby spurs can be obtained by reducing scope attenuation to a minimum. Alternatively, you might disconnect the detector circuit and measure the output voltage of the filter with a well-calibrated RF millivoltmeter.

For narrow passband ceramic or crystal filters, follow the manufacturers' recommendations for input and output terminations. The values may be quite different from the 1.8 kilohm series and shunt resistors I chose. (Mine were close to the 1.5-to-2 kilohm terminations specified for the Murata CFS series filters that are commonly used in 2-meter fm receivers and in VHF marine radios.) Mechanical filters usually require shunt C at both input and output to resonate the coupling coils within them. You may wish to remove R13 from the board and use it or other values externally between BP2 and BP3.

For the home brewer of multipole crystal filters, this generator should make it much easier to trim to the desired center frequency and minimize ripple.

For discriminator alignment, input a signal through a capacitor of 1000 pF to a point in the receiver ahead of the discriminator but following any 455-kHz filter. Use a 1-kilohm potentiometer for level adjustment and check with a scope to see that sufficient signal is injected to cause limiting before the discriminator. Set the center frequency and sweep width as required to obtain a trace of the S-curve and adjust the primary and secondary for best linearity. The desired center frequency should be halfway between those at the ends. If a very narrow (for fm) filter such as the CFS-F is used in the receiver, you may wish to remove the filter and determine its actual passband and center the discriminator to match.

You can also determine the curve for the ceramic discriminator now used in many 2-meter transceivers. These are fixed and no adjustment is provided. They appear to be inferior to a good Foster-Seeley discriminator with respect to linearity, although they are undeniably smaller and probably less expensive.

ham radio

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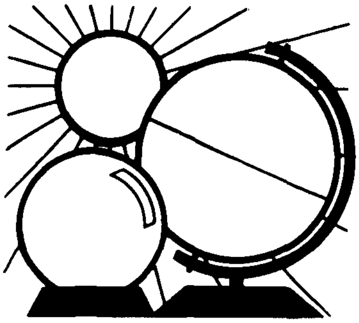


DX FORECASTER

Garth Stonehocker, KØRYW

DX propagation

When you're working DX, you can usually expect that the conditions that optimize your transmitted signal will do the same for your receiving capability. There are exceptions to this rule, of course — during ionospheric tilt conditions, for example.*

For the strongest signals, it's best to use the highest frequency band (i.e., near the maximum usable frequency, or MUF) the ionosphere will support for the path in the direction of interest (see chart). Doing so reduces the number of hops required through the signal-absorbing D-region to the distant station and results in a stronger, more readable signal with less distortion and variation.

To be able to use the maximum hop length (the lowest number of hops) the take-off angle (TOA) of the signal from the antenna must be about 10 degrees. The longest paths in the chart are to Australia (from Eastern USA), South Africa (from mid-USA), and Antarctica (western USA). All of these paths' hop lengths are between 1711 and 2456 miles, with TOAs within a range of from 3 to 9 degrees and 2 to 5 hops.

Because the MUFs and TOAs exhibit diurnal, seasonal, and solar variations (sunspot/solar flux numbers), a new chart is published each month. MUFs for specific locations can be found by using programs like MINIMUF 3.5[1] and modified versions that consider other path parameters such as bearings, distances and TOA, as discussed in previous columns.[2,3]

*(We like to think of the D, E and F region as concentric layers, but this is not always the case—Ed.)

The italicized numbers in the chart refer to MUFs during the night and predawn hours, which may be problem times. At these times, particularly near sunrise, the ionosphere develops a tilt that causes rapid changes in frequency and height, affecting east-west paths every day. Bands come in or go out at these sunrise and sunset times on the path, and DX openings are often unusually good, if brief.

To be continued next month . . .

last-minute forecast

Because of the increased probability of solar activity, the middle of January is expected to be the best time for openings on 10 through 30 meters. Good transequatorial openings in the evenings can be expected to continue through the third week of the month, when an unstable geomagnetic field is anticipated. The lower frequency bands, open mainly during the night, should be at peak performance during the first week of the month. The last week will also be very good, except for a greater probability of lower-level signals being affected by winter anomolous absorption after the 15th.[4] However, because January is the month in which atmospheric noise is lowest and the geomagnetic field is least disturbed, operation should be *outstanding*.

band-by-band summary

Ten, twelve, fifteen, and twenty meters will be open to most areas of the world from morning to early evening almost every day. Openings on the higher of these bands will be shorter and will occur closer to local noon. Transequatorial propagation on these bands will more likely occur toward evening during conditions of highest solar flux and disturbed geomagnetic field conditions.

Thirty and forty meters will be useful almost 24 hours a day. Daytime conditions will resemble those on 20 meters. Skip distances and signal strength may decrease during midday on days that coincide with the higher solar flux values. Nightime DX will be good except after days of high MUF conditions and during geomagnetic disturbances. Look for DX from unusual places on east, north, and west paths during this time. The usable distance is expected to be somewhat less than 20 in daytime and greater than on 80 at night.

