MARCH 1981 / $2.50

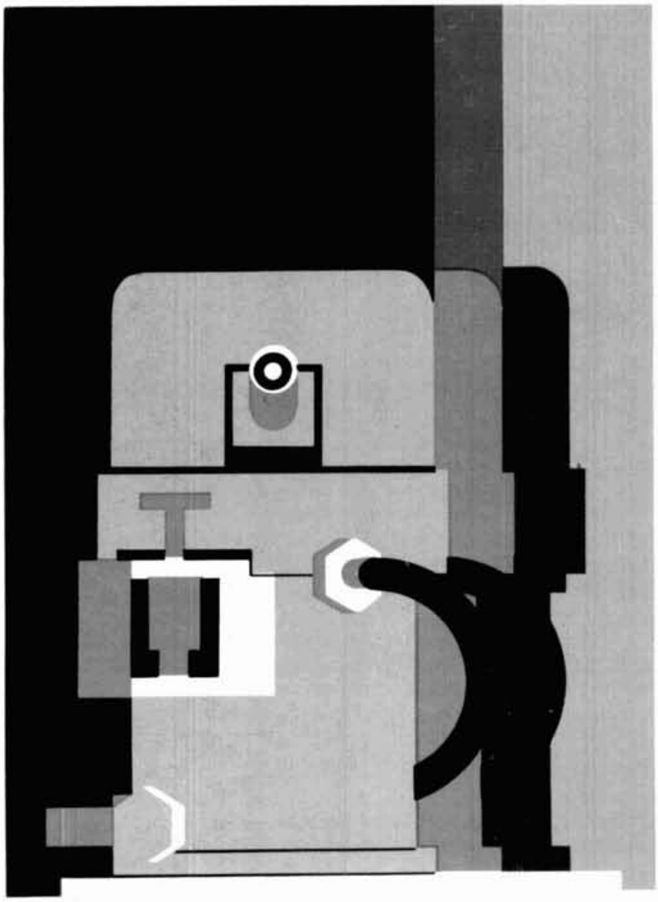
ham radio magazine

incorporating HAM RADIO HORIZONS

hr

fo: s

nunications
ıology



converting surplus AN/UPX-6 cavities

2K *Classic*

A new edition of the world's most famous linear amplifier

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

Features:

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

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

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

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

Announcing!

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

53 YEARS OF SERVICE

Please note, as of Dec. 1, 1980 we will occupy our new world headquarters building with a new Los Angeles address and phone number

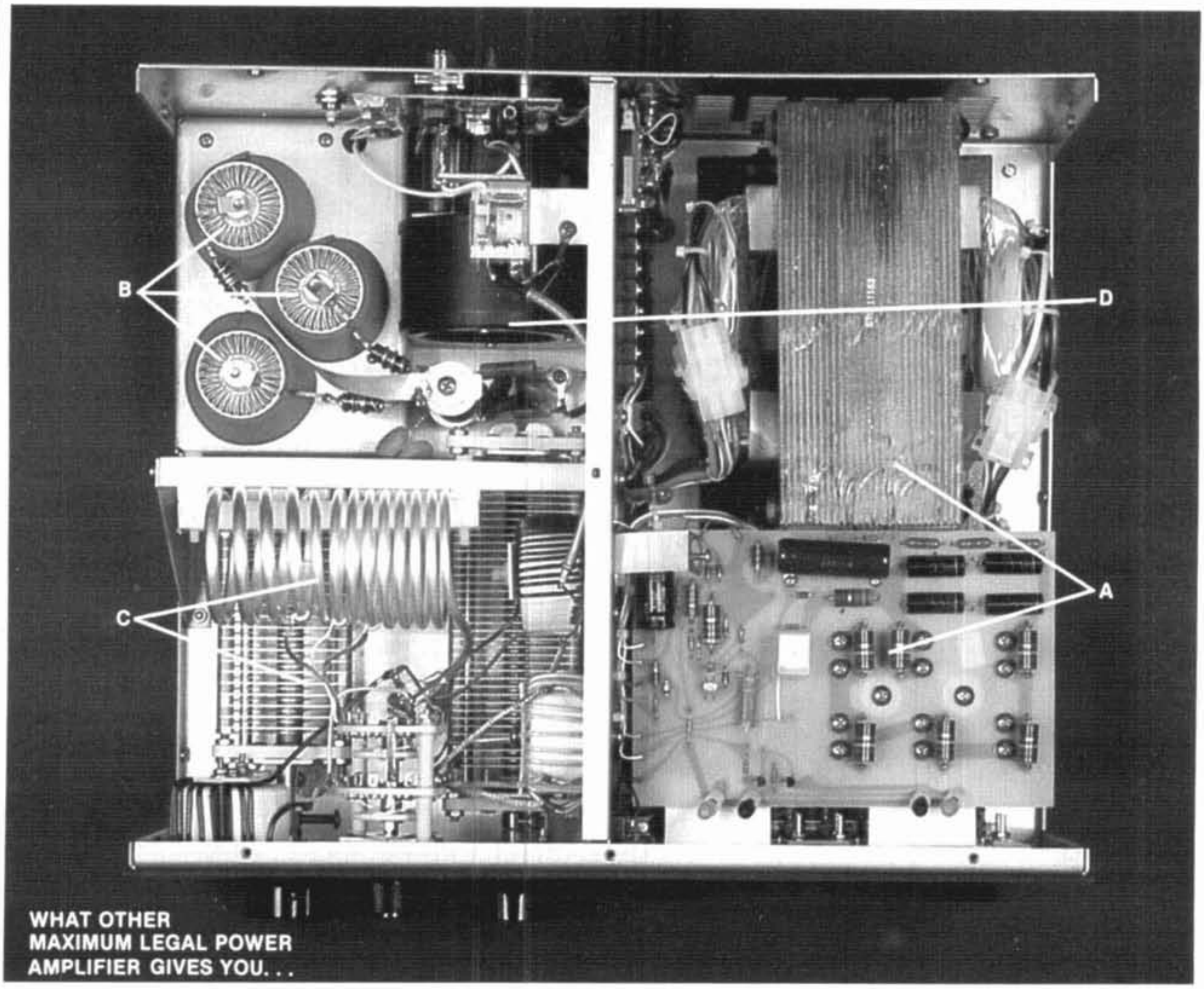
2050 S. Bundy Dr., Los Angeles, CA 90025 (213) 820-1234
931 N. Euclid, Anaheim, CA 92801 (714) 772-9200
Butler, Missouri 64730 (816) 679-3127

TOLL FREE ORDER NUMBER: (800) 421-6631
For all states except California.
Calif. residents please call collect on our regular numbers.

Henry Radio

Prices subject to change without notice

It couldn't be anything but...



(A) A FULL KW CCS POWER SUPPLY WITH A 45 POUND, 1.5 KVA TRANSFORMER that plugs in for easy handling. . .

(B) TOUGH EIMAC CERAMIC TRIODES, THOROUGHLY COOLED by ETO's exclusive full-cabinet ducted air system. . .

(C) HEAVY SILVER PLATED TUBING COIL IN A FULL PI-L NETWORK that extends to 160 meters and provides 10-15 dB better harmonic suppression than the pi networks commonly used. . .

(D) CENTRIFUGAL BLOWER FLOATING ON A FOAM RUBBER "SANDWICH" that absorbs noise and vibration, permitting whisper quiet operation. . .

AND WHO ELSE BUT ETO rates linears for "a full kilowatt key-down forever?"

(ALPHA 76 PA SHOWN)

Alpha!

NOBODY BUT ETO, so far as we know, provides amplifier warranty coverage beyond a scant 90 days. We'd be embarrassed to offer you a 90 day warranty! That's scarcely long enough to become really familiar with your new linear.

EVERY NEW ***ALPHA*** CARRIES A TWO YEAR (limited) FACTORY WARRANTY-just one factor that makes ***ALPHA*** such a sensible investment. Most ***ALPHA*** s command resale prices close to what they sold for new five or even ten years earlier!

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

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

ETO

ham radio

magazine

incorporating

HAM RADIO HORIZONS

MARCH 1981

volume 14, number 3

ham radio magazine
is published monthly by
Communications Technology, Inc
Greenville, New Hampshire 03048
Telephone: 603-878-1441

subscription rates

United States: one year, $15.00
two years, $26.00; three years, $35.00

Canada and other countries (via Surface Mail)
one year, $18.00; two years, $32.00
three years, $44.00

Europe, Japan, Africa (via Air
Forwarding Service) one year, $28.00

All subscription orders payable in
United States funds, please

foreign subscription agents

Foreign subscription agents are
listed on page 89

Microfilm copies
are available from
University Microfilms, International
Ann Arbor, Michigan 48106
Order publication number 3076

Cassette tapes of selected articles
from *ham radio* are available to the
blind and physically handicapped
from Recorded Periodicals
919 Walnut Street, 8th Floor
Philadelphia, Pennsylvania 19107

Second-class postage
paid at Greenville, N.H. 03048
and at additional mailing offices
ISSN 0148-5989

**Postmaster send Form 3579 to *ham radio*
Greenville, New Hampshire 03048**

contents

Observation & Opinion

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

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

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

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

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

caution

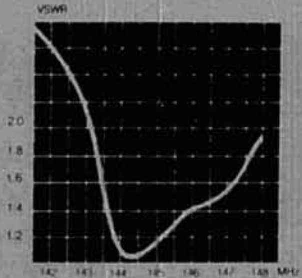
I'd like to direct your attention to a letter in this month's "Comments" column taking us to task for a potential safety hazard in the modular amplifier article that appeared in the January issue on page 12. It's a point very well taken, and I'd recommend that anyone planning to build this circuit take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

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

Alf Wilson, W6NIF
Editor

Boomer

6 and 2 meter High Performance Yagis



Two Meter Boomers

Whether you have the space for the 3.2 λ 32-19 or the compact 2.2 λ models, two meter Boomers are your best choice. They offer the maximum gain available for their boom length (See NBS no. 688). They feature trigon reflectors for additional front-to-back ratio and clearer patterns. All stainless steel hardware and heavy gauge heat treated aluminum are used throughout. Whatever your choice of two meter amateur activity, the Boomer will fill your needs. For FM use the 228FB or 214FB. For CW/SSB on the low end use 32-19 or 214B, in EME, DX or just reliable QSOs Boomer will perform for you.

Six Meter Boomer

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

Specifications

Model No.	32-19	214B	214FB	228FB	617-6B
Frequency range (MHz)	144-146	144-146	144.5-148	144.5-148	50.0-51
Forward gain (dBd)	16.2	15.2	15.2	18.2	14
Front to back ratio (dB)	24	24	24	24	30
E-plane B/width (deg)	2x14	2x17	2x17	2x17	2x19
H-plane B/width (deg)	2x17	2x18	2x18	2x9	NA
Side lobe antenuation (dB)	>60	>60	>60	>60	>60
SWR less than (typ)	1.2:1	1.2:1	1.2:1	1.2:1	1.2:1
Impedance (ohm)	50	50	50	50	50
Recommended stacking distance E-plane (ft)	14	10	10	10	NA
E-plane (m)	4.27	3.05	3.05	3.05	NA
H-plane (ft)	12	10	10	10	22.5
H-plane (m)	3.66	3.05	3.05	3.05	6.86
Weight (lbs)	12	8	8	22	26
(kg)	5.44	3.63	3.63	9.98	11.79
Length (ft)	22	15	15	15	34
(m)	6.71	4.57	4.57	4.57	10.36
Longest element (in)	40 3/8	40 7/16	39 1/2	39 1/2	113 3/4
(cm)	102.5	102	100.3	100.3	289
Turning radius (ft)	11	7.5	7.5	9.5	17.7
(m)	3.35	2.29	2.29	2.90	5.39
Windload (sq ft)	3.5	1.7	1.7	4.0	4.8
(sq m)	.33	.16	.16	.37	.45

Stacking Kits

For stacking two Boomers, use the following coax harness and power divider kits.

32-19 = 32-SK   214B = 22-SK   617-6B = 617-SK

When stacking four Boomers, use the following complete stacking kits. They include H frame, harness, hardware and complete instructions.

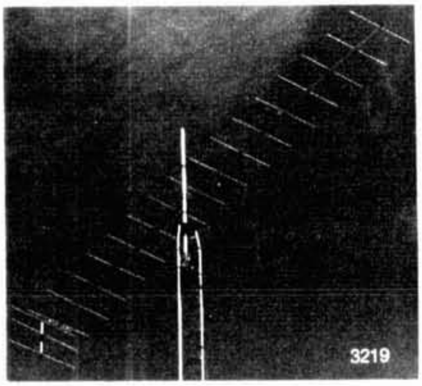
32-19 = 324-QK   214B = 224-QK

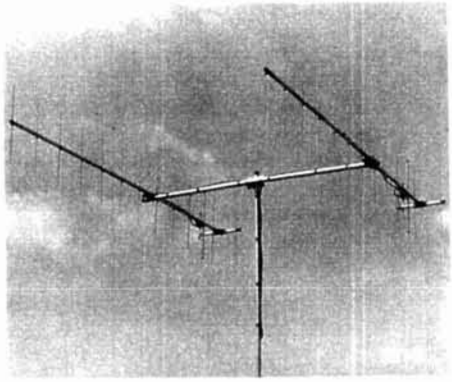
Specifications, Stacked Boomers

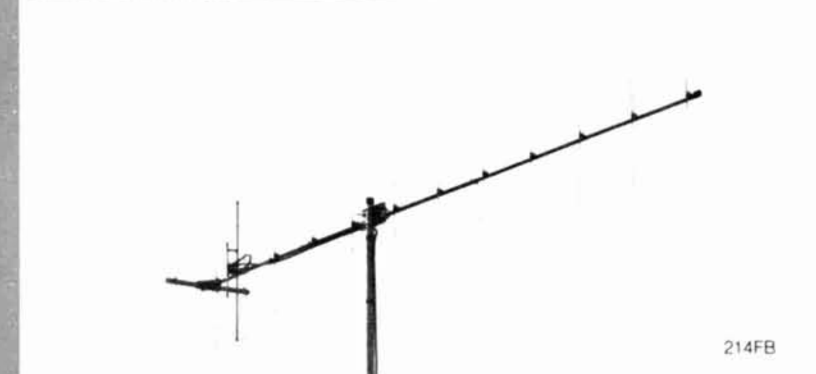
Antenna	2x214-B	2x32-19	2x617-6B	4x214-B	4x32-19
Forward gain (dBd)	17.8	18.8	16.6	20.2	21.2
Front to back ratio (dB)	24	24	30	24	24
E/H plane beamwidth (deg) E-plane	34°	28°	35°	17°	12°
H-plane	19°	17°	20°	19°	15°
Stacking dist. Vert. (ft)	10	12	34	10	12
(m)	3.05	3.66	10.36	3.05	3.66
Horiz. (ft)	—	—	—	10	14
(m)	—	—	—	3.05	4.27
Wt approx (lb)	18*	26*	62*	69	97
(kg)	8.16	11.79	28.12	31.30	44.00
Turn radius (ft)	9	11	18	9	13'4"
(m)	2.74	3.35	5.49	2.74	4.06
Wind Area (Ft2)	3.4*	7.0*	9.6*	8.3	15.2
(sq m)	.32	.65	.89	.77	1.41

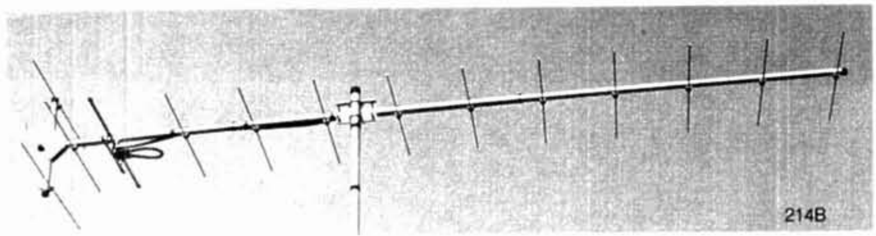
(2) 1 + 2.6dB (4) 1 + 2.6 + 2.4 *Support mast not included

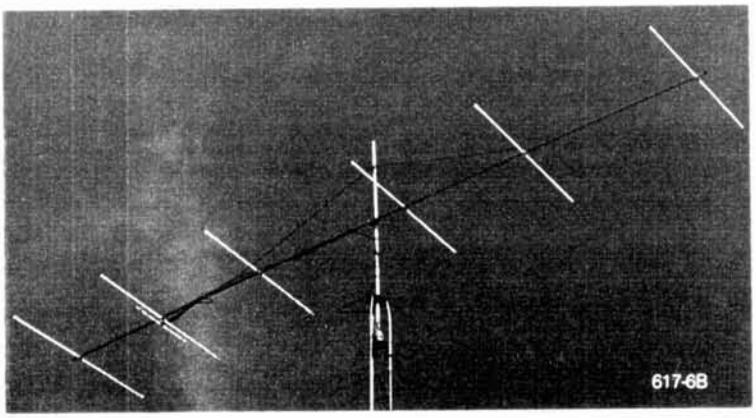
The nominal dimensions and weights listed are for complete arrays. The antennas and stacking kits must be ordered separately.


3219




214FB


214B


617-6B

cushcraft CORPORATION

The Antenna Company

48 Perimeter Road, P.O. Box 4680
Manchester, NH 03108

Tell 'em you saw it in HAM RADIO!

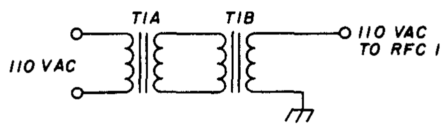
comments

safety hazard

Dear HR:

The otherwise excellent design of the modular linear amplifier by K8RA in the January, 1981, issue contains a potential safety hazard. In **fig. 3**, the amplifier control circuit, the two transformers are shown with one side of their primary windings connected to ground. If these primaries ever become disconnected from ground or were not properly soldered to the chassis, the entire chassis would be floating at 110 volts ac above ground. I sure wouldn't want to be touching the chassis if that ever happened.

Dave Karpiej, K1THP
Plainville, Connecticut



T1A, T1B 5V, 15A STANCOR P6433 OR EQUIV.

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

Dear HR:

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

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

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

Dear HR:

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

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

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

Thurman Smithey, N6QX
Chula Vista, California

Dear HR:

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

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

Donald C. Mead, K4DE
Greensboro, North Carolina

presstop

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

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

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

ARRL'S DXCC ETHICS RULE, Rule 12, has been strengthened considerably in a move directed primarily at DX stations who have allegedly been demanding payment before providing confirmation of a contact. The rules change comes as two additions to Rule 12, the first addition stating, "Credit for contacts with individuals who have displayed continued poor operating ethics may be disallowed by action of the ARRL Awards Committee," and the second including "confirmation procedures" as "operating ethics."

Impetus For The New Rule tightening had come from the ARRL's DX Advisory Committee, which in turn had been under ongoing pressure from many DXers over the practices of "buying" QSLs. The issue had come to a head following a well-known Israeli Amateur's insistence that only QSLs accompanied by a dollar bill would be acknowledged for his recent operations from various rare Pacific locations. The specifics of the change have been worked out and approved unanimously by the League's Awards Committee, and circulated to the DXAC.

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

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

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

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

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

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

MFJ Super Keyboard

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

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

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

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

HUMAN ENGINEERED

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

For example, you press only a one or two key sequence to execute any command.

All controls and keys are positioned logically and labeled clearly for instant recognition.

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

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

PROGRAMMABLE, AUTOMATIC MESSAGES

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

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

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

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

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

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

TEXT BUFFER

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

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

You can preload a message into the buffer. Then when you are ready to transmit press the control key.

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

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

Simply backspace to delete errors.

RTTY: BAUDOT, ASCII

5 level Baudot is transmitted at 60 WPM. RTTY and CW ID are provided via message A.

Carriage return, line feed, and "LTRS" are sent automatically on the first space after 63 characters on a line. After 70 characters the function is initiated without a space. This gives unbroken words at the receiving end and frees you from sending the carriage return.

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

The buffer, programmable and automatic messages, backspace delete and PTT control (keys your rig) are included.

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

MORSE CODE PRACTICE

There are two Morse code practice modes. Mode 1: random length groups of random characters. Mode 2: pseudo random 5 character groups in 8 separate repeatable list. With answer list.

Insert space between characters and groups to form high speed characters at slower speed for easy character recognition.

Select alphabetic only or alphanumeric plus punctuation. Pause function lets you stop and then resume.

IT'S A KEYER, TOO

Plug in a paddle to use it as a deluxe full feature keyer with automatic and programmable memories, iambic operation, dot-dash memories, and all the features of the CW mode.

MORE FEATURES

Tune switch with LED keys transmitter for tuning. Tune key provides continuous dots to save finals. Built-in sidetone and speaker.

PTT (push-to-talk) output keys transmitter for Baudot and ASCII modes.

Reliable solid state keying for CW: grid block, cathode, solid state transmitters (-300 V, 10 ma. Max, +300 V, 100 ma. Max). TTL and open collector outputs for RTTY and ASCII.

Fully shielded. RF proof. All aluminum cabinet. Black bottom, eggshell white top. 12"D x 7"W x 1¼"H (front) x 3½"H (back).

9-12 VDC or 110 VAC with optional adapter.

OPTIONS

MFJ-53 AFSK PLUG-IN MODULE. 170 and 850 Hz shift. Output plugs into mic or phone patch jack for FSK with SSB rigs and AFSK with FM or AM rigs. $39.95 (+$3).

MFJ-54 LOOP KEYING PLUG-IN MODULE. 300 V, 60 ma. loop keying circuit drives your RTTY printer. Opto-isolated. TTL input for your computer to drive your printer. $29.95 (+$3).

BENCHER IAMBIC PADDLE. $42.95 (+$4).

110 VAC ADAPTER. $7.95 (+$3).

A PERSONAL TEST

Give the MFJ-494 Super Keyboard a personal test right in your own ham shack.

Order one from MFJ and try it — no obligation. See how easy it is to operate and how much more enjoyable CW and RTTY can be. If not delighted, return it within 30 days for refund (less shipping). One year unconditional guarantee.

To order, call toll free 800-647-1800. Charge VISA, MC or mail check or money order for **$279.95** for MFJ-494 Super Keyboard, **$39.95** for MFJ-53 AFSK module, **$29.95** for the MFJ-54 loop keying module, **$42.95** for Bencher Paddle, and **$7.95** for the 110 VAC adapter. Include $5.00 shipping and handling per order or as indicated in parentheses if items are ordered separately.

Why not really enjoy CW and RTTY? Order your MFJ Super Keyboard at no obligation today.

TO ORDER OR FOR YOUR NEAREST DEALER
CALL TOLL FREE 800-647-1800

Call 601-323-5869 for technical information, order/repair status. Also call 601-323-5869 outside continental USA and in Mississippi.

Write for FREE catalog, over 60 products

MFJ ENTERPRISES, INCORPORATED

Box 494, Mississippi State, MS 39762

More Details? CHECK—OFF Page 110

HAMVENTION® '81

DAYTON

- ★ Technical Forums
- ★ ARRL and FCC Forums
- ★ GIANT 3-Day Flea Market
- ★ New Products and Exhibits
- ★ Grand Banquet
- ★ Women's Activities
- ★ Special Group Meetings
- ★ Microprocessor Forum
- ★ YL Forum
- ★ Hundreds of Prizes
- ★ Amateur of Year Award
- ★ Special Achievement Awards

April 24, 25, 26, 1981
Hara Arena and Exhibition Center – Dayton, Ohio

Meet your amateur radio friends from all over the world at the internationally famous Dayton HAMVENTION.

Seating will be limited for Grand Banquet and Entertainment on Saturday evening so please make reservations early.

If you have registered within the last 3 years you will receive a brochure in late February. If not write Box 44, Dayton, OH 45401.

Nominations are requested for Radio Amateur of the Year and Special Achievement Awards. Nomination forms are available from Awards Chairman, Box 44, Dayton, OH 45401.

For special motel rates and reservations write to Hamvention Housing, 1980 Winters Tower, Dayton, OH 45423. **NO RESERVATIONS WILL BE ACCEPTED BY TELEPHONE.**

All other inquiries write Box 44, Dayton, OH 45401 or phone (513) 296-1165 — 5-10 P.M. EST.

Rates for ALL 3 Days:

Admission: $6 in advance, $7 at door.
Banquet: $12 in advance, $14 at door.
Flea Market Space: $12 in advance, $14 at gate.

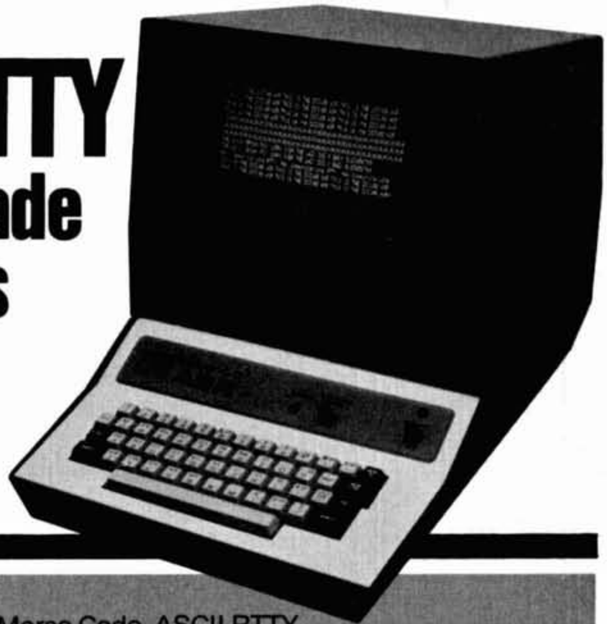
Make checks payable to Dayton HAMVENTION, Box 33, Dayton, OH 45405.

Bring your family and enjoy a great weekend in Dayton.

Sponsored by the Dayton Amateur Radio Association, Inc.

UNSURPASSED RTTY

No other RTTY terminal made gives you ALL the features of our new DS3100 ASR:



- TX/RX operation with 3 codes: Baudot RTTY, Morse Code, ASCII RTTY
- Storage buffers for 150 lines of RX storage and 50 lines of TX storage
- The HAL "original" split screen shows both RX and TX buffers or whole screen for RX
- Ten programmable "Here Is" messages can be chained from one to next
- The EAROM allows power-off storage of 2 "Here Is" messages and terminal operating conditions
- Programmable WRU answer-back and selective-call features
- Separate CW identification key for RTTY operations
- Automatic TX/RX control with KOS plus 4 keyboard controlled accessory switches
- Internal real time clock keeps 24 hour time plus date
- Newly developed CW receive circuitry and programs give superior CW reception
- New green, P31 phosphor display screen gives clear, eye-easing viewing
- On-screen status indicators give continuous display of terminal operating conditions
- Word-Wrap-Around prevents splitting of words at end of display line
- Continuous, line, and word modes offer flexibility in editing transmit text
- Attractive streamlined metal cabinet gives effective RFI shielding from transmitters

Here Are More DS3100 ASR Specifications that Give You State-of-the-Art RTTY Operation:

QBF and RY test messages ■ Loop and RS 232 RTTY I/O ■ Plus or minus CW key output ■ 25 pin EIA modem connector ■ Half or full duplex ■ Upper-lower case ASCII ■ All ASCII control codes ■ Optional line printer for all codes ■ Selectable ASCII parity ■ 110 to 9600 baud ASCII ■ 45 to 100 baud Baudot ■ 1 to 175 WPM Morse receive and transmit ■ UnShift on space for Baudot ■ SYNC idle for RTTY and Morse ■ Break key for RTTY ■ Tune key for Morse ■ Automatic CR-LF ■ 120/240 v, 50/60 Hz power ■ Custom labeled key tops show control operation ■ Copy receive text into transmit buffer ■ TX flags allow segmenting of TX buffer ■ One year warranty

PRICE: $1995.00

HAL COMMUNICATIONS CORP.
Box 365
Urbana, Illinois 61801
217-367-7373

For our European Customers Contact:
Richter & Co., D3000 Hannover 1
I.E.C. Interelco, 6816 Bissone/Lugano

Write or give us a call. We'll be glad to send you our new RTTY catalog.

More Details? CHECK—OFF Page 110

converting surplus AN/UPX-6 cavities

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

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

According to *MIL-HDBK-162B*, "Radar Recognition Set AN/UPX-6 is part of the target identification equipment for a radar set in an IFF* system."

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

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

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

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

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

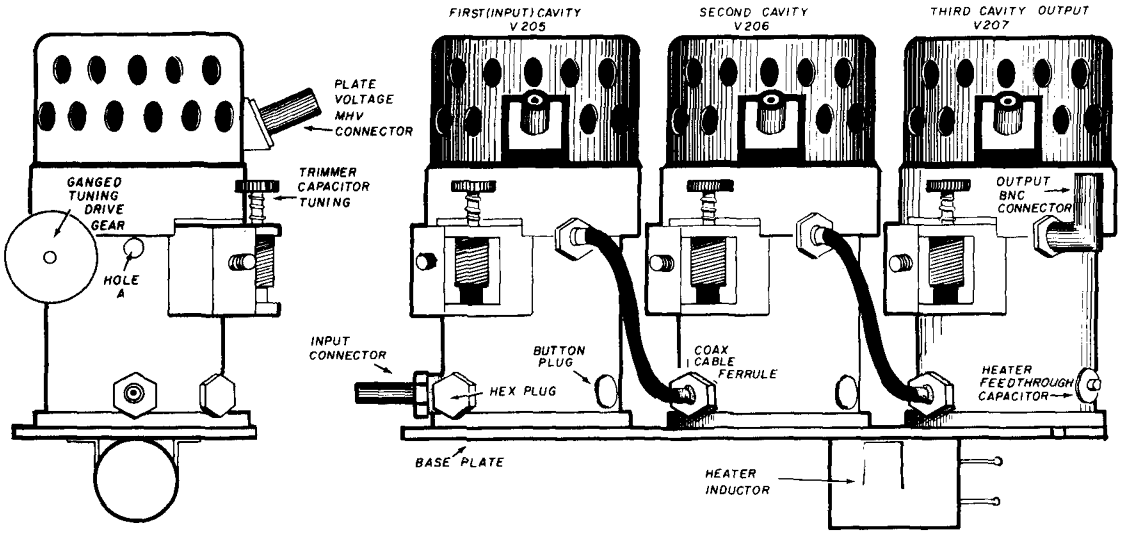


fig. 1. Unmodified AN/UPX-6 cavity assembly.

modifying the cavities

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

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

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

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

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

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

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

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

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

9. Remove the first cavity from the baseplate.

10. Perform **step 7** on the second cavity.

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

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

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

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

15. Enlarge the input connection hole in the first cavity by drilling it out with a 3/8-inch (9.5-mm) drill.

Then ream or file the hole so that it will accept the threaded end of a UG-1094/U BNC connector. *Be careful not to damage the input coupling capacitor inside the base of the cavity*! Clean out all filings, especially on the faces of the input coupling capacitor.

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

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

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

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

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

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

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

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

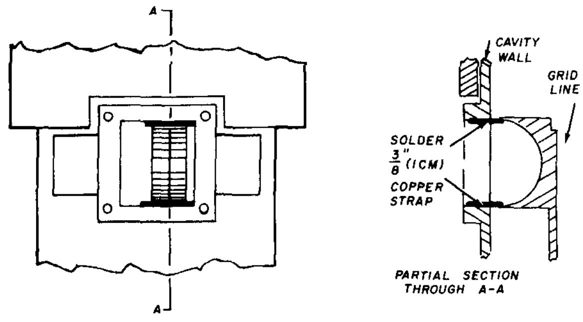


fig. 2. Modification inside cavity access hole.

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

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

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

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

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

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

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

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

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

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

34. Push the braid back slightly, being careful not to unravel the braid. Cut 1/8 inch (3.2 mm) of dielectric and center conductor off the end.

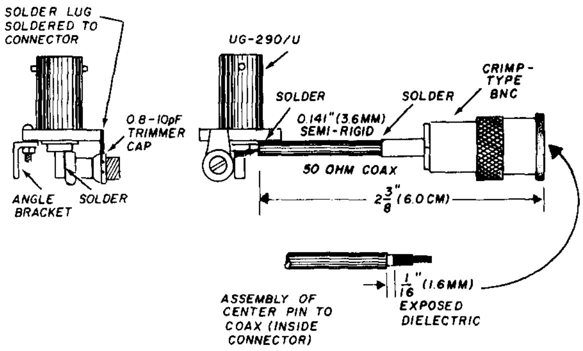


fig. 3. Stub matching network used at input to first cavity. The 0.8-10 pF trimmer capacitor is a Johanson 5200, JFD MVM010M or equivalent. The crimp-type BNC connector is similar to the UG-88/U series except that it's normally used for crimp assembly of RG-58/U cable.

35. Reform the braid so that it tapers over the cut end, which will make it easier to assemble the ferrule to the cable.

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

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

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

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

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

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

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

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

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

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

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

input matching

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

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

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

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

input VSWR

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

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

power supplies

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

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

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

Plate voltage is applied to each cavity through the MHV connectors shown in **fig. 1**. The required mating MHV connector is an Amphenol 29100 for RG-58/U cable, or an Amphenol 28000 for RG-59/U. The latter is recommended, since the RG-59/U has a higher breakdown voltage rating than RG-58/U. If you can't obtain the mating MHV connectors, or if the receptacles on the cavities are damaged, the cavity receptacles can be replaced with more conventional UG-290/U BNC connectors. In that case, use UG-260/U cable connectors so that RG-59/U can be used.