Eighty and one-sixty meters will exhibit short-skip propagation during daylight hours and lengthen for DX at dusk. These bands follow the darkness regions, opening to the east just before local sunset, swinging more to the south near midnight, and ending up in the Pacific areas during the hour or so before dawn. The 160-meter band opens later and closer earlier than 80.

references

1. Robert B. Rose, K6GKU, "A Simplified MUF-Prediction Program For Microcomputers," *QST*, December, 1982, page 36.
2. Garth Stonehocker, K0RYW, "Antenna-to-Ionospheric Path Match," DX Forecaster, *ham radio*, October, 1986, page 92.
3. Garth Stonehocker, K0RYW, "Ionosphere Matching," DX Forecaster, *ham radio*, January 1985, page 92.
4. Garth Stonehocker, K0RYW, "More On Winter Anomalous Absorption," DX Forecaster, *ham radio*, December, 1986, page 101.

ham radio

JANUARY

WESTERN USA

GMT	PST	N (Asia, Far East)	NE (Europe)	E (S. Africa)	SE (S. America)	S (Antarctica)	SW (New Zealand)	W (Oceania, Australia)	NW (Japan)
0000	4:00	_40_	40	20	12	12	10	12	20
0100	5:00	30	40	20	15	12	10	10	20
0200	6:00	30	_40_	20	20	12	12	12	20
0300	7:00	40	_40_	30*	20	15	15	15	30
0400	8:00	40	_40_	_30_	20	20	20	20	30
0500	9:00	40	_40_	_30_	20	20	20	20	40
0600	10:00	40	_40_	_30_	30*	20	20	20	40
0700	11:00	40	_40_	_30_	_30_	20	20	30	40
0800	12:00	40	_40_	_30_	_30_	20	_30_	30	40
0900	1:00	40	_40_	_30_	_30_	_30_*	_30_	_30_	40
1000	2:00	_40_	_40_	_30_	_30_	_30_	_30_	_30_	_40_
1100	3:00	_40_	_40_	_30_	_30_	_30_	_30_	_30_	_40_
1200	4:00	_40_	_40_	_30_	_30_	_30_	_30_	_30_	_40_
1300	5:00	_40_	_40_	20	20	_30_	_30_	_30_	_40_
1400	6:00	_40_	30	12	12	_30_	_30_	_30_	_40_
1500	7:00	_40_	20	12	12	20	20	_30_	_40_
1600	8:00	40	20	10	10	15	30	20	_40_
1700	9:00	40	20	10	10	15	20	20	_40_
1800	10:00	40	30	10	10	15	15	20	_40_
1900	11:00	_40_	40	10	10	12	15	20	_40_
2000	12:00	_40_	40	12	10	12	12	20*	30
2100	1:00	_40_	40	12	10	12	12*	15	20
2200	2:00	_40_	40	15	10	12	10	12	20
2300	3:00	_40_	40	20	10	12	10	12	20

MID USA

MST	N (Asia, Far East)	NE (Europe)	E (S. Africa)	SE (S. America)	S (Antarctica)	SW (New Zealand)	W (Oceania, Australia)	NW (Japan)	CST
5:00	_40_	40	20	15	12	10	12	20	6:00
6:00	30	40	30	20	15	12	12	30	7:00
7:00	30	_40_	30	20	15	15	12	30	8:00
8:00	40	_40_	_30_	20	20	20	12	40	9:00
9:00	40	_40_	_30_	20	20	20	15	40	10:00
10:00	40	_40_	_30_	20	30	20	20	40	11:00
11:00	40	_80_	_30_	_30_	30	20	20	40	12:00
12:00	_40_	_80_	_30_	_30_	_30_	30	20	40	1:00
1:00	_40_	_80_	_30_	_30_	_30_	_30_	_30_	40	2:00
2:00	_40_	_80_	_30_	_30_	_30_	_30_	_30_	_40_	3:00
3:00	_40_	_40_	_30_	_30_	_30_	_30_	_30_	_40_	4:00
4:00	_40_	_40_	20	_30_	_30_	_30_	_30_	_40_	5:00
5:00	_40_	40	15	20	_30_	_30_	_30_	_40_	6:00
6:00	40	30	12	15	_30_	_30_	_30_	_40_	7:00
7:00	40	20	10	12	20	20	_30_	_40_	8:00
8:00	40	20	10	12	20	20	20	40	9:00
9:00	40	20	10	10	15	20	20	40	10:00
10:00	40	20	10	10	15	20	20	_40_	11:00
11:00	40	20	10	10	12	15	20	_40_	12:00
12:00	_40_	30	10	10	12	15	20	_40_	1:00
1:00	_40_	40	10	10	12	12	15	_40_	2:00
2:00	_40_	40	12	10	12	12	15	30	3:00
3:00	_40_	40	15	10	12	10	12	30	4:00
4:00	_40_	40	15	12	12	10	12	20	5:00

EASTERN USA

EST	N (Asia, Far East)	NE (Europe)	E (S. Africa)	SE (Caribbean, S. America)	S (Antarctica)	SW (New Zealand)	W (Oceania, Australia)	NW (Japan)
7:00	_40_	40	20	20	15	12	15	40
8:00	_40_	40	30	20	20	20	20	40
9:00	40	_40_	_30_	20	20	20	20	40
10:00	40	_80_*	_30_	20	20	20	20	40
11:00	40	_80_*	_30_	20	20	30	30	40
12:00	_40_	_80_	_30_	_30_	20	30	30	40
1:00	_40_	_80_	_30_	_30_	_30_*	_30_	_30_	40
2:00	_40_	_80_	_30_	_30_	_30_	_30_	_30_	_40_
3:00	_40_	_80_	_30_	_30_	_30_	_30_	_30_	_40_
4:00	_40_	_80_	_30_	_30_	_30_	_30_	_30_	_40_
5:00	_40_	40	20	_30_	_30_	_30_	_30_	_40_
6:00	40	30	12	20	_30_	_30_	_30_	_40_
7:00	30	20	10	15	_30_	_30_	_30_	_40_
8:00	40	20	10	12	20	20	20*	40
9:00	40	20	10	12	20	20	20	40
10:00	40	20	10	12*	15	20	20	40
11:00	40	20	10	10	15	20	20	_40_
12:00	40	20	10	10	12	20	30	_40_
1:00	40	20	10	10	12	15	20	_40_
2:00	40	30	10	10	12	12	20	_40_
3:00	_40_	40	12	10	12	12	15	_40_
4:00	_40_	40	12	10	12	12	15	30
5:00	_40_	40	20	12	12	10	12	20
6:00	_40_	40	20	15	12	12	12	30

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

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

product REVIEW

Heath SA-2550 remote antenna matcher

Heathkit has always been known for being the "haven" for gadgeteers — I'm one of them, and I've always been intrigued by their various offerings.