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

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

If the plate voltage for the first two stages is limited to about 350 volts, the heater and bias circuits shown in **fig. 4A** may be used. The values of R1 and R2 must be such that the heater voltage, measured at the heater ends of the rf chokes, is 5.5 volts. CR_k provides cathode bias and is made of several silicon rectifiers (1N4001 or similar), so that the quiescent

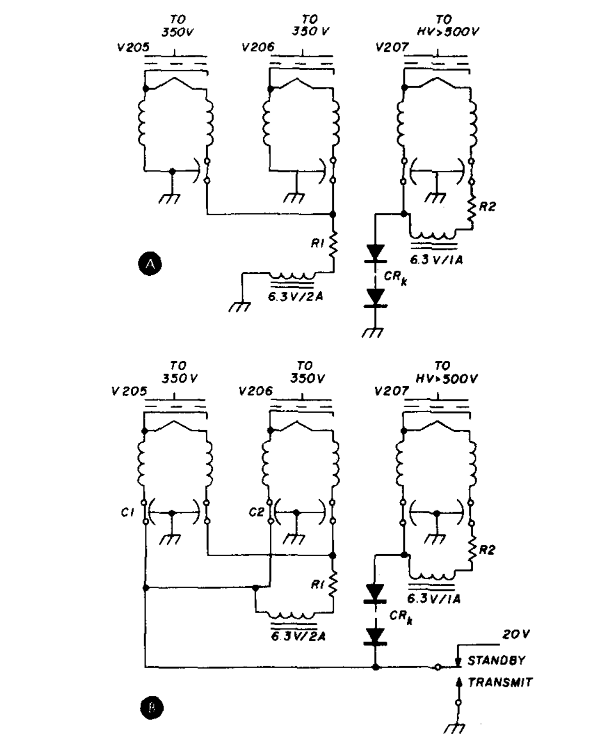


fig. 4. Suggested heater and bias circuits for the modified cavities. (Refer to text for a discussion of C1, C2, R1, R2, and CR_k.) Illustration *A* shows heater and bias circuits for plate voltages indicated. Heater and bias circuits for the same plate voltages in *A* are shown in *B*, with cutoff bias during standby.

plate current of V207 is between 40 and 60 milliamperes; the number of diodes in series will depend on the plate voltage and the tube characteristics. With a plate supply of 600-700 volts, four diodes should provide the proper bias.

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

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

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

operation

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

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

wrap-up

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

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

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

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

postscripts

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

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

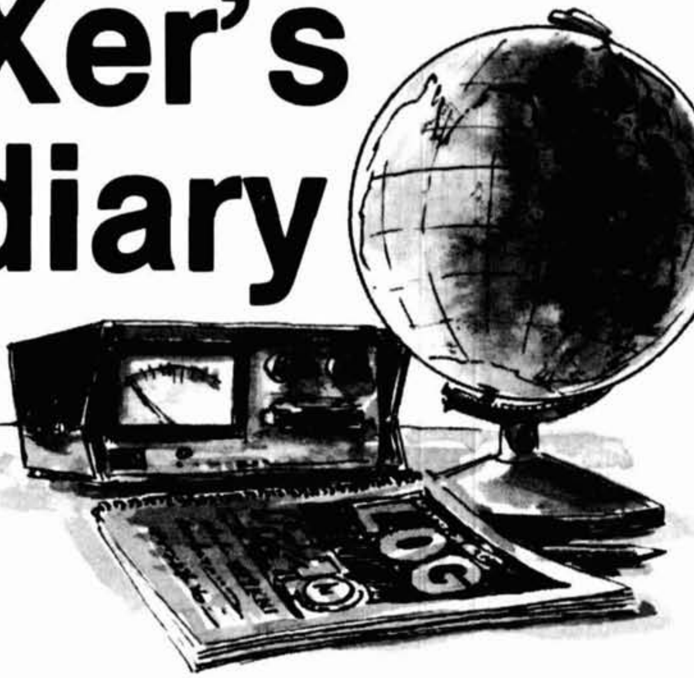
It's interesting to conjecture on the results that might be obtained by matching. If we assume a gain of 11 dB per stage and an output of 40 watts, only 20 milliwatts of drive should be required.

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

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

ham radio

DXer's diary



Author Locher was a popular contributor to *Ham Radio Horizons*. Because many *Horizons* readers are now receiving *ham radio*, we are presenting this episode of W9KNI's ongoing battle of the big guns in the DX world. Want to see more articles by W9KNI? Let us know how you like it. **Editor.**

By Bob Locher, W9KNI

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

"He's mostly on W4s. He's getting a few threes, and W9ZRX with that super stacked system got him too. But I think the W4s have a long-path opening to him, and they're working it to death. The guy's a pretty good op, for sure."

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

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

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

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

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

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

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

In minutes I'm back at the rig. Let's see here... I adjust the headset a bit to seat it comfortably, and move the gleaming Bencher paddle to where it is most comfortably placed. KP2A is a pretty sharp operator — I ease the keyer speed up a bit, and dry fire a few letters to get my timing down. My fingers respond almost instantly to the higher speed — I feel like a sports car driver just before the start of the race: headphones are my driving helmet, my paddle the gear shift, the receiver dial my steering wheel. I fire up the linear, get it all tuned on an empty frequency just above 14030, and I'm set.

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

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

I reach for my cup of coffee — and leave it — I've got butterflies enough.

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

"Hey Bob?"

"Yeah, John, go ahead."

"Hey, don't forget, it's only a hobby."

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

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

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

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

"Oh. Yeah, he's VK9YR — Yankee Radio."

"Thanks."

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

Huh, what's that? There, on 020, maybe 559, 569, "5NN W4QM, K."

4QM — yeah, he's one of the South Florida aces. I give the receiver a quick turn up a few kHz. "5NN TU VK9YR DE W4QM E E." Yup, there he is, as I pick up the VK9 again.

"R 73 QRZ NA NA UP5 DE VK9YR K."

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

"DE W9KNI K."

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

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

But, while the fours still have it in such convincing fashion, I'd be smart to quit transmitting and study his techniques. That way, when he does start working W9s, I'll be ready for him. Okay, he's back to W4MLP. Find MLP. There he is; note the frequency — yes, 026.3, plus or minus. He clears. Now — KB4CH has him. Okay, 026.6. He clears. Listen to that pileup! Back to the VK9. Yes, he's got KT4X. There's the KT4, 026.9. All right! The VK9 is working up through the pile. Fast, too. One call seems to get him. None of your 1X3s for this boy. Great!

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

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

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

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

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

"WB8EUN 5NN K." Darn! Okay, there's EUN, right on the same frequency I was. He clears. "DE W9KNI K."

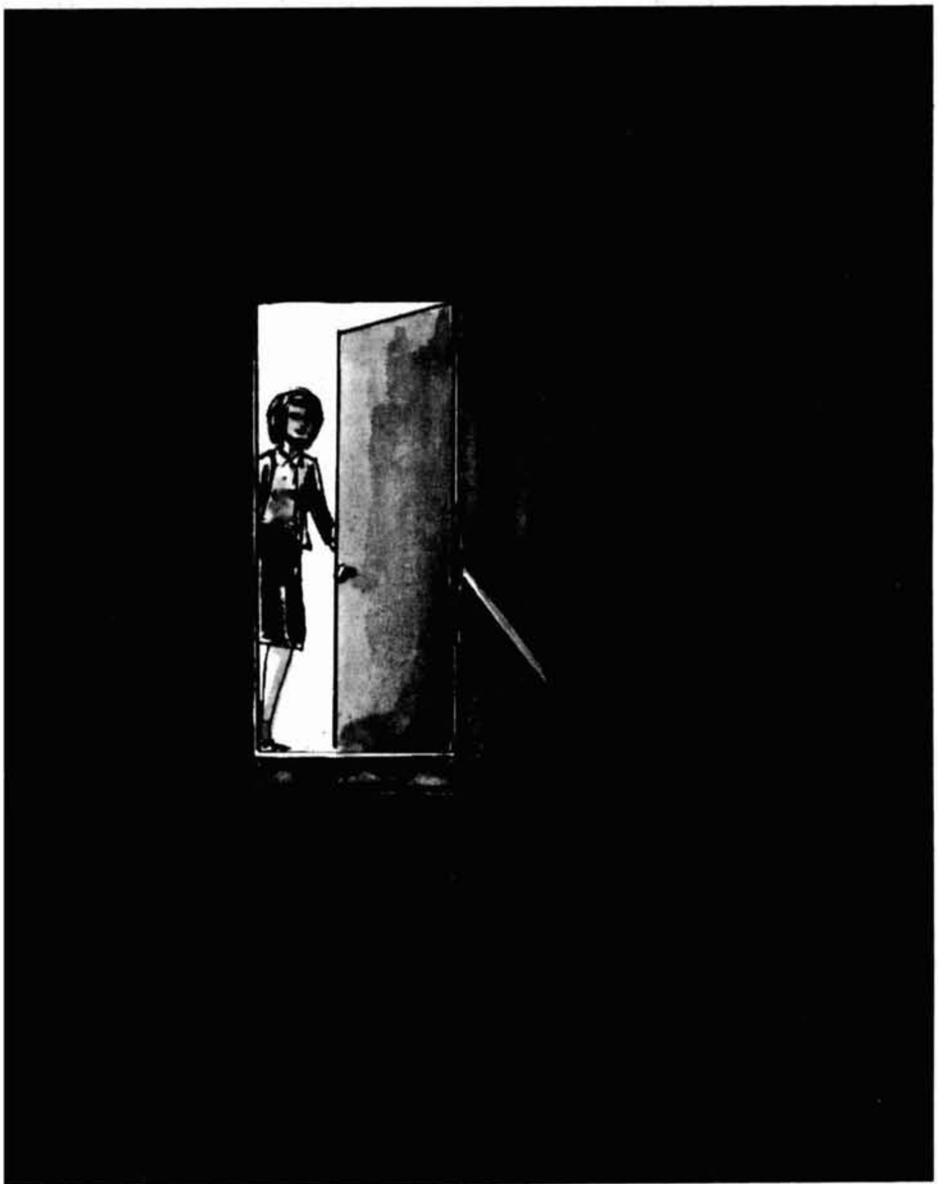
"W9BW DE VK9YR 5NN K." Where's BW? There, above me about 200 hertz. Up 300 for me above BW.

"DE W9KNI K."

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

"DE W9KNI K."

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



"DE W9KNI K."

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

"DE W9KNI K."

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

"DE W9KNI K."

"W9KNI 5NN DE VK9YR."

"VK9YR 5NN TNX DE W9KNI."

"R TU E E."

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

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

"Twenty-eight. Twenty-eight."

"DWQ's got him. Way to go Ed!"

"Twenty-eight point five, eight point five." I recognize K9DX's voice.

"It's WØVX." There's K9RF giving the call signs.

"Twenty nine oh. Watch it, he's going to move back down."

"K5LM."

"He moved. Oh twenty three two. Call up a little."

"K9AJ, good work, Mike."

"Twenty three five."

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

"W9OA — way to go, George."

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

"Bob, breakfast's ready." A wave of sausage aroma follows my wife's voice. They don't need me here on 2 meters — and I'm hungry!

ham radio

Collins Owners' Reports:

KWM-2
KWM-2A

A survey of owners' opinions on these two popular transceivers

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

the good features

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

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

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

By Martin Hanft, WB1CHQ, Production Editor, *ham radio* magazine

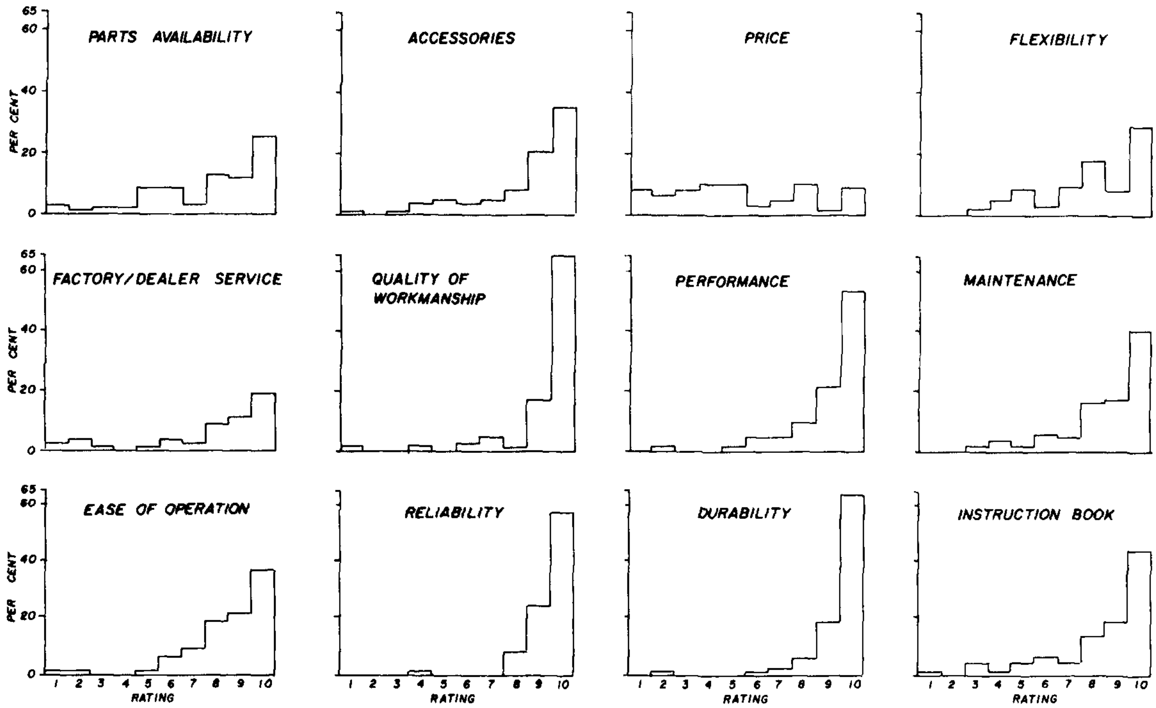


fig. 1. How the KWM-2/2A was rated, from 1 (poor) to 10 (perfect).

it's built like a battleship. Long life expectancy and very neat looking design of front panel." — WØRJ

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

table 1. Best features

	percent
reliability	37
stability	25
superior audio quality	18
wide frequency coverage	14
dial accuracy	13
solid construction	13
easy to operate	11
good frequency readout	11
good selectivity	6
front panel design	4
easy to service	4
frequency accuracy	3
service manual	3
resale value	3
no TVI	1
VFO	1

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

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

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

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

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

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

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

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

"Faults with the Collins are few and far between." — WAØPSG

"Dependability." — K9LKA

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

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

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

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

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

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

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

"I can always count on this rig to do what it is capable of without fail, without eccentricity or deviation — and do it rather well." — K5OCS

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

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

"Solid investment — especially with today's stock market." — KA6ACD

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

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

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

the other side of the coin

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

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

table 2. Worst features

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

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

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

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

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

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

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

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

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

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

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

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

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

"Not solid state. I hope the tubes for this rig do not become obsolete. The open relays in the VOX circuit collect dust. No notch filter or noise eliminator." — W5TTF

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

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

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

"Noisy VOX relays." — WB1FYV

"Band switch problems." — WB4NTM

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

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

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

"Power consumption on battery source and lack of CW filter." — N7AA

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

"Not easily adaptable for mobile use." — WA1PEL

"If judged during its heyday, I can think of *none*. Now, of course, it lacks some of the little conveniences of the newer rigs: R.I.T., digital readout, power requirements, etc." — K5OCS

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

problems

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

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

"PTT relay contacts dirty." — WB6AWU

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

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

table 3. Problems

	percent
tubes	42
relays	23
shorted capacitor	11
long wait for parts also high cost	6
band switch	5
VFO dial	4
VOX circuit	4
alignment	2
difficult to change components	2
AGC	1

shaft to replace. I occasionally have to replace tubes." — AH6U

"Just worn tubes." — HI3HEG

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

"Tubes and alignment." — WA6UZL

"VOX circuit erratic — had to change many components." — K6RK

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

"Tubes and heat." — K2OB

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

"Mica capacitor in the i-f failed. Loose screw in the power supply shorted B+."

"The usual tube replacements." — K9LKA

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

"Had to replace the power transformer after ten years."

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

"VFO dial slippage." — WA2CBA

accessories

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

table 4. Accessories

	percent
noise blanker	13
speech processor	10
amplifier	10
external VFO	8
rejection tuning	8
mike	5
crystal pack	5
Q multiplier	4
digital display	4
dummy load	3
wattmeter	3
antenna tuner	1
transverter	1
SWR bridge	1

related findings

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

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

would you buy one again?

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

Next month, *ham radio* will present the results of its survey of owners of the 32S-line transmitter and 75S-line receiver. Watch for it. And don't forget to return the questionnaire on the ICOM 701, Drake TR7, and Kenwood 520 series that appeared on page 22 of the February issue. If you own, or have owned, one of these rigs, now is your chance to tell the world what you think of it.

ham radio

MORE KEYER FEATURES FOR LESS COST

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

MM-1	KT-1	MT-1	CK-1	MK-1
				
MorseMatic™	**Keyer Trainer**	**Morse Trainer**	**Contest Keyer**	**Morse Keyer**

IMPORTANT KEYER AND/OR TRAINER FEATURES	AEA MM-1	AEA KT-1	AEA MT-1	AEA CK-1	AEA MK-1	COMPETITOR A	B	C	D
Speed Range (WPM)	2-99	1-99	1-99	1-99	2-99	8-50	5-50+	?	8-50
Memory Capacity (Total Characters)	500			500		400	100/400	400	
Message Partitioning	Soft			Soft		Hard	Hard	Hard	
Automatic Contest Serial Number	Yes			Yes		No	No	No	
Selectable Dot and Dash Memory	Yes	Yes		Yes	Yes	No	No	No	No
Independent Dot & Dash (Full) Weighting	Yes	Yes	Yes	Yes	Yes	No	No	No	No
Calibrated Speed, 1 WPM Resolution	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No
Calibrated Beacon Mode	Yes			No		No	No	No	
Repeat Message Mode	Yes			No		Yes	Yes	Yes	
Front Panel Variable Monitor Frequency	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Message Resume After Paddle Interrupt	Yes			Yes		No	No	Yes	
Semi-Automatic (Bug) Mode	Yes	Yes		Yes	Yes	No	No	No	No
Real-Time Memory Loading Mode	Yes			Yes		Yes	Yes	No	
Automatic Word Space Memory Load	Yes			Yes		No	No	Yes	
Instant Start From Memory	Yes			Yes		No	No	Yes	
Message Editing	Yes			Yes		No	No	No	
Automatic Stepped Variable Speed	No	No	No	Yes	No	No	No	No	No
2 Presettable Speeds, Instant Recall	No	No	No	Yes	No	No	No	No	No
Automatic Trainer Speed Increase	Yes	Yes	Yes						No
Five Letter or Random Word Length	Yes	Yes	Yes						No
Test Mode With Answers	Yes	Yes	Yes						No
Random Practice Mode	Yes	Yes	Yes						Yes
Standard Letters, Numbers, Punctuation	Yes	Yes	Yes						Yes
All Morse Characters	Yes	Yes	Yes						No
Advertised Price	**$199.95**	**$129.95**	**$99.95**	**$129.95**	**$79.95**	**$139.95**	**$ 99.50/ $139.50**	**$229.00**	**$129.95**

OPTIONS:

- **MT-1P** (portable version of MT-1) with batteries, charger, earphone — **$139.95**
- **ME-1** 2000 character plug-in memory expansion for MM-1 — **$ 59.95**
- **AC-1** 600 Ma. 12 Volt wall adaptor for MM-1 with ME-1 — **$ 14.95**
- **AC-2** 350 Ma. 12 Volt wall adaptor for all AEA keyer and trainer products except MM-1 w/ ME-1 — **$ 9.95**
- **DC-1** Cigarette lighter cord for all AEA keyers and trainers except MT-1P — **$ 5.95**
- **MT-1K** Factory conversion of MT-1 to KT-1 — **$ 40.00**

PRICES AND SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE OR OBLIGATION.

All our keyers (except the MT-1) will operate with any popular single lever or iambic squeeze paddle and will key any type of modern amateur transmitter with no external circuitry required. AEA keyers are as easy to operate as a four function calculator. The internal AEA computers are all pre-programmed for the features shown above. Each AEA product is fully RF protected and receives a complete elevated temperature burn-in and test before it is shipped from the factory.

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

Advanced Electronic Applications, Inc., P.O. Box 2160, Lynnwood, WA 98036. Call 206/775-7373

AEA Brings you the Breakthrough!

More Details? CHECK—OFF Page 110

digital frequency display

for single-conversion transceivers

Update your rig for numerical frequency readout

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

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

common display methods

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

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

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

preset and complement

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

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

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

By Everett L. Beall, K6YHK, 715 East Cook Street, Santa Maria, California 93454

sults in zero. The subtrahend will be the tens complement of the minuend. For example, the complement of 35 is 65, since $35 + 65 = 100$ (ignore the highest carry). The complement of 850 is 150 since $850 + 150 = 1000$ (again, ignore the highest carry).

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

some examples

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

load i-f	05500.0
add VFO	8502.2
display sum	14002.2

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

input VFO	12505.3
subtract i-f	5500.0
difference	7005.3

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

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

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

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

digital dial and display for the Atlas transceiver

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

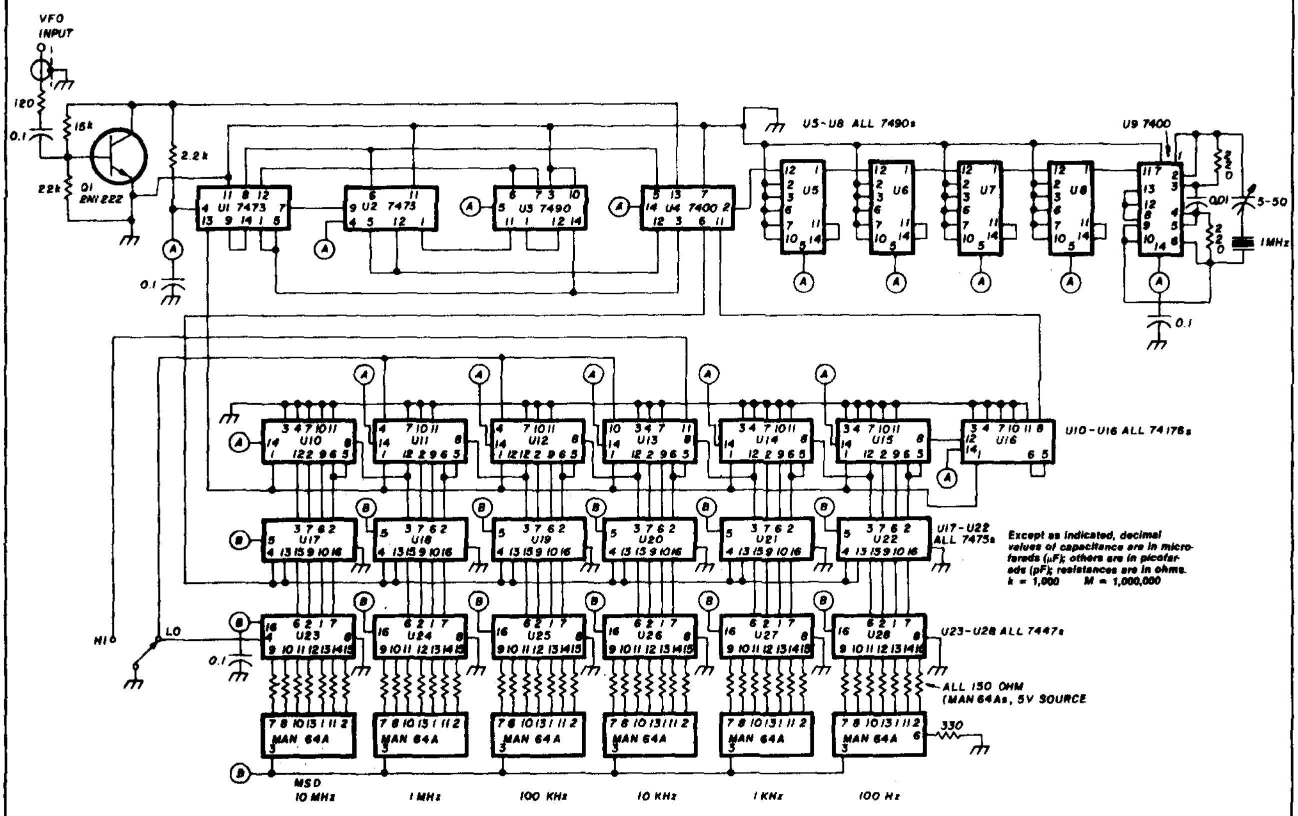


fig. 1. Schematic of Atlas transceiver digital display. Points marked *A* and *B* are 5 Vdc, regulated, from supplies in either *fig. 3* or *6*.

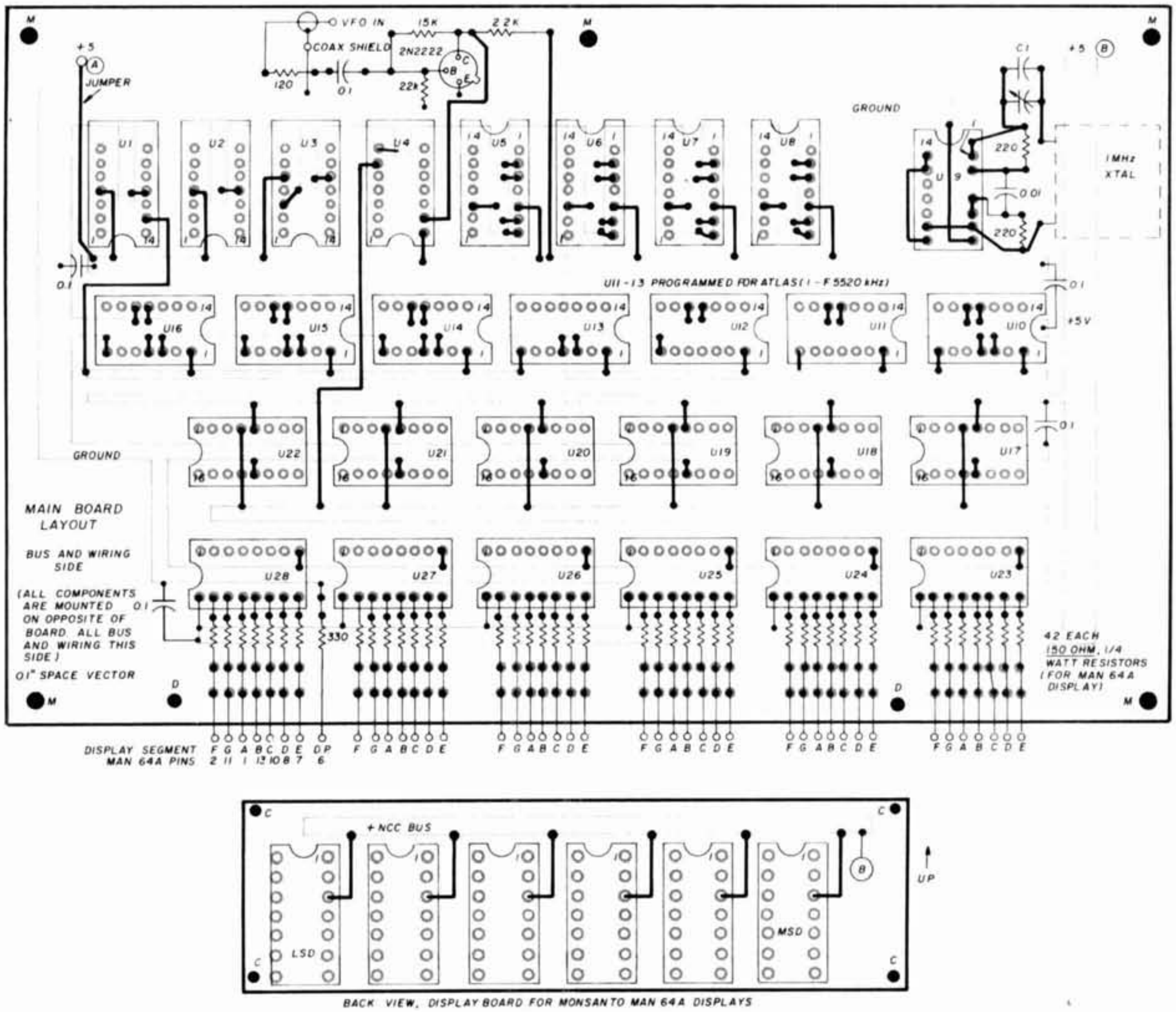


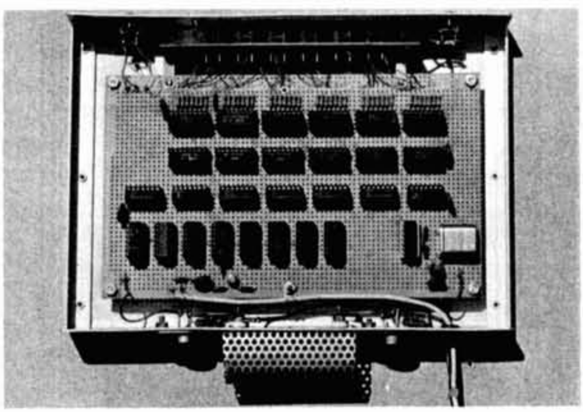
fig. 2. Bus and jumper wiring diagram, wiring side of main and display boards.

stituted. The 74176 consumes less current, and the 35 MHz maximum count frequency is well above any expected frequency.

Counter preset data pin connections are:

decimal preset	11	3	10	4
		preset pin levels		
9	1	0	0	1
8	1	0	0	0
7	0	1	1	1
6	0	1	1	0
5	0	1	0	1
4	0	1	0	0
3	0	0	1	1
2	0	0	1	0
1	0	0	0	1
0	0	0	0	0

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



Cover removed to show parts placement on perf board. Perforated metal cover on rear is used for protection from the heat of the series-dropping resistor.

supply. The high, or 1, state may be obtained by leaving the pin unconnected.*

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

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

internal sequencing and display

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

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

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

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

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

layout and construction

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

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

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

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

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

connection to the Atlas

Power requirements are 5 Vdc at 1.2 amperes. My display used 12 volts from the Atlas external oscillator socket (**fig. 3**). Two National LM309K three-terminal regulators were used, the outputs divided into **A** and **B** power connections of **figs. 1** and **2**. The 5-ohm dropping resistor reduces regulator dissipation. It is mounted inside the perforated metal cover at the display enclosure back panel.

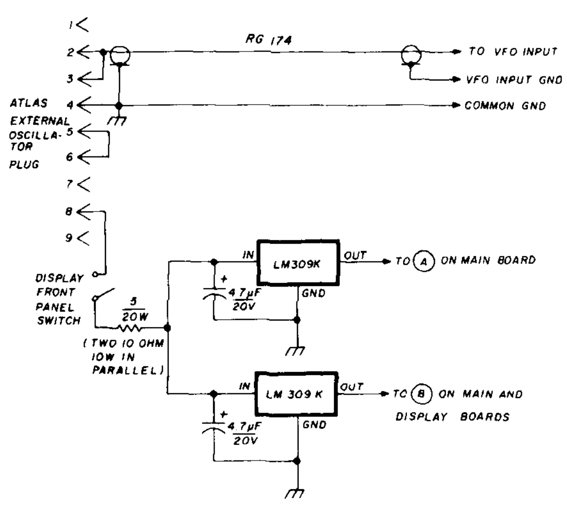


fig. 3. Atlas transceiver connections and power-supply regulator.

The Atlas requires a nine-pin miniature vacuum-tube plug connector. I used a Pomona Electronics TVS 9 tube-test adapter. Originally used for tube-circuit testing, it has solderable lugs on the socket end.

packaging

No miniaturization was attempted. The enclosure,

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

†If possible, use several 0.01-μF bypasses, distributed evenly along power and ground buses, which reduces the possibility of digital noise entering the receiver.

which is 9-1/2 inches (24 cm) wide and 6-3/4 inches (17.1 cm) deep, fits nicely on top of an Atlas cabinet. Shown in **fig. 4**, this homemade enclosure uses aluminum sheet plus angle stock for strength and joining the cover.

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

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

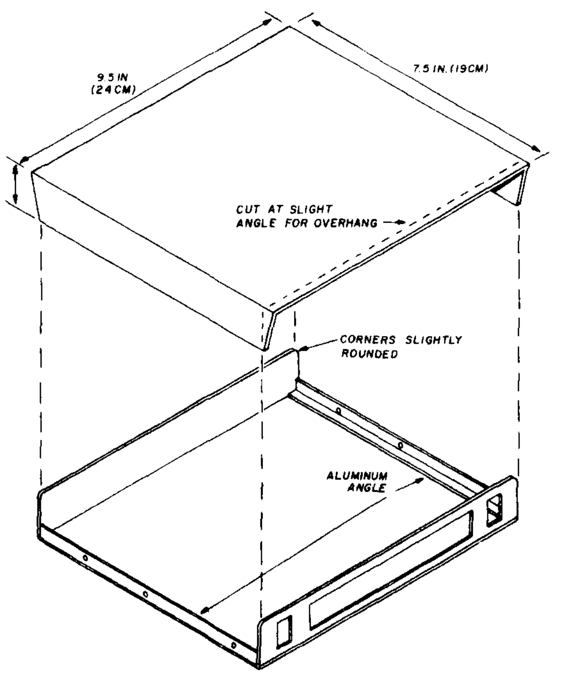


fig. 4. Enclosure as seen in the photographs. Aluminum sheet 0.05 inch (0.060 cm) used for bottom and top. L-angle stiffeners are 1/2 inch (1.3 cm) which are available at hardware stores.

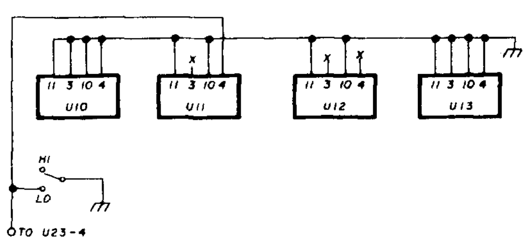


fig. 5. Swan transceiver preset connections. U14, U15, U16 connections are the same as in *fig. 1*.

modification for the Swan transceiver

Preset connections must be changed for the Swan's 5500 kHz i-f, and this information is given in **fig. 5**. Pins 4, 10, 2, and 11 of U14 through U16 remain grounded. External oscillator connection and power-supply arrangements are shown in **fig. 6**.