Their latest Ham gadget is the new Remote Antenna Matcher, the SA-2550 (see **fig. 1**). Simple in design but elegant in use, this remotely tuned 40-500 pF variable capacitor can be continuously varied from the comfort of your hamshack.

The control unit is a power supply and dc rectifier with a switch that allows you to turn the capacitor either clockwise or counter-clockwise by reversing the polarity of the voltage it sends to the matching unit motor. The motor-driven capacitor moves slowly enough so that it's hard to miss the lowest point of SWR, but not so slowly that you have to wait forever for it to make its rounds. The control voltage can be sent to the remote unit either through the antenna feedline or through two control wires.

Heath designed the Remote Matcher to be compatible with their Remote Antenna Switch (see the product review on page 124 of the May, 1986 issue). If you want to use the two units together, you'll have to control the remote matcher through the two external wires because of a dc-blocking capacitor in the HA-1481; in most Amateur installations, this will be no more than a minor inconvenience. Owners of other brands of remote switches will have to check their schematics to see what configuration their units use. If you use external cable to control your remote switch, you'll be able to use the feedline to control the SA-2550. If the remote switch uses the feedline for control, you'll need to use two external wires.

construction

Heath should get an award for their construction manuals. My hat's off to their technical writers. While this isn't a particularly difficult kit to build, the clear, concise style of writing makes building *very* easy.

As per any kit, I highly recommend you read the manual at least twice before you even open one parts envelope. Then, I suggest you take a complete parts inventory to make sure that nothing is missing. Try stealing a muffin pan from the kitchen and use it to sort and organize all the parts. This is especially helpful with all the hardware: screws, nuts, bolts, and washers. A few extra minutes in organization will save plenty of time later on.

Construction is straightforward and really progresses quite quickly. You start with the control unit/power supply (about an hour's work) and then move on to the matcher unit chassis. Here's where it gets a bit interesting; building the capacitor proved to be a slight stumbling block for me. It wasn't the instructions or anything other than my own sloppiness. Putting all the plates of the stator and rotor together went fine, but I had my problems in getting the proper alignment between the plates. I spent a little time carefully adjusting the four alignment nuts and had the capacitor positioned exactly where it was supposed to be. (If the plates aren't properly spaced and aligned, the voltage rating will decrease and the capacitance won't be within specifications. The unit won't perform as it should and could arc over under full-power applications.)

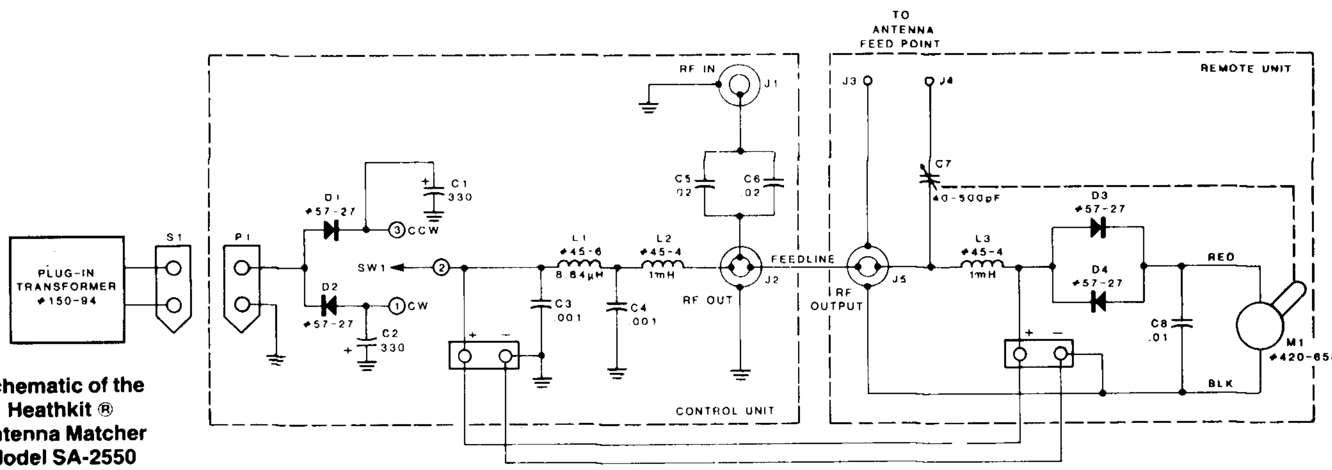
After the capacitor was set aside, completion of the project took just about an hour more. My total time into the project was about three hours, with another ten minutes to run some resistance and voltage checks and to run the operational "smoke" test. When it was all hooked up, everything worked as expected.