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

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

preset options

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

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

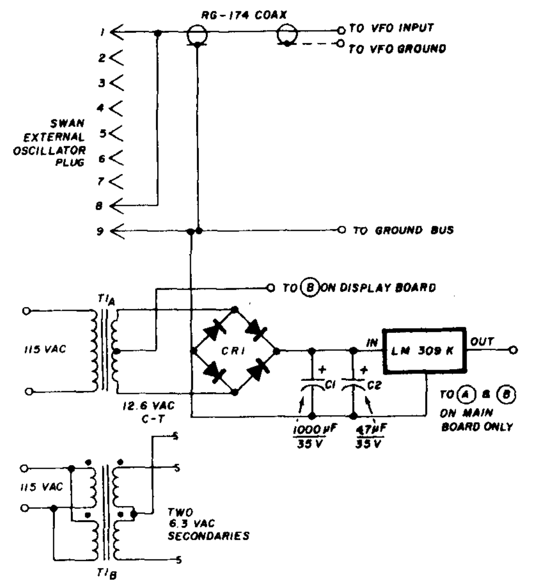


fig. 6. Swan transceiver connections and optional ac power supply. Part numbers indicated are available in Radio Shack stores.

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

load mixed complement	97000.0	
add VFO frequency	15000.0	
display sum	12000.00	(MSD carry ignored)

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

summary

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

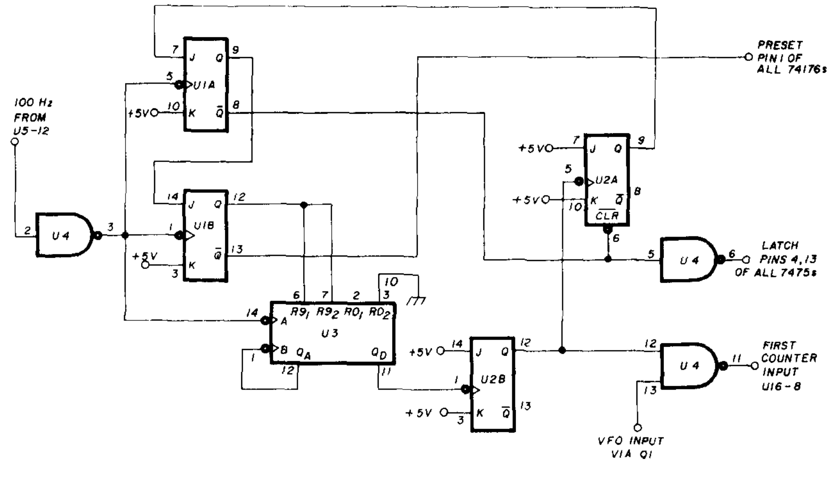


fig. A-1. Counter gate and display timing circuit.

appendix

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

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

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

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

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

The following negative edge from U4-3 will toggle U1-12 high and force U3 into a decimal 9 state through the R9 control pins. The 7490 used for U3 will be held in the decimal 9 state until pins 6 and 7 go low. The first stage of U3 will toggle low and remain for 15 to 20 ns until forced high; flip-flop delays account for the negative spike.

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

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

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

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

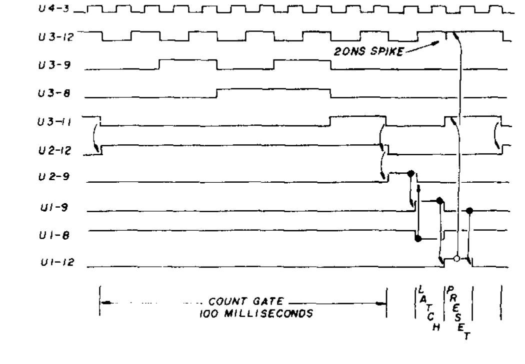


fig. A-2. Counter gate and display timing diagram.

ham radio

ham radio TECHNIQUES

Bill Orr W6SAI

more about moonbounce

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

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

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

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

Since the round-trip gain is supposedly constant, stations having an antenna gain less than 21 dB can't hear their own echos but can hear other

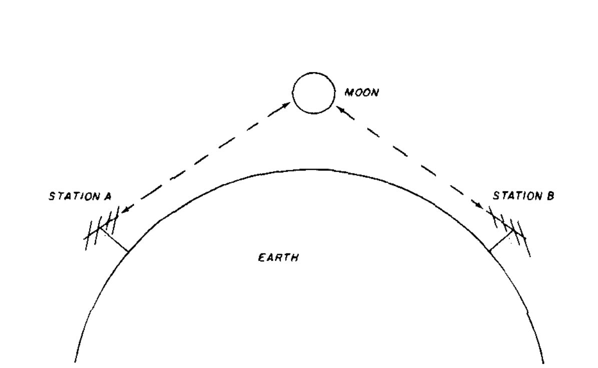


fig. 1. The earth-moon-earth communications circuit. Stations beyond the curvature of the earth communicate on vhf bands by reflecting their signals from the moon.

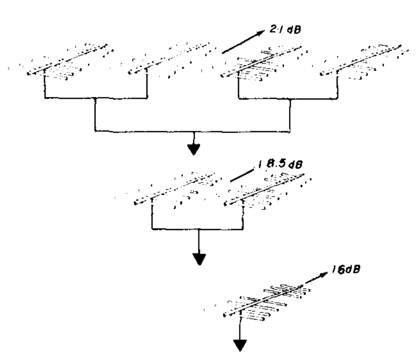


fig. 2. Combining Yagi antennas provides enhanced gain. Doubling number of antennas raises gain by about 2.5 dB. Eight 16-dB antennas, for example, can provide a power gain of 23.5 dB.

stations having more than 21 dB of antenna gain. A station having an 18-dB gain antenna, for instance, should be able to hear and work moonbounce stations having an antenna gain of 24 dB. Exceptions to this rule make moonbounce very exciting.

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

how to achieve moonbounce antenna capability

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

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

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

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

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

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

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

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

moonbounce station equipment

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

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

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

Next item to consider is the station receiver. A good, *low-noise preamplifier* is required. The *receiver* may consist of an hf receiver with a 2-meter converter in front of it. The receiver should be equipped with a *narrow-band filter* such as used for CW reception. This will provide the best signal-to-noise ratio and enhance the operator's ability to hear weak signals. A passband of about 500 Hz is a good compromise.

Finally, the transmitter must be considered. While moonbounce contacts have been made on rare occasions by stations using as little as 200 watts output, a practical moonbounce station calls for 1 kW input, with about 700 watts going into the antenna system. Maximum power, of course, provides the greatest margin for success.

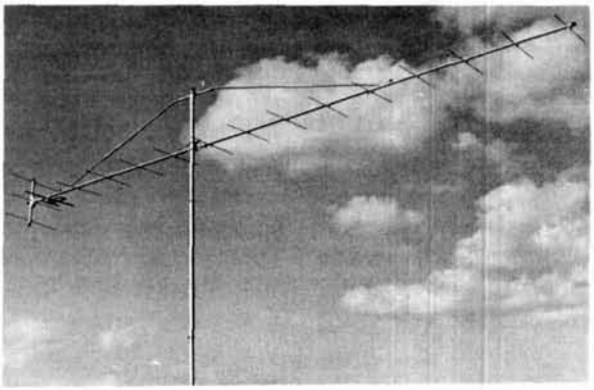
In addition to the transmitting and receiving equipment, the practical EME station requires an accurate clock. A tape recorder is very handy for recording received signals. And finally, if the moonbounce antenna is steerable, the operator requires alignment information to aid in finding and tracking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

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

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

a day in the life of a moonbouncer — K1WHS

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



One of the "Boomer" antenna arrays of the type used by K1WHS in his moonbounce antenna.

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

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

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

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

All right. I scan the 2-meter band between 144.000 and 144.015 MHz and hear a few signals. They are coming back at me from the moon. WA1JXN/7 is calling CQ on 144.007 MHz. Lance is about two and one-half S units above the background noise and very steady. Good copy. That's a good sign!

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

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

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

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

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

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

Back to the idea of a CQ. I move up the band a few kHz and send a short call. Wow! A pileup calling me! This is difficult, as all signals are zero-beat and all about the same strength! Sort of like 20 meters, I say to myself. Through the din I can make out...I4 (Italy) and W...DU. The other calls are lost. After two minutes, I've just been able to pull out one complete call...here it is: HB9QQ (Switzerland)!

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

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

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

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

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

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

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

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

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

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

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

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

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

ham radio

genesis of a synthesizer

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

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

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

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

1. Coverage of the entire 2-meter band in 5-kHz increments

2. Adequate output drive at 12 MHz (transmit) and 45 MHz (receive)

3. Switch-selectable offsets of +600 kHz, −600 kHz, or simplex operation

4. Low power consumption (less than 250 mA)

5. Good temperature stability, small physical size, and low cost (less than $100)

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

system design

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

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

how it plays

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

The desire for low-power consumption made the MC14046 (or RCA CD4046) a logical choice for the phase detector. The loop filter was adapted from the design of DJ2LR[1] and was designed to provide a worst-case settling time of about 50 ms. The output of the loop filter controls the frequency of an MC1648 VCO, tuned by an MV104 varactor. A 2N2369, Q1, converts the VCO output (an ECL square wave) into a TTL-compatible signal to drive the output buffer and divide-by-four circuits.

This signal is divided by two by U14, an SN74S74

By Ken Grant, VE3FIT, 46 Merryfield Drive, Scarborough, Ontario, Canada M1P 1J9

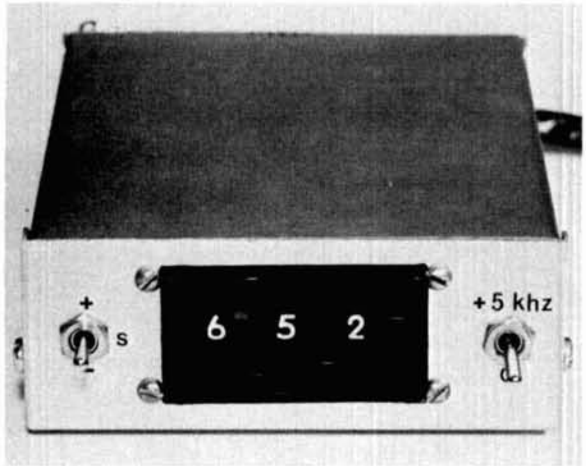
flip-flop. The flip-flop output is then level-translated to clock U15, an MC12013 dual-modulus prescaler. U3-U8, and U15, form the divide-by-N counter. Note that, since the MC12013 output is at ≈2.5 MHz, subsequent stages can be relatively low-speed CMOS devices. The divide-by-N arrangement divides the VCO signal down to 1.666 kHz for the phase detector. It's based on the scheme used by K4VB and WA4GJT.[2]

The divide-by-N counter is programmed in two ways: first, according to whether you're in transmit or receive mode (Q4 and associated circuit); second, by U9-U12 in conjunction with the thumbwheel switches and the transmit offset selection toggle switch, S2. U9-U12 form a two-decade BCD adder/subtractor capable of adding 0.6 MHz (600 kHz), or zero MHz, or subtracting 0.6 MHz from the thumbwheel switch settings.

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

construction

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



Completed synthesizer. Unit is a compact 4 by 5 by 1.5 inches (10 by 13 by 3.8 cm).

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

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

Feedthrough caps (500 pF) filter any rf from the PTT and +12-volt lines, while the transmit and receive outputs are taken from a pair of phono sock-

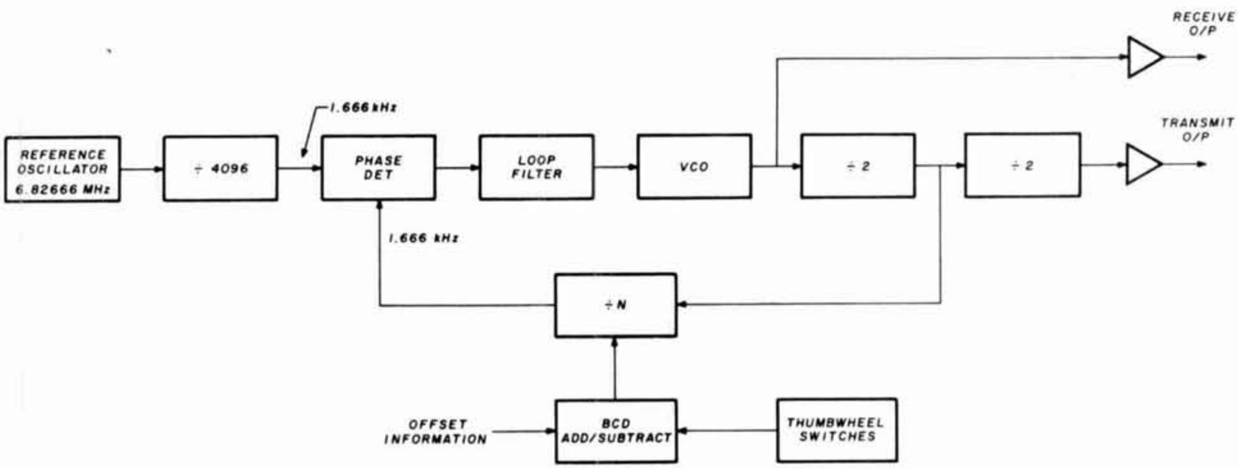


fig. 1. Synthesizer block diagram. "N" is determined by thumbwheel switch settings and the choice of frequency offset. The entire 2-meter band is covered in 5-kHz increments.

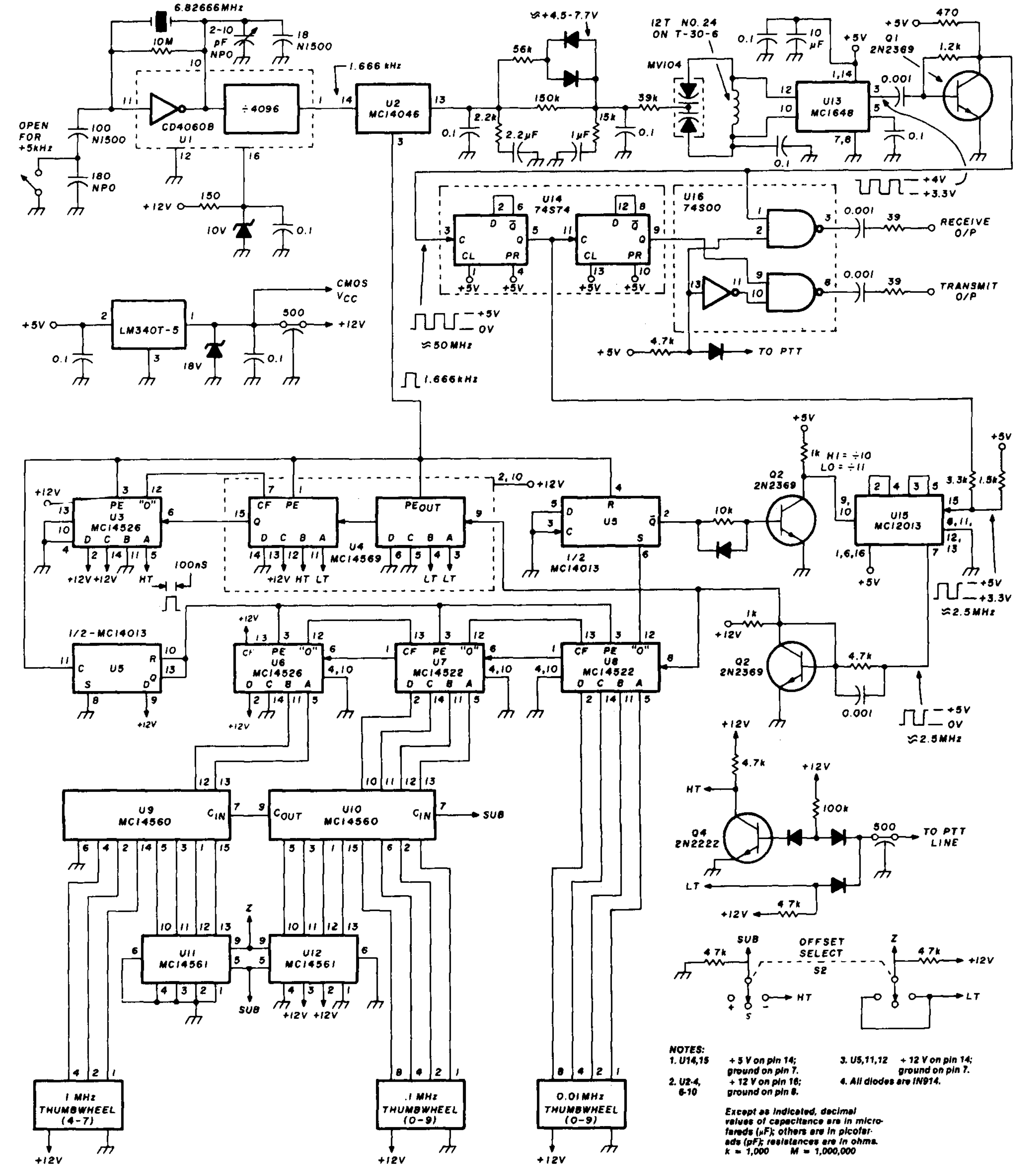


fig. 2. Schematic diagram of the 2-meter synthesizer. Reference oscillator operates in the range 5-10 MHz for best stability. Crystal is cut for 30-pF load capacitance.