Though I was impressed with the motor that Heath supplies to turn the capacitor, I was a little concerned that I hadn't left enough slack in the capacitor's rotor and that the motor would have trouble turning the capacitor. Not to worry: my guess is that the motor could probably be used to turn the Empire State Building! There's plenty of torque, with some to spare. The motor gear drive lube is specified for operation over −40 to +60 degrees.

installation

The remote matcher is designed to be mounted at the antenna feedpoint. If you're designing a dipole, the remote matcher can be used in place of a center insulator. It's too heavy, however, to be used without support and should either be mounted on the side of a tower or suspended from a catenary wire.

Here's a typical installation you might use with the remote matcher. Cut an antenna to the middle of the 80-meter band. By formula, each leg of the dipole will be approximately 64.3 feet. (Heath recommends that you add an additional 15 percent — in this case, 9.6 feet — to the length of each leg.) Each leg of the dipole becomes 73.9 feet long. Installation proceeds as with any other dipole, except in that the remote matcher takes the place of the center insulator. When the antenna is installed, the capacitor is



Schematic of the Heathkit ® Antenna Matcher Model SA-2550

NOTES
1. ALL CAPACITOR VALUES ARE IN uF (MICROFARADS) UNLESS MARKED IN pF (PICOFARADS)
2. ⏚ INDICATES A CHASSIS GROUND

fig. 1. Heathkit antenna matcher (SA2550).

used to tune out the reactive inductance of one leg of the antenna as you move away from the design frequency. This allows the transmitter to see close to a 50-ohm impedance over a wider portion of the band. This "magic" is accomplished by varying the capacitor over its tuning range and adjusting for minimum SWR.

Heath includes instructions on using the remote matcher with inverted Vs and bottom-fed verticals of both single and multi-band designs.

tuning and adjustment

Simply hook the remote unit up according to Heath's instructions and you're ready to go. If you have a linear amplifier, don't use it during tuning of *any* antenna; you could damage both the remote matcher and the amplifier.

Key the transmitter in CW on the bottom of the band you want to use and turn the remote capacitor until you have a minimum SWR reading. It's a good idea to tune up the whole band and make yourself an SWR chart to refer to so that you'll know approximately what SWR you're looking for as the antenna nears resonance.

Quoting from Heath's instruction manual: *when the antenna is properly tuned at the low end of the band, with the Antenna Matcher adjusted for minimum SWR, the Variable capacitor should be between 2/3 and 3/4 meshed. You do not want a situation where the capacitor is either fully closed or fully open. If the capacitor is fully closed when tuned for the low end of the band, the antenna is too long. On the other hand, if the capacitor is fully open at the high end of the band, the antenna is too short.*

other applications

With the addition of a tapped coil and relays, you can use the Remote Matcher as a multi-band tuner. Consider the application discussed by Jack Belrose, VE2CV, in a *ham radio* article ("The Half-Delta Loop") in May, 1982. In a follow-up article written with Doug DeMaw and published in *QST* (September, 1982), the idea was further pursued, with actual on-the-air testing. The antenna was fed with a remotely tuned LC network (with variable C and tapped L — see **fig. 2**). The problem in replicating this antenna was locating a suitable remotely tuned capacitor. The SA-2550 seems to be designed with this project in mind.

Using a tuning network with the same configuration, you can tune a variety of different antennas for full- and multi-band performance. Folded uni-poles, base-fed verticals, Bob-tail Curtains, and loops of all kinds are just a few of the examples of antennas that can be used with this remotely controlled capacitor.

While not inexpensive ($149.95), the Heath SA-2550 represents a great value for anyone who's looking for a way of remotely tuning antennas. I had fun with this project and look forward to trying out all my antenna ideas before too much snow flies. See you on the bands!

Circle #301 on Reader Service Card.

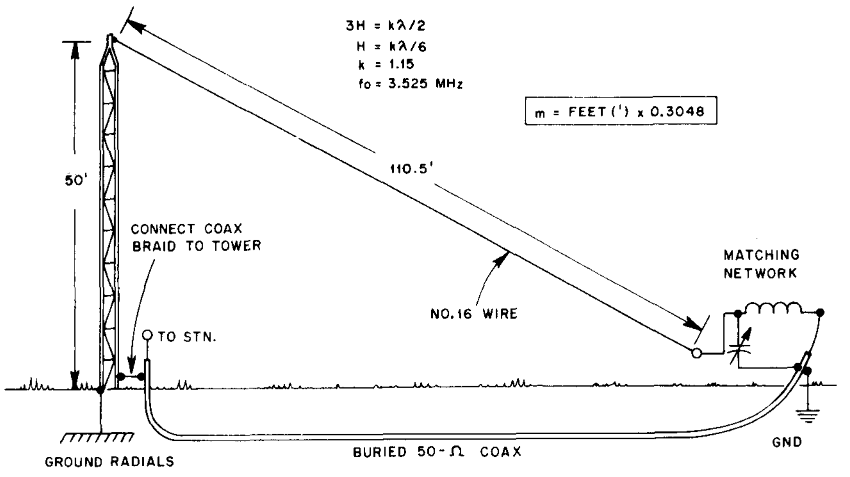


fig. 2A. The half-delta loop. (Reprinted with permission from QST, September, 1982, page 31.)

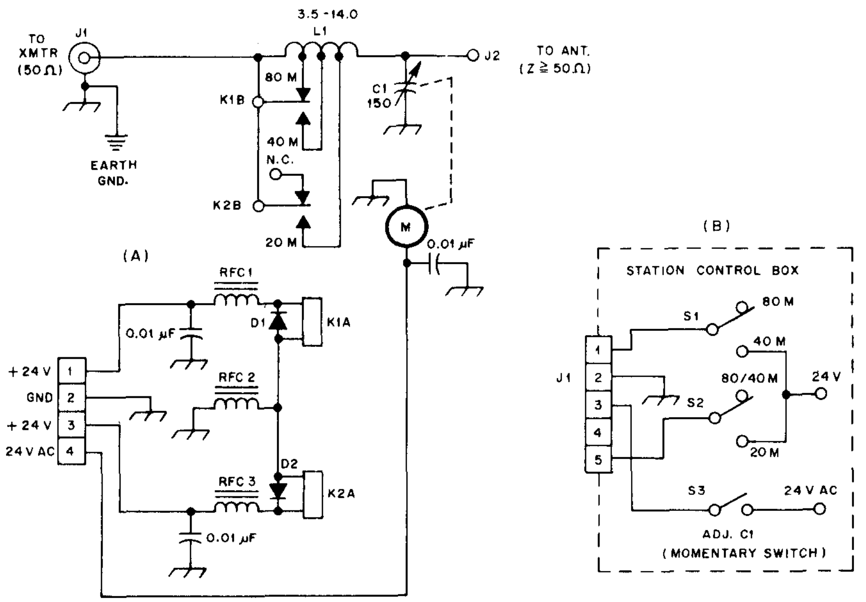


fig. 2B. Three-band L-network matches half-delta loop to 50-ohm cable. (Reprinted with permission from QST, September, 1982, page 31.)

NEW products

packet repeater controllers

Pac-Comm has announced the release of its new DR-series of packet repeater controllers. The DR-200 dual-port controller provides an inexpensive, off-the-shelf packet switch to move traffic on inter-LAN networks. The DR-100 provides basic, single-port controller capability in a ruggedized package at low cost, and is well suited to applications in which a single-frequency repeater is appropriate.

Both units share the same digital design, which provides a Z80 CPU with up to 32k bytes of EPROM program storage and up to 32k bytes of RAM for buffering, configuration parameters, and other functions. Packet HDLC operations are handled by a Z8530 Serial Communications Controller.

The DR-200 has two independent 300/1200 baud modems using the AMD 7910 World Chip™ modem. Each modem channel also has a standard disconnect header for accessory modems. Both channels have PTT line time-out-

NEW products

timers and the CPU has a watchdog timer. Both models support two methods for communication with external terminals.

Several versions of dual-port software adapted to the DR-200 are available through Pac-Comm. The "Dual-Port Digipeater" program written by Jon Bloom, KE3Z, uses an easily-implemented routing algorithm based on default SSID's and an explicit routing table. The single- or dual-port version of the "AX.25 Level 3 Packet Switch" program by Howie Goldstein, N2WX, is available for both the DR-100 and DR-200. The other single-port program is an adaptation of Pac-Comm's Version 1.1.3 that provides standard AX.25 Level 2, Version 2 digipeater support. All software has been enhanced to utilize the optional serial ports for setting site-specific parameters. Any one of these programs may be selected with the purchase of a Pac-Comm digital controller and will be provided at no charge; additional copies are available for the cost of reproduction and documentation.

At presstime, the DR-100 Single-Port was priced at $79.95 (kit) and $99 (assembled). The DR-200 Dual-Port was priced at $139.95 (kit) and $159.95 (assembled); final prices may be subject to variation because of changes in the semiconductor market.

For complete details, contact Pac-Comm Packet Radio Systems, Inc., 3652 West Cypress Street, Tampa, Florida 33607.

Circle #302 on Reader Service Card.

ICOM IC-03AT 220-MHz handheld

ICOM has announced the release of the IC-03AT, a new 220-MHz counterpart to its IC-02AT and IC-04AT top-of-the-line handhelds.

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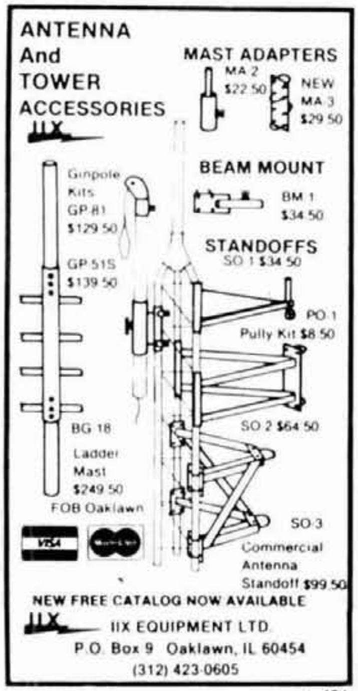

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WANTED: Tube HiFi Equipment, loudspeakers, magazines. Anything relating to 1950's HiFi. Jack Smith, 288 Winter Street, N. Andover, MA 01845.

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RF POWER METER .01-12.4 GHz Narda 8440 $95. Heath Grid Dip meter $15. Comco remote base, outside cabinet, perfect for repeater $75. K6KZT, 2255 Alexander, Los Osos, CA 93402.

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FOR SALE: Heathkit SB-104 $200. SB-604 w/ps $75, SB-644 vfo $45, SB-634 console $45, HW-2036A 2m $100, Kenwood R-1000 $130, Conar 2m $30. All equipment in good condition. NV0R, 1205 North Main, O'Fallon, MO 63366.

10 WATT HF linear amplifier kit. For info SASE to: A & A Engineering, 2521 W. LaPalma Ave, #K, Anaheim, CA 92801. (714) 952-2114.

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FOR SALE: Hy-Gain #389 Antenna, Tri-Ex W-51 Tower. A. Galvan, 4808 Bergenline Avenue, Union City, NJ 07087. (201) 864-4881.