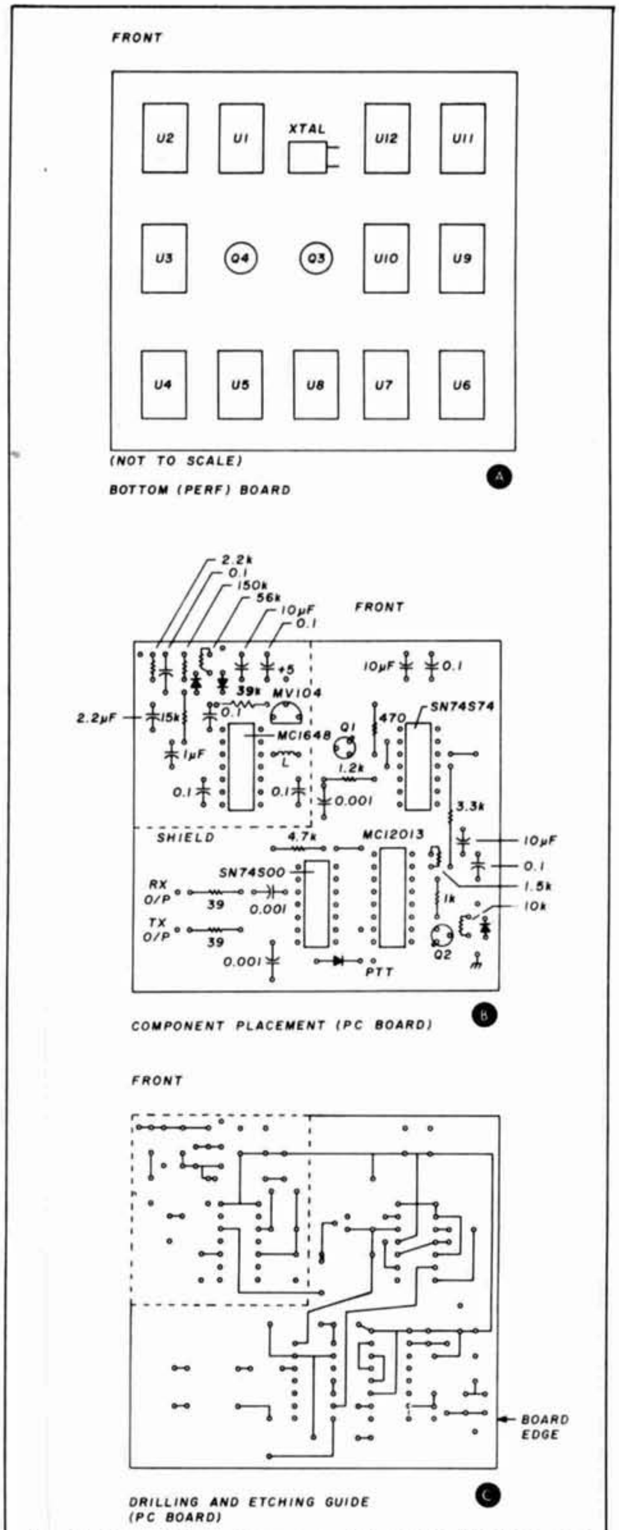
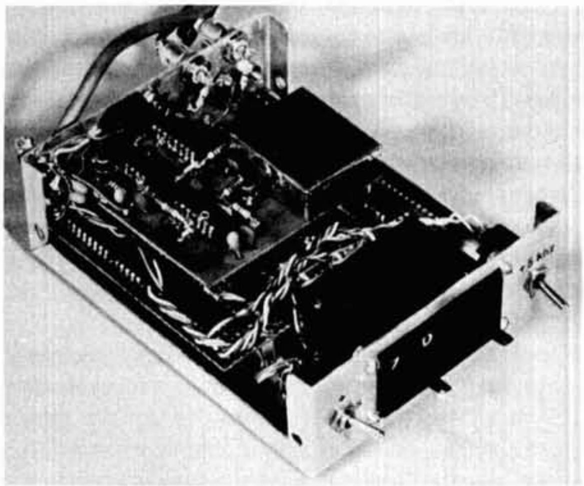


fig. 3. Circuit-board layout. All CMOS devices are mounted on a piece of Veroboard (*A*). (The American equivalent is Vectorboard No. 3682-4.) Interconnections on this board are made using No. 30 (0.25-mm) insulated wire on the underside. The PC board, (*B*) and (*C*), is double-sided copperclad. The bottom is left unetched to serve as a ground plane and shield. Circuit trails, made with a resist pen, are on top.



Inside the 2-meter synthesizer. All CMOS circuits are mounted on a piece of Veroboard and are supported by four standoffs. Remaining circuitry is on a double-sided PC board.

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

checkout and alignment

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

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

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

installation

Only five connections are required between the synthesizer and your rig. These are: +12V, ground, PTT line, and receive and transmit inputs. The latter two should be coaxial cable. Try to terminate both coax lines with somewhere between 50 and 100 ohms. K9LHA provides excellent interfacing suggestions in his article.[3]

A common occurrence in outboard synthesizer installations is one of vhf rf coming back into the synthesizer through the two interconnecting coaxial lines. My setup was such a case, and the results were very evident — nobody could understand a thing I said for all of the squealing and hum! The cure was to install a pair of in-line lowpass filters, thus stopping the vhf rf before it can get inside the synthesizer. Circuit details are given in **fig. 4**.

results

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

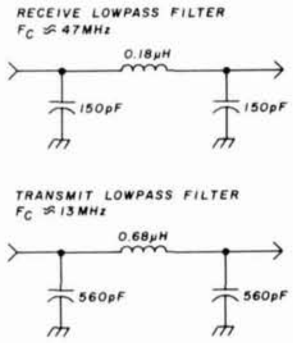


fig. 4. In-line lowpass filters prevent rf from re-entering the synthesizer through the interconnecting coax cables.

acknowledgments

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

references

1. Ulrich Rohde, DJ2LR, "Modern Design of Frequency Synthesizers," *ham radio*, July, 1976.
2. B. Fanning, K4VB, and G. Grantland, WA4GJT, "800-Channel 2-Meter Synthesizer," *ham radio*, January, 1979.
3. Tom Cornell, K9LHA, "C-MOS 2-Meter Synthesizer," *ham radio*, December, 1979.

ham radio

New Automatic Antenna Tuner Auto-Track Model AT 2500

Options Available at Extra Cost

Shown with Rack Mount

Shown with Front Panel Handles

Check these state-of-the-art specifications

- Power Capability: 2500 W PEP.
- Frequency Range: Continuous 3.0 to 30 MHz (Including WARC Bands).
- Impedance Matching: 10 ohms to 300 ohms to 50 ohms resistive.
- Direct Reading SWR Meter: 1:1 to infinity.
- Direct Reading Power Meter: Two meter scales from 0 W to 250 W and 0 W to 2500 W; front panel switch selects FWD or Reflected Power *(Illuminated panel meters)*.
- Power meter displays RMS with continuous carrier and automatically displays PEAK when driven with SSB signal.
- Average "Automatic" tune-up time: 15 seconds or less.
- Tune-up time not affected by power level; can be as low as 1 W (5-10 W preferred).
- A unique "Linear Disable" circuit automatically switches companion linear amplifier to standby within milliseconds whenever SWR exceeds the threshold preset on front panel, thus protecting the linear from excessive SWR.
- Toroidal bridge coupler provided in separate enclosure, permitting it to be installed directly at the output of the transmitter for meaningful SWR measurements.
- Power requirements are 115/230 VAC 50-60 Hz, 10 W operating/5 W standby; or 13.5 VDC, 1 A operating/.5 A standby.
- Antenna tuner packaged in cabinet 17"W x 5¼"H x 14"D (Front panel handles or rack mount optional).

Specifications subject to change without notice.

See us in Dayton in April and enter drawing for free AT 2500.

Write for literature.

J.W. Miller Division

BELL INDUSTRIES

19070 REYES AVE. ■ P.O. BOX 5825
COMPTON, CALIFORNIA 90224

More Details? CHECK—OFF Page 110

CW anyone?

A challenge to break the world's code-speed record

Have you been telling your wife and kids what a hot-shot code operator you were back in the big war? Your wife was probably impressed, and your kids were spellbound each time you related your war stories. Or perhaps you wax nostalgic over your wireless days in that rusty old oil tanker? Wasn't that the vessel whose officers recruited high-speed operators from Joe's waterfront bar? Didn't you copy code eight hours a day at 50 words a minute from that coastal station? A most remarkable achievement — particularly since that Navy station never transmitted faster than 18 words per minute!

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

a challenge

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

1. The first is a *sanctioned code contest* to determine a national CW champion.

2. Next is a challenge to manufacturers of CW-oriented equipment to provide a suitable gift certificate to make the effort worthwhile.

3. Finally, I propose that *ham radio* magazine sponsor and perpetuate this contest on an annual basis, with a special award to anyone *officially exceeding the current world's record*. Quite a challenge. Are you game?

code-speed record

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

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

By Harry W. Lewis, W7JWJ, 10352 Sandpoint Way, N.E., Seattle, Washington 98125

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

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

the competition

I know a number of operators who can copy Morse in excess of 75 words per minute. Just listen to Bill Eitel, W6UF, and the members of the Five-Star Net as they roar along at this speed. They can do it! Have you heard K7BW and his super speed contacts with N6AO? Watch Evelyn Headings, W7LLD, make a believer out of you as she copies at nearly 60 words per minute with a *pencil*. That's right — with a pencil. Can she break the world's record? Sure she can.

Jerry Ferrell, WB7VKI, has a certificate for 69.4 words per minute. Can he break the record? Well, he can as soon as he upgrades to General class and gets off the Novice bands. After that his code should begin to improve. However, he may be the first Novice to exceed 75 words per minute. There are many operators that can, and will, break this 42-year-old record. Why not this year?

getting started

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

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

contest rules

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

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

word count

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

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

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

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

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

ham radio

tracking satellites in elliptical orbits

Computer program and sample problem for tracking OSCAR

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

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

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

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

sample program

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

By **Paul C. Bunnell, WA6VJR,** 1053 Nordhal Road, San Marcos, California 92069

R02=	0.685
R03=	328
R10=	15
R11=	9
R12=	21.05
R14=	0.5592
R15=	0.8290
R16=	0.8387
R17=	118
R18=	210
R19=	3963.2
R20=	100
R21=	0.1768

table 1. Storage locations of problem variables.

R00	= λ
R01	= Re/Rs
R02	= e
R03	= Ps
R04	= COSδs
R05	= Γ or COSθ
R06	= E or SINλgs
R07	= δs or eCOSE−1
R08	= Δt
R09	= λs or SINθ
R10	= TIME INCR.
R11	= λref
R12	= Tref
R13	= SINδs
R14	= SINδg
R15	= COSδg
R16	= SINi
R17	= λg
R18	= Ω
R19	= Re
R20	= ORBIT
R21	= μ

table 2. Problem initial conditions.

GROUND TRACK

TIME	LAT	LONG	RNG
-315	-55.0	159.6	3.1
-300	-51.0	104.6	4.0
-285	-38.5	86.2	4.5
-270	-28.8	79.7	4.8
-255	-21.4	77.3	5.0
-240	-15.5	76.7	5.2
-225	-10.7	77.1	5.3
-210	-6.7	78.2	5.3
-195	-3.1	79.6	5.4
-180	0.0	81.3	5.4
-165	2.8	83.3	5.5
-150	5.4	85.4	5.5
-135	7.7	87.5	5.5
-120	10.0	89.8	5.6
-105	12.1	92.1	5.6
-90	14.1	94.5	5.6
-75	16.0	96.9	5.6
-60	17.8	99.4	5.6
-45	19.6	101.8	5.6
-30	21.4	104.2	5.6
-15	23.1	106.6	5.6
0	24.8	109.0	5.6
15	26.5	111.3	5.6
30	28.2	113.6	5.6
45	29.8	115.9	5.6
60	31.5	118.0	5.6
75	33.3	120.1	5.6
90	35.0	122.0	5.6
105	36.8	123.7	5.6
120	38.6	125.3	5.6
135	40.5	126.6	5.5
150	42.5	127.6	5.5
165	44.5	128.2	5.5
180	46.6	128.2	5.4
195	48.8	127.5	5.4
210	51.0	125.7	5.3
225	53.3	122.4	5.3
240	55.3	116.9	5.2
255	56.8	108.1	5.0
270	56.7	95.0	4.8
285	52.9	77.1	4.5
300	41.4	56.6	4.0
315	14.6	35.2	3.1

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

reference orbit No.	100
time reference at apogee (*Tref*)	21.0500 (HH.MMSS)
longitude reference at apogee (λ*ref*)	9°
inclination (i)	57°
argument of perigee (Ω)	210°
eccentricity (e)	0.685
period of ½ orbit (P_s)	328 minutes

The radius of the earth, R_e, is 3963.2 statute miles, the normalized gravational constant, μ', is 0.176842228. We will choose time increments of 15 minutes. These initial conditions are stored as shown in **table 2**. If ground track information is desired, the program is started at label **E**. The calculator halts and prompts you for the number of the orbit you wish to investigate. Let's look at orbit 105. Enter that number and press the **R/S** key to resume program execution. In a few minutes **table 3** is printed. The apogee is at time 0, negative times occur before apogee, and the RNG (maximum range) column is in 1000s of statute miles. Also note that negative latitudes are in the southern hemisphere. To print the range with dimensions of kilometers or nautical miles, it's only necessary to enter R_e in those units.

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

Another part of the program calculates satellite azimuth and elevation. Only lines in which the satellite is above the horizon are printed. Start the program at label **ST** and again enter orbit 105. **Table 4** is the result, showing how azimuth and elevation change with time. The asterisk locates the time of apogee. It's not necessary to re-enter any of the orbital constants to plot other orbits. But, keep in mind that elliptic orbits suffer pertubations with time, and the latest orbital parameters available should be used.

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

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

ORBIT 105

TIME	AZIMUTH	ELEVATION			
23:30	139	5	4:15	146	82
23:45	135	12	4:30	156	85
0:00	132	18	4:45	180	87
0:15	129	23	5:00	247	88
0:30	128	28	5:15	288	86
0:45	127	32	5:30	302	84
1:00	126	36	5:45	310	81
1:15	126	41	6:00	316	79
1:30	126	45	6:15	321	76
1:45	126	48	6:30	326	74
2:00	127	52	6:45	331	72
2:15	127	56	7:00	337	69
2:30	128	59	7:15	344	67
2:45	129	63	7:30	352	65
3:00	131	66	7:45	2	61
3:15	133	69	8:00	13	57
3:30	135	73	8:15	28	50
3:45*	137	76	8:30	44	36
4:00	141	79	8:45	62	11

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

bibliography

Davidoff, "AMSAT-OSCAR Phase III on the Horizon," *QST*, May, 1980, pages 46-50.

Davidoff, "Using Satellites in the Classroom; a Guide for Science Educations," Cantonsville Community College, Cantonsville, Maryland, 1978.

Bate, Mueller, and White, Fundamentals of Astrophysics, Dover Publications, New York, New York 1971.

appendix

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

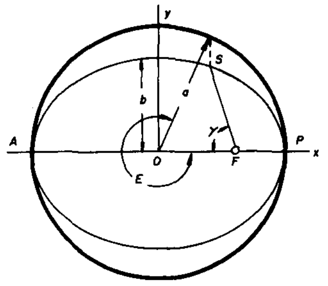


fig. 1. Geometry of the tracking problem for elliptical orbits.

A circle has been constructed with center, 0, bisecting AP, and with radius a. Angle E is identified as the elliptic anomaly, and Γ is the true anomaly. Both E and Γ are related to the mean anomaly, M (see **eqs. A1** and **A3**).