FOR SALE: Collins Equipment: KWM-2 and 30L1 1 KW. Complete with power supply. 110V and 220V. SM-2 Fix sta. Dynamic Mic. (voice control carrier). Collins Speaker equip. for phone patch. Quad Ant. 80-40-20-10 meters. Carrying cases. Samsonite for KWM-2 and 30L-1 Amp. Complete with instructions by Collins. Complete with instructions by US Gvt. (FRC 93, TM-11-5820-554). Mobile Mount: MP-1 (new not used). Mobile pwr sup. 35-D2 (new not used). Mobile Dynamic Mic. MM-1 (new not used). The equipment above in excellent condition. Will sell complete for $1,000.00. Contact William J. Maida, 274 W. Sabal Palm Pl, Longwood, FL 32779 or phone 305-869-6138.

HOMEBREW PROJECTS. List SASE. PO Box 708, East Hampton, NY 11937.

DRAKE TR-7, power supply, SB filter, N.B., desk mic., mint, complete with manuals. $850.00 plus UPS. K5MEC, 4 Sombrero Lane, St. Rose, LA 70087.

UHF PARTS. GaAs Fets, MMICs, trimmers, chip caps, teflon pcb, and other builder parts. SASE brings list. Microwave Components, 11216 Cape Cod, Taylor, MI 48180.

SIGNAL ONE, CX7-B, w/spare final, maintenance manual. $850.00 plus UPS. K5MEC, 4 Sombrero Lane, St. Rose, LA 70087.

LASERS: Illustrated how-to manual on Ham Radio use of Lasers. 112 bound pages of practical information, plans, schematics, photos, sources of inexpensive parts. $13.95 ppd. S. Noll, 1288 Winford, Ventura, CA 93004.

APPLE II^s/c/e Morse Code Program menus, 18 modes, lesson plans, graphics, word processor, 1-100 wpm, etc. Write LARESCO, PO Box 2018, 1200 Ring Rd, Calumet City, IL 60409. (312) 891-3279.

SPECIAL ANTENNAS by K3RPW featuring the RIW 19-432 MHz beam, 14.9 dBd for $69.95 and the K1FO 22-el. 14 ft. 432 MHz beam, 15.8 dBd for $76.64. SASE for information. Thomas H. Rutland, 1703 Warren St, New Cumberland, PA 17070.

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MARCO: Medical Amateur Radio Council, Ltd. operates daily and Sunday nets. Medically oriented Amateurs (physicians, dentists, veterinarians, nurses, physiotherapists, lab technicians, etc.) invited to join. Presently over 550 members. For information write MARCO, Box 73's, Acme, PA 15610.

IBM-PC RTTY/CW. New CompRtty II is the complete RTTY/CW program for IBM PC's and compatibles. Now with larger buffers, better support for packet units, pictures, much more. Virtually any speed ASCII, BAUDOT, CW. Text entry via built-in screen editor! Adjustable split screen display. Instant mode/speed change. Hardcopy, diskcopy, break-in buffer, select calling, text file transfer, customizable full screen logging, 24 programmable 1000 character messages. Ideal for MARS and traffic handling. Requires 256k PC or AT compatible, serial port, RS-232C TU. $65. Send call letters (including MARS) with order. David A. Rice, KC2HO, 25 Village View Bluff, Ballston Lake, NY 12019.

ELECTRONIC ENCLOSURES: Attractive, reasonably priced. Aluminum top and sides. Walnut stained solid wood ends. Variety of sizes and custom sizes available. Sample $5.00. Information free. Energy Engineering, Custom Division, Rt. 4, Box 330, Fayetteville, AR 72701.

NATIONAL RADIO EQUIPMENT manual list or NCL-2000 parts kits. SASE. Maximilian Fuchs, 11 Plymouth Lane, Swampscott, MA 01907.

RTTY JOURNAL—Now in our 34th year. Join the circle of RTTY friends from all over the world. Year's subscription to RTTY JOURNAL, $10.00, foreign $15.00. Send to: RTTY JOURNAL, 9085 La Casita Ave., Fountain Valley, CA 92708.

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RUBBER STAMPS: 3 lines $4.50 PPD. Send check or MO to G.L. Pierce, 5521 Birkdale Way, San Diego, CA 92117. SASE brings information.

ELECTRON TUBES: Receiving, transmitting, microwave . . . all types available. Large stock. Next day delivery, most cases. Daily Electronics, PO Box 5029, Compton, CA 90224. (213) 774-1255.

CUSTOM MADE EMBROIDERED PATCHES. Any size, shape, colors. Five patch minimum. Free sample, prices and ordering information. Hein Specialties, Inc., Dept 301, 4202 N. Drake, Chicago, IL 60618.

RECONDITIONED TEST EQUIPMENT $1.25 for catalog. Walter, 2697 Nickel, San Pablo, CA 94806.

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WANTED: Heath ET-100. Call 913-898-4695. Mike W0XM.

MORSE CODE Practice program for IBM PC and Compatibles. Send $19.95 check to SP Microcomputing Co., 1008 Swallow Drive, Cherry Hill, NJ 08003. Developed by KD2SM.

COMING EVENTS

Activities — "Places to go . . ."

PENNSYLVANIA: JANUARY 18: Amateur Radio Brunch. The Chaverim of Delaware Valley will hold their 7th annual brunch, Parktowne Place Apartment Complex, 2200 Benjamin Franklin Parkway, Philadelphia at 10 AM. Everyone invited. Contact Bill Soble, W3OXT, (215) 676-6769 or write to 9357 Hoff Street, Philadelphia, PA 19115. Reservations are necessary.

SOUTH BEND, INDIANA: Hamfest Swap & Shop, January 4, 1987, first Sunday after New Year's Day. Century Center downtown on US 33 Oneway North between St. Joseph Bank Bldg and river. Four lane highways to door from all directions. Tables: $5-5 ft. Round, $10-8x2.5 Rectangular, $2-ft. wall locations. Talk in freq. 52/52, 99/39, 93/33, 69/09, 145.29. K9IXU (219) 233-5307.

OPERATING EVENTS

"Things to do . . ."

January 20: Mission Trail Net will celebrate its 50th anniversary. MTN meets on 3928 kHz every night at 7 PM Pacific time. President Harry Edwards, N6ESU, has invited all old time Mission Trail Net members to visit MTN during the month of January to say Hi to old friends.

Feb 1-2: YL-ISSB QSO Parties. CW 0001Z to 2359Z. Phone 0001Z March 21 to 2359Z March 22. Open to all. 3.5 - General Class portions of bands. Exchange call, report, QTH, name, ISSB number and partner or teammate. Certificates to category, country, state winners. For information: Bill Early, WA9AEA, PO Box 401, McHenry, IL 60050-0401, USA.

NEW products

The IC-03AT features 220-224.995-MHz coverage, an LCD readout, DTMF, 2.5-W output (5W optional), ten memories, memory scan, program scan, and 32 built-in subaudible tones. It comes with an IC-BP3 rechargeable battery pack, AC wall charger, belt clip, wrist strap, and earphone.

For information, contact ICOM America, Inc., 2380 116th Avenue N.E., Bellevue, Washington 98009-9029.

Circle #303 on Reader Service Card.

1.3-GHz shirt-pocket frequency counter

OPTOelectronics, Inc. has introduced the model 1300H frequency counter. With an anodized aluminum cabinet measuring only 3-1/2 x 4 x 1 inches, the new unit includes self-contained, rechargeable Ni-Cad batteries, a signal measurement range of 1 MHz to over 1.3 GHz, 8 red 0.28-inch high LED digits, and a BNC signal input connector. Switches are provided for AC or battery operation, fast or slow gate time, high or normal sensitivity and range select: 1-500 MHz or 500-1300 MHz. Resolution to 1 kHz in 0.25 seconds or 100 Hz in 2.5 seconds over the entire range. Accuracy to ±1 count LSD is achieved with an RTXO time base. Additional features include a "measurement in progress" indicator, calibration adjustment without the need to open the case, and excellent sensitivity.

Priced at $150, the 1300H comes equipped with internally installed Ni-Cad batteries and a 110 VAC/9 VDC adapter for AC operation and charging batteries. Optional accessories include a carrying case, probe and telescoping antenna.

For details, contact OPTOelectronics, 5821 NE 14th Avenue, Fort Lauderdale, Florida 33334.

Circle #304 on Reader Service Card.

C-band/Ku-band receiver

Luxor North America Corporation has introduced the 9993 C/Ku Receiver, a new mid-line block satellite receiver. Decoder-compatible, it's designed to give optimum performance on both C-band and Ku-band.

It has a crisp, bright green front panel LED for display of all basic functions, built-in remote antenna control with three-digit display and a digital signal strength meter.

The 9993 is easily operated by a hand-held, 35-key, full-function, remote control. A three-digit code for lock-out of undesirable channels is controlled via the remote unit. Built-in remote polarity control offers convenience; non-volatile memory is unaffected by power loss.

Video features include functional compatibility with most popular signal decoders, and an optimal TI (terrestrial interference) filter operable by remote control. Built-in AFC maintains optimum signal reception on each channel; fine-tuning can be executed from the remote. The 9993 also has outputs for both tv set and monitor.

Audio features include monaural, discrete, and matrix stereo formats, a three-digit display to indicate tunable audio frequencies, wide and narrow bandwidth switchability, and volume control and muting from the hand-held remote.

For details, contact Luxor North America Corporation, 600 108th Avenue N.E., Suite 539, Bellevue, Washington 98004.

Circle #305 on Reader Service Card.

plug-in CTCSS for handhelds

Communications Specialists, of Orange, California, is currently expanding their line of programmable CTCSS tone equipment that will plug directly in to many popular two-way radios. Two recent additions to this line — adapter kits for the Standard Communications and TAD USA handhelds — utilize the new TS-32HB hybrid-sized encoder-decoder. The Standard 734L/834L may now use a TS-32HBL (low profile) encoder-decoder and a 01-1030 adapter plug. The TS32HBL is priced at $64.95 and the 01-1030 adapter is $7.50.

The TAD M1520-454 uses the TS32HBH (high profile) encoder-decoder and 01-1031 adapter plug. The TS32HB used in these applications employs the popular DIP switch programmability first introduced in 1979 with the company's larger TS-32. The TS32HB uses state-of-the-art hybrid packaging to obtain its small size. A crystal-controlled clock oscillator provides stability under all conditions, and sensitivity is rated at 6mv RMS for use with the lowest output receivers. The adjustable sinewave output is accurate to within ±0.5 Hz at a level of 6 volts peak-to-peak across 10k.

For details, contact Communications Specialists, Inc., 426 West Taft Avenue, Orange, California 92665-4296.