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

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

λ_0 is commonly called the longitude of the ascending node. It is derived from the argument of perigee, Ω. The location of the subsatellite point is given by latitude δs, and the longitude, λs. Rs is the instantaneous satellite distance from the center of the earth. The maximum range is an arc on the surface of the earth from the subsatellite point to a location where the satellite elevation drops to zero.

```
01◆LBL "ST"
02 XEQ 04
03 STO 00
04 CF 12
05 "TIME  A
ZIMUTH"
06 "⊢  ELEV
ATION"
07 AVIEW
08◆LBL 05
09 XEQ 01
10 FIX 2
11 60
12 /
13 RCL 12
14 HR
15 +
16 RND
17 FIX 0
18 24
19 MOD
20 INT
21 10
22 X>Y?
23 "⊢ "
24 ARCL Y
25 "⊢:"
26 LASTX
27 FRC
28 60
29 *
30 X<Y?
31 "⊢0"
32 ARCL X
33 RCL 08
34 X=0?
35 "⊢*"
36 X≠0?
37 "⊢ "
38 RCL 13
39 RCL 17
40 RCL 09
41 -
42 SIN
43 STO 06
44 X<> L
45 COS
46 RCL 15
47 *
48 RCL 04
49 *
50 RCL 14
51 RCL 13
52 *
53 +
54 STO 05
55 RCL 14
56 *
57 -
58 RCL 15
59 /
60 RCL 05
61 ACOS
62 SIN
63 STO 09
64 /
65 ACOS
66 RCL 06
67 SIGN
68 *
69 360
70 MOD
71 XEQ 08
72 "⊢        "
73 RCL 05
74 RCL 01
75 -
76 RCL 09
77 /
78 ATAN
79 XEQ 06
80 GTO 05
81◆LBL E
82 XEQ 04
83 STO 00
84 "GROUND
TRACK"
85 AVIEW
86 CF 12
87 ADV
88 "TIME
LAT"
89 "⊢   LON
G   RNG"
90 AVIEW
91◆LBL 03
92 XEQ 01
93 FIX 0
94 XEQ 02
95 FIX 1
96 RCL 07
97 XEQ 08
98 RCL 09
99 XEQ 08
100 RCL 01
101 ACOS
102 D-R
103 RCL 19
104 *
105 .1
106 %
107 XEQ 06
108 GTO 03
109◆LBL 01
110 FIX 6
111 1
112 RCL 08
113 RCL 03
114 /
115 -
116 PI
117 *
118 STO 06
119 ENTER↑
120◆LBL 00
121 CLX
122 RCL 06
123 R-D
124 RCL 02
125 P-R
126 1
127 -
128 STO 07
129 CLX
130 RCL 06
131 -
132 +
133 RND
134 RCL 07
135 /
136 ST- 06
137 X≠0?
138 GTO 00
139 RCL 06
140 R-D
141 COS
142 RCL 02
143 -
144 RCL 07
145 /
146 ACOS
147 RCL 08
148 SIGN
149 *
150 STO 05
151 RCL 18
152 +
153 XEQ 07
154 RCL 00
155 -
156 RCL 08
157 3.989
158 /
159 +
160 RCL 11
161 +
162 360
163 MOD
164 STO 09
165 1
166 RCL 02
167 RCL 05
168 COS
169 *
170 -
171 RCL 03
172 PI
173 /
174 2
175 ENTER↑
176 3
177 /
178 Y↑X
179 /
180 RCL 21
181 /
182 1
183 RCL 02
184 X↑2
185 -
186 /
187 STO 01
188 CLA
189 RCL 08
190 RTN
191◆LBL 08
192 "⊢ "
193◆LBL 02
194 RND
195 ENTER↑
196 ABS
197 X=Y?
198 "⊢ "
199 100
200 X>Y?
201 "⊢ "
202 SQRT
203 X>Y?
204 "⊢ "
205 ARCL Z
206 RTN
207◆LBL 04
208 FIX 0
209 SF 12
210 CF 29
211 "ORBIT
212 PROMPT
213 ARCL X
214 AVIEW
215 ADV
216 ENTER↑
217 X<> 20
218 -
219 RCL 03
220 *
221 2
222 /
223 ENTER↑
224 X<> 11
225 +
226 360
227 MOD
228 X<> 11
229 15
230 /
231 RCL 12
232 HR
233 +
234 24
235 MOD
236 HMS
237 STO 12
238 RCL 03
239 RCL 10
240 MOD
241 RCL 03
242 -
243 STO 08
244 RCL 18
245◆LBL 07
246 1
247 P-R
248 X<>Y
249 CHS
250 RCL 16
251 *
252 STO 13
253 ASIN
254 STO 07
255 COS
256 STO 04
257 /
258 ACOS
259 RCL 07
260 SIGN
261 *
262 RTN
263◆LBL 06
264 XEQ 02
265 RCL Z
266 X>0?
267 AVIEW
268 RCL 08
269 RCL 10
270 +
271 STO 08
272 RCL 03
273 X<Y?
274 STOP
275 .END.
```

Program listing for the Hewlett-Packard HP-41C programmable calculator.

additional definitions:

Ps = period of ½ orbit
e = eccentricity
i = inclination
Ω = argument of perigee
λref = longitude reference at apogee
Re = radius of earth
Rs = distance from earth center to satellite
μ' = normalized gravitational constant
δg = ground station latitude
λg = ground station longitude

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

$$Guess\ E = M$$

$$M' = e \sin\left(\frac{360E}{2\pi}\right) - E \quad \text{(A1)}$$

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

$$E' = E - \xi$$

$$If\ E' \neq E \quad \text{(A2)}$$

$$\Gamma = SIGN(\Delta t)\cos^{-1}\left(\frac{\cos E - e}{e\cos E - 1}\right) \quad \text{(A3)}$$

$$\delta o = \sin^{-1}(-\sin\Omega \sin i)$$

$$\lambda o = SIGN(\delta o)\cos^{-1}\left(\frac{\cos\Omega}{\cos\delta o}\right)$$

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

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

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

$$maximum\ range = \frac{Re}{1000}\,\frac{2\pi}{360}\left[\cos^{-1}\left(\frac{Re}{Rs}\right)\right]$$

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

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

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

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

Note: $SIGN(x) = -1$ if x is negative
$+1$ if x is positive or zero

ham radio

protection for your solid-state devices

Fail-safe regulator for bench supply reduces mortality rate

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

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

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

built-in protection

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

general-purpose regulator

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

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

$$P_o(max) = \frac{(E_{in})^2}{4R1}$$

where $E_{in} = 18.7$ (manufacturer's tolerance)
$R1 = 91\text{-}5\ percent$ (tolerance)

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

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

By Henry H. Cross, W1OOP, 111 Birds Hill Avenue, Needham, Massachusetts 02192

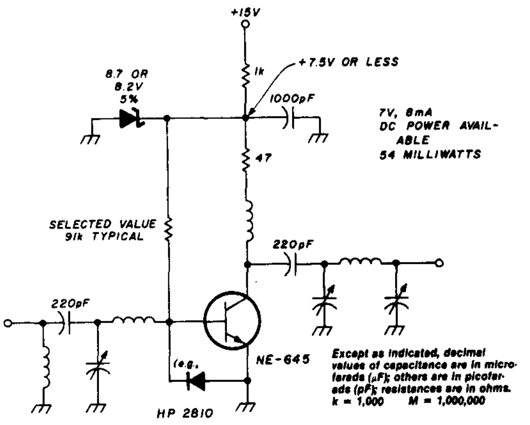


fig. 1. An amplifier with built-in protection.

current beyond this point will take the shunt regulator off-line, and the output voltage (and load power) will drop, as shown in **fig. 3**. The maximum current the regulator can supply is 198 milliamperes.

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

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

The bench power supply regulator also includes an adjustable 5-volt negative supply. A 741 op amp is included to provide good regulation; only a limited current capacity is needed. Gate bias should reduce (become less negative) in response to clockwise rotation of the control. V_D should increase with clockwise control rotation. In either case, *current* in-

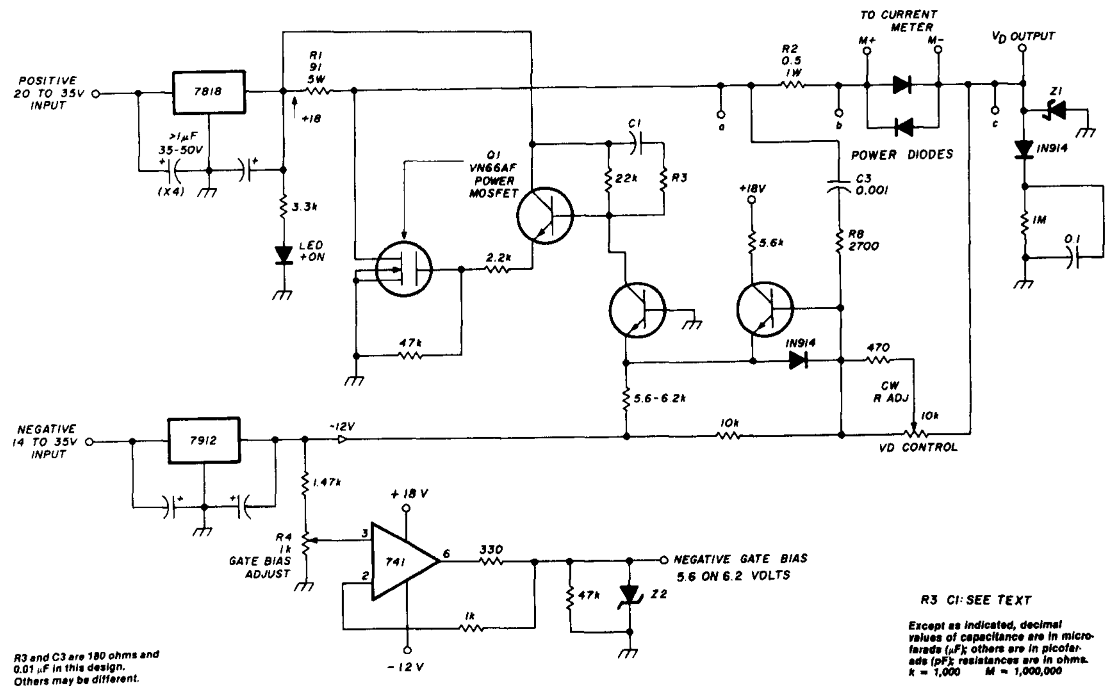


fig. 2. Basic essentials of a bench supply regulator.

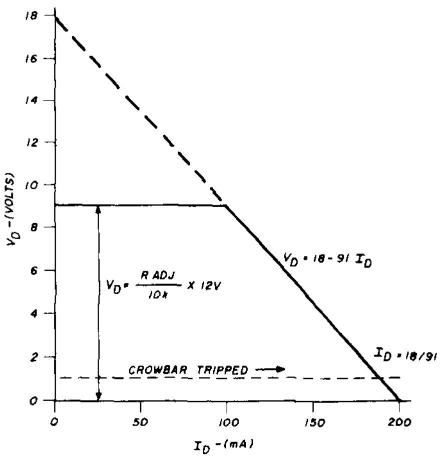


fig. 3. Performance of the general-purpose bench power-supply regulator. Maximum power condition is 98.9 milliamperes at 9 volts.

creases with clockwise rotation. With some additional effort, you may be able to adjust the control-circuit parameter values so that the output voltage and current match the dial readings.

low-voltage regulators

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

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

An LM339 comparator functions as an open-loop op amp. R6 is adjusted so that the output will go low if the regulator output exceeds 3.1 volts. When this happens, the trigger voltage goes high, firing the SCR. Note that the anode sustaining current is about

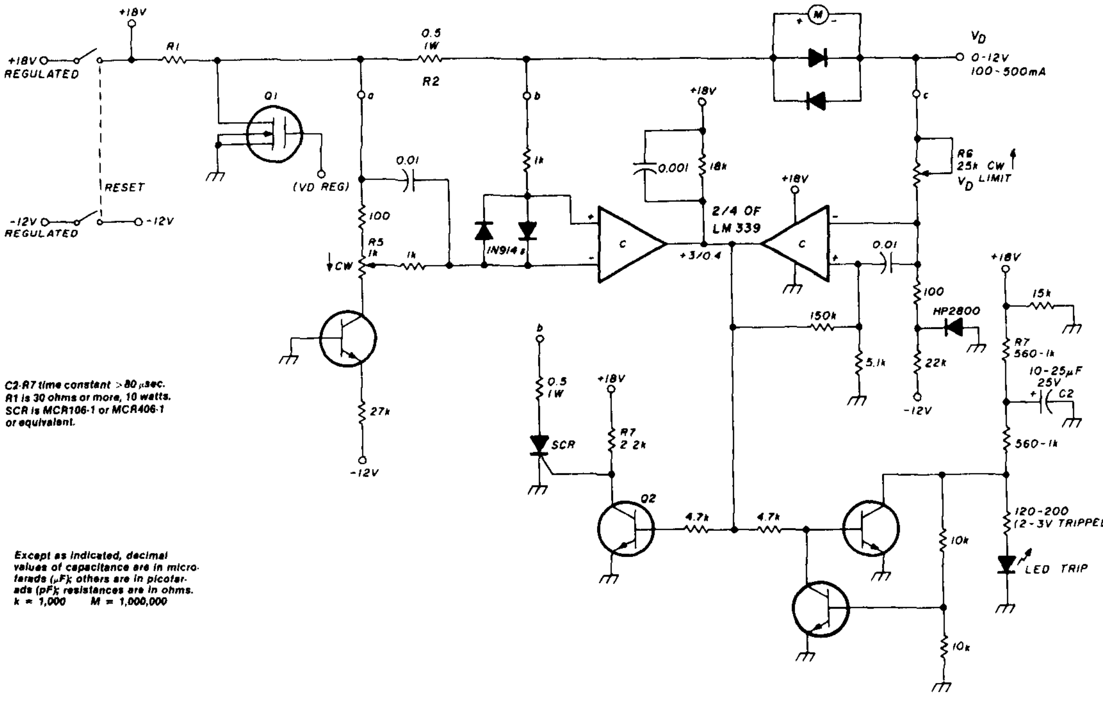


fig. 4. Crowbar circuit for low-voltage regulators.

More Details? CHECK—OFF Page 110

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

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

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

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

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

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

summary

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

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

Regulators should be equipped with limit controls on output voltage and current. (Limit controls should not be confused with adjustments.) Shunt-type regulators can be power limited and stable without requiring a large energy-storing, transistor-killing capacitor across the output terminals. Simple electronic biasing circuits are generally best.

ham radio

More Details? CHECK—OFF Page 110

Only TEN-TEC Offers A Money Back Guarantee.

See your nearest participating dealer for details on this new no-risk trial offer.

TEN-TEC PARTICIPATING DEALERS

Alabama
Alabama Treasure Hunter
Huntsville

California
Ham Radio Outlet
Anaheim
Ham Radio Outlet
Burlingame
Ham Radio Outlet
Oakland
Ham Radio Outlet
San Diego
Ham Radio Outlet
Van Nuys

Colorado
CW Electronics
Denver

Connecticut
Hatry Electronics
Hartford

Delaware
Delaware Amateur Supply
New Castle
Amateur & Advance Communications
Wilmington

Florida
Mike's Electronics
Fort Lauderdale
Hialeah Communications
Hialeah
Amateur Electronic Supply
Orlando

Idaho
Custom Electronics
Boise
Ross Distributing Co.
Preston

Illinois
Organs & Electronics
Lockport

Indiana
Lakeland Electronic Supply
Angola
The Ham Shack
Evansville
Electronic Communications Industries
South Bend

Iowa
Hi Inc.
Council Bluffs

Massachusetts
Tufts Radio Electronics
Medford

Michigan
Omar Electronics
Durand
Radio Parts, Inc.
Grand Rapids

Missouri
Henry Radio
Butler
Ham Radio Center, Inc.
St. Louis
Mid-Com Electronics
St. Louis

Nebraska
Omaha Amateur Center
Omaha

Nevada
Amateur Electronic Supply
Las Vegas

New Jersey
Radios Unlimited
Somerset

New Mexico
Pecos Valley Amateur Radio
Roswell

New York
Grand Central Radio
New York
Ham Radio World
Oriskany

North Carolina
Bino Communications
Greensboro

Ohio
Ken-Mar Industries
North Canton
Universal Amateur Radio
Reynoldsburg
Amateur Electronic Supply
Wickliffe

Oklahoma
Radio Incorporated
Tulsa

Oregon
Eugene Radio Supply
Eugene

Pennsylvania
Supelco Inc.
Bellefonte
South Hills Electronics
Pittsburgh
Carr Electronics
Telford
Ham Buerger Inc.
Willow Grove

South Carolina
GIZMO Communications
Rock Hill

South Dakota
Burgharat Amateur Center
Watertown

Tennessee
ARSON
Madison
Germantown Amateur Supply
Memphis
J-Tron
Springfield

Texas
Texas Tower
Plane

Virginia
Tuned Circuit
Harrisonburg
Radio Communications Co.
Roanoke

Washington
Amateur Radio Supply
Seattle
C-COM
Seattle

Wisconsin
Amateur Electronic Supply
Milwaukee

More Details? CHECK—OFF Page 110

Questions and Answers

Entries must be by letter or post card *only. No telephone requests will be accepted. All entries will be acknowledged when received. Those judged to be most informative to the most Amateurs will be published. Questions must relate to Amateur Radio.*

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

congratulations to...

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

narrow-band voice modulation

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

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

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

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

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

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

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

recommended reading

Harris, R.W., and Gorski, J.C., "A New Era Voice Communications," *QST*, December, 1977. Harris, R.W., and Cleveland, J.F., "A Baseband Communications System," *QST*, November, 1978 (part 1), and December, 1978 (part 2). Also, *The Radio Amateur's Handbook*, 57th edition, 1980, ARRL, Newington, Connecticut 06111, Chapter 14.

USB, LSB, or DSB?

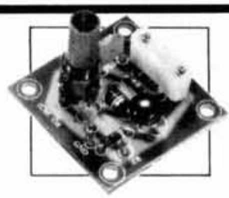
Would you please explain the difference between USB, LSB, and Double Sideband. Stephen Serio.

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

If the modulation takes place in a *balanced modulator*, the carrier is balanced out (nulled), and the result is two sidebands with no carrier, **B**.

FOR THE EXPERIMENTER

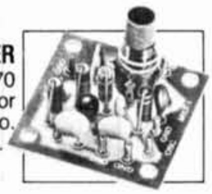
CRYSTALS & KITS/OSCILLATORS • RF MIXERS • RF AMPLIFIER • POWER AMPLIFIER



OX OSCILLATOR

Crystal controlled transistor type. 3 to 20 MHz, OX-Lo, Cat. No. 035100. 20 to 60 MHz, OX-Hi, Cat. No. 035101.