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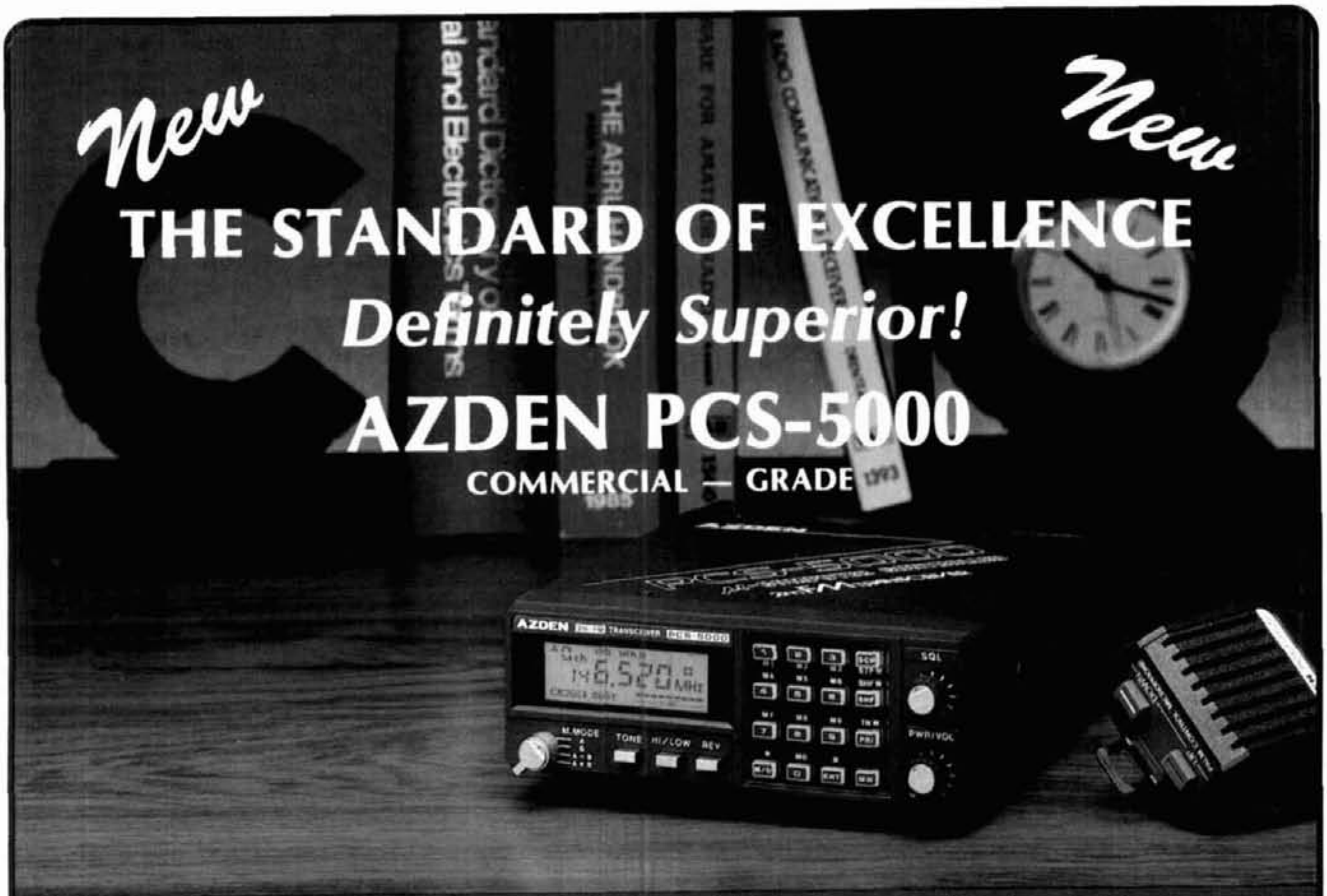

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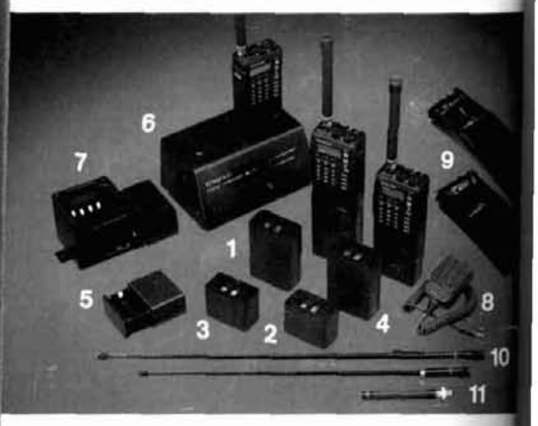

Optional Accessories:

1) PB-1 12 V 800 mAh NiCd batt. pack (5 W output) **2)** PB-2 8.4 V 500 mAh NiCd batt. pack (2.5 W output) **3)** *PB-3 7.2 V 800 mAh NiCd batt. pack* (1.5 W output). **4)** PB-4 7.2 V 1600 mAh NiCd batt. pack (1.5 W output) **5)** BT-5 AA manganese/alkaline battery case. **6)** *BC-7 Rapid charger for PB-1, 2, 3, or 4.* **7)** BC-8 Battery charger for PB-1, 3 or 4. **8)** SMC-30 Speaker microphone. **9)** SC-12, SC-13 Soft cases. **10)** *RA-3, RA-5 Telescoping antennas.* **11)** RA-8B StubbyDuk antenna • TSU-3 CTCSS encode/decode unit • VB-2530 2 m, 25 W RF power booster • *LH-4, LH-5 Leather cases* • MB-4 Mobile bracket • BH-5 Swivel mount • PG-2V DC cable • PG-3C Filtered cigar lighter cord.

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