Specify when ordering. $6.31 ea.



MXX-1 TRANSISTOR RF MIXER

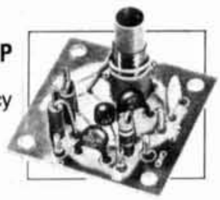
A single tuned circuit intended for signal conversion in the 3 to 170 MHz range. Harmonics of the OX or OF-1 oscillator are used for injection in the 60 to 170 MHz range. 3 to 20 MHz, Lo Kit, Cat. No. 035105. 20 to 170 MHz, Hi Kit, Cat. No. 035106.

Specify when ordering. $7.02 ea.

OF-1 OSCILLATOR

Resistor/capacitor circuit provides osc over a range of freq with the desired crystal. 2 to 22 MHz, OF-1 LO, Cat. No. 03t108, 18 to 60 MHz, OF-1 H Cat. No. 035109.

Specify when ordering. $5.42 ea.



PAX-1 TRANSISTOR RF POWER AMP

A single tuned output amplifier designed to follow the OX oscillator. Outputs up to 200 mw, depending on frequency and voltage. Amplifier can be amplitude modulated 3 to 30 MHz, Cat. No. 035104.

Specify when ordering. $7.34 ea.

SAX-1 TRANSISTOR RF AMP

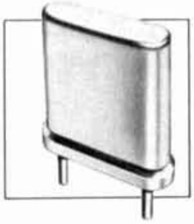
A small signal amplifier to drive the MXX-1 Mixer, Single tuned input and link output. 3 to 20 MHz, Lo Kit, Cat. No. 03512. 20 to 170 MHz, Hi Kit, Cat. No. 035103.

Specify when ordering. $7.02 ea.

BAX-1 BROADBAND AMP

General purpose amplifier which may be used as a tuned or untuned unit in RF and audio applications. 20 Hz to 150 MHz with 6 to 30 db gain. Cat. No. 035107.

Specify when ordering. $7.34 ea.



.02% Calibration Tolerance

EXPERIMENTER CRYSTALS (HC 6/U Holder)

Cat. No.	Specifications	
031080 *3 to 20 MHz	— For use in OX OSC Lo	$6.88 ea.
031081 *20 to 60 MHz	— For use in OX OSC Hi	$6.88 ea.
031300 *3 to 20 MHz	— For use in OF-1L OSC	$6.88 ea.
031310 *20 to 60 MHz	— For use in OF-1H OSC	$6.88 ea.

**Specify when ordering*

Shipping and postage (inside U.S., Canada and Mexico only) will be prepaid by International Prices quoted for U.S., Canada and Mexico orders only. Orders for shipment to other countries will be quoted on request.

ICM

INTERNATIONAL CRYSTAL MFG. CO., INC.
10 North Lee / Oklahoma City, Okla. 73102

Loop Antenna

Here is an exciting new device to improve your reception on 160, 80, the broadcast band, and on VLF.

It is well known that loops pick up far less noise than most other antennas. And they can null out interference. Now Palomar Engineers brings you these features and more in a compact, carefully engineered, attractive desktop package.

Unlike ordinary direction-finder loops, it tilts to match the incoming wave front. The result: Deep nulls up to 70 db. You have to listen to believe it!

Does the Loran on 160 give you a headache? The loop practically eliminates it. Broadcast station 2nd harmonic ruining your DX? Turn and tilt the loop and it's gone. Does your friend in the next block with his kilowatt block those weak ones? Use the loop and hear him fade out.

Loop nulls are very sharp on local and ground wave signals but usually are broad or nonexistent on distant skywave signals. This allows local interference to be eliminated while DX stations can still be heard from all directions.

The loops are Litz-wire wound on RF ferrite rods. They plug into the Loop Amplifier which boosts the loop signal 20 db and isolates and preserves the high Q of the loop. The tuning control peaks the loop and gives extra preselection to your receiver.

Plug-in loops are available for these bands:

- 10-40 KHz (Omega)
- 40-150 KHz (WWVB, Loran)
- 150-550 KHz (VLF)
- 540-1600 KHz (Broadcast)
- 1600-5000 KHz (160 & 80 meters)
- 5-15 MHz (HF-1)

Send for free descriptive brochure.

master charge THE INTERBANK CARD — VISA

Loop Amplifier $77.50; Plug-in Loop Antennas $59.95 each (specify frequency band). To order add $3 packing/shipping. California residents add sales tax.

Palomar Engineers

Box 455, Escondido, CA. 92025
Phone: [714] 747-3343

More Details? CHECK—OFF Page 110

The next step is to filter out the unwanted sideband by a mechanical or crystal filter that passes only the sideband you want, **C**. To obtain the other sideband, you could use another filter to pass that one and reject the unwanted one. However, that's too expensive.

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

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

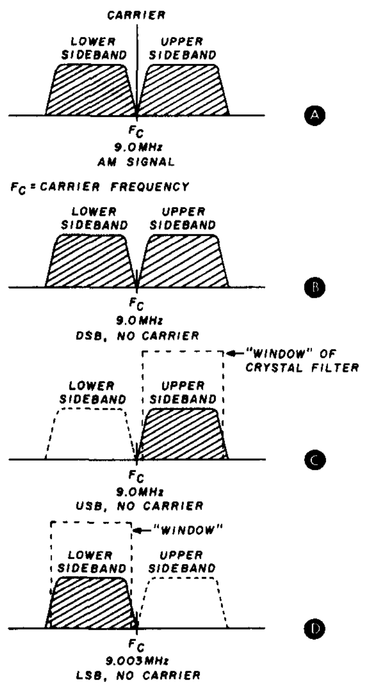


fig. 1. The derivation of DSB, LSB, and USB from an amplitude-modulated signal. Note that to obtain lower sideband, the carrier is moved to keep the desired sideband in the "window" of the filter, rather than use a separate filter, which would be very expensive. The frequencies shown are for illustration purposes only — SSB can be generated at any frequency and then heterodyned to the ham band of your choice.

final protection

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

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

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

velocity factor

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

Velocity factor is a property of transmission lines that must be taken into account when calculating the physical length of a tuned line or a matching transformer made from the line. The velocity of a radio wave traveling down the line is less than in free space. It varies from about 0.65 for polyethylene-dielectric coaxial cables to 0.975 for open-wire (air dielectric) transmission lines.

efficiency

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

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

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

ham radio

transmission-line circuit design

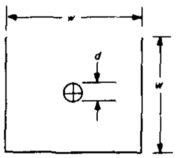
Using distributed resonant circuits for VHF/UHF transmission lines

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

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

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

circular wire in a square shield



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

$$Z_0 = \frac{59.96}{\sqrt{\epsilon_r}} \ln\left(1.0787\,\frac{w}{d}\right) \qquad (41)$$

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

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

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

step	HP-97 key	HP-97 code	step	HP-97 key	HP-97 code
001	*LBLA	21 11	036	STO5	35 05
002	STO0	35 00	037	5	05
003	√X	54	038	9	09
004	STO1	35 01	039	.	−62
005	RTN	24	040	9	09
006	*LBLB	21 12	041	6	06
007	STO2	35 02	042	÷	−24
008	R↓	−31	043	RCL1	36 01
009	STO3	35 03	044	X=0?	16-43
010	RCL2	36 02	045	GSB8	23 08
011	÷	−24	046	x	−35
012	STO4	35 04	047	e^x	33
013	*LBL1	21 01	048	1	01
014	1	01	049	.	−62
015	.	−62	050	0	00
016	0	00	051	7	07
017	7	07	052	8	08
018	8	08	053	7	07
019	7	07	054	÷	−24
020	x	−35	055	STO4	35 04
021	LN	32	056	R/S	51
022	5	05	057	*LBLD	21 14
023	9	09	058	STO4	35 04
024	.	−62	059	GTO1	22 01
025	9	09	060	*LBL9	21 09
026	6	06	061	1	01
027	x	−35	062	STO1	35 01
028	STO6	35 06	063	RCL6	36 06
029	RCL1	36 01	064	RCL1	36 01
030	X=0?	16-43	065	RTN	24
031	GSB9	23 09	066	*LBL8	21 08
032	÷	−24	067	1	01
033	STO5	35 05	068	STO1	35 01
034	R/S	51	069	RTN	24
035	*LBLC	21 13	070	R/S	51

By H.M. Meyer, Jr., W6GGV, 29330 Whitley Collins Drive, Rancho Palos Verdes, California 90274

table 36. Register contents for HP-67/97 program for calculating Z_0 and w/d for a wire in a square shield.	STO 0	ϵ_r
	STO 1	$\sqrt{\epsilon_r}$
	STO 2	d
	STO 3	w
	STO 4	w/d
	STO 5	Z_0
	STO 6	INTERIM

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

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

Note: If no value for ϵ_r is entered, program assumes $\epsilon_r = 1 = air$.

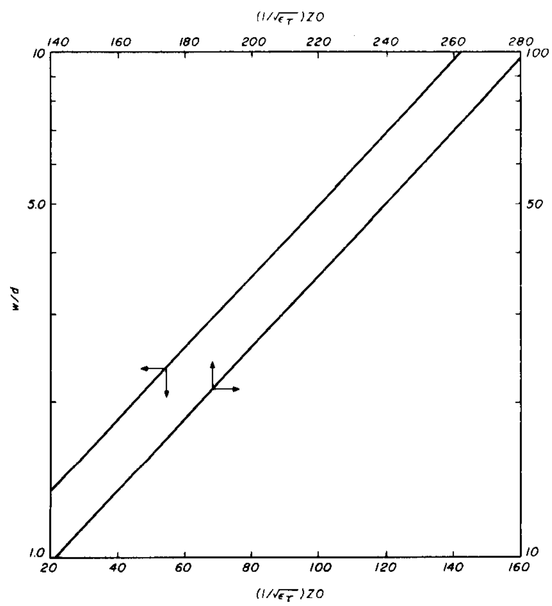
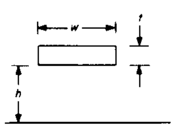


fig. 18. Z_0 versus w/d for a circular wire in a square shield.

stripline over a plane



This is perhaps one of the more useful transmission line configurations presently in use. Its applications are primarily stimulated by solid-state technology and the subsequent extensive use of microwave integrated circuits. One original formulation by S.B. Cohn (reference 6) was subsequently followed by M.V. Schneider (reference 7). The most accurate formulation known is by H.A. Wheeler (reference 3), and that is used here.

Table 38 identifies the method for calculating strip width, w, with h, t, Z_0, and ϵ_r known. The formulations from reference 3 are:*

$$\frac{w'}{h} = 8\,\frac{\sqrt{\left[e\,exp\left(\frac{Z_0}{42.4}\sqrt{\epsilon_r+1}\right)-1\right]\left[\frac{7+4/\epsilon_r}{11}+\frac{1+1/\epsilon_r}{0.81}\right]}}{\left[e\,exp\left(\frac{Z_0}{42.4}\sqrt{\epsilon_r+1}\right)-1\right]} \quad \textbf{(42)}$$

$$\frac{\Delta w}{t} = \frac{1}{\pi}\,\ell n\,\frac{4e}{\sqrt{\left(\frac{t}{h}\right)^2+\left(\frac{1/\pi}{w'/t-0.26}\right)^2}} \quad \textbf{(43)}$$

$$\Delta w' = \frac{1+1/\epsilon_r}{2}\Delta w \quad \textbf{(44)}$$

$$w = w' - \Delta w' \quad \textbf{(45)}$$

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

$$\frac{\Delta w}{t} = \frac{1}{\pi}\,\ell n\,\frac{4e}{\sqrt{\left(\frac{t}{h}\right)^2+\left(\frac{1/\pi}{w/t+1.10}\right)^2}} \quad \textbf{(46)}$$

$$\Delta w' = \frac{1+1/\epsilon_r\Delta w}{2} \quad \textbf{(47)}$$

$$w' = w + \Delta w' \quad \textbf{(48)}$$

$$Z_0 = \frac{42.4}{\sqrt{\epsilon_r+1}}\,\ell n\left\{1+\left(\frac{4h}{w'}\right)\left[\left(\frac{14+8/\epsilon_r}{11}\right)\left(\frac{4h}{w'}\right) + \sqrt{\left(\frac{14+8\epsilon_r}{11}\right)^2\left(\frac{4h}{w'}\right)^2+\left(\frac{1+1/\epsilon_r\pi}{2}\right)^2}\right]\right\} \quad \textbf{(49)}$$

table 38. Method of calculating strip width:

1. Specify h, t, Z_0, and ϵ_r (from **fig. 1K**).
2. Determine w/h (from **eq. 42** — yields w').
3. Determine Δw (from **eq. 43**).
4. Determine $\Delta w'$ (from **eq. 44**).
5. Determine w (from **eq. 45**).

table 39. Method of calculating line Z_0:

1. Specify h, t, ϵ_r, and w.
2. Determine Δw (from **eq. 46**).
3. Determine $\Delta w'$ (from **eq. 47**).
4. Determine w' (from **eq. 48**).
5. Determine Z_0 (from **eq. 49**).

*The expression in parentheses following *exp* indicates the power to which *e* is raised.

table 40. HP-67/97 program for calculating w and Z_0 for a stripline over a plane:

step	HP-97 key	HP-97 code	step	HP-97 key	HP-97 code	step	HP-97 key	HP-97 code	step	HP-97 key	HP-97 code
001	*LBLA	21 11	056	STO9	35 09	111	*LBL2	21 02	166	1	01
002	STO0	35 00	057	RCL1	36 01	112	RCL4	36 04	167	4	04
003	RTN	24	058	1/X	52	113	RCL3	36 03	168	+	– 55
004	*LBLB	21 12	059	1	01	114	÷	– 24	169	1	01
005	STO1	35 01	060	+	– 55	115	1	01	170	1	01
006	RTN	24	061	.	– 62	116	.	– 62	171	÷	– 24
007	*LBLC	21 13	062	8	08	117	1	01	172	X²	53
008	STO2	35 02	063	1	01	118	+	– 55	173	RCL8	36 08
009	RTN	24	064	÷	– 24	119	Pi	16-24	174	4	04
010	*LBLD	21 14	065	RCL8	36 08	120	x	– 35	175	x	– 35
011	STO3	35 03	066	+	– 55	121	1/X	52	176	X²	53
012	RTN	24	067	√X	54	122	X²	53	177	x	– 35
013	*LBLE	21 15	068	RCL7	36 07	123	STO7	35 07	178	RCL7	36 07
014	STO4	35 04	069	÷	– 24	124	RCL3	36 03	179	+	– 55
015	RTN	24	070	8	09	125	RCL2	36 02	180	√X	54
016	*LBLa	21 16 11	071	x	– 35	126	÷	– 24	181	STO7	35 07
017	STOI	35 46	072	STO6	35 06	127	X²	53	182	8	08
018	GSB;	23 45	073	RCL2	36 02	128	RCL7	36 07	183	RCL1	36 01
019	*LBL9	21 09	074	x	– 35	129	+	– 55	184	÷	– 24
020	RCL1	36 01	075	STOC	35 13	130	√X	54	185	1	01
021	1/X	52	076	RCL3	36 03	131	1/X	52	186	4	04
022	1	01	077	÷	– 24	132	1	01	187	+	– 55
023	+	– 55	078	.	– 62	133	eˣ	33	188	1	01
024	2	02	079	2	02	134	x	– 35	189	1	01
025	÷	– 24	080	6	06	135	4	04	190	÷	– 24
026	RCL5	36 05	081	–	– 45	136	x	– 35	191	RCL8	36 08
027	x	– 35	082	Pi	16-24	137	LN	32	192	4	04
028	STOA	35 11	083	x	– 35	138	Pi	16-24	193	x	– 35
029	RTN	24	084	1/X	52	139	1/X	52	194	x	– 35
030	*LBL1	21 01	085	X²	53	140	x	– 35	195	RCL7	36 07
031	RCL1	36 01	086	RCL3	36 03	141	STOB	35 12	196	+	– 55
032	1	01	087	RCL2	36 02	142	RCL3	36 03	197	RCL8	36 08
033	+	– 55	088	÷	– 24	143	x	– 35	198	4	04
034	√X	54	089	X²	53	144	STO5	35 05	199	x	– 35
035	RCL0	36 00	090	+	– 55	145	GSB9	23 09	200	x	– 35
036	x	– 35	091	√X	54	146	RCL4	36 04	201	1	01
037	4	04	092	1/X	52	147	+	– 55	202	+	– 55
038	2	02	093	4	04	148	STOC	35 13	203	LN	32
039	.	– 62	094	x	– 35	149	RCL1	36 01	204	STO7	35 07
040	4	04	095	1	01	150	1/X	52	205	RCL1	36 01
041	÷	– 24	096	eˣ	33	151	1	01	206	1	01
042	eˣ	33	097	x	– 35	152	+	– 55	207	+	– 55
043	1	01	098	LN	32	153	2	02	208	√X	54
044	–	– 45	099	Pi	16-24	154	÷	– 24	209	1/X	52
045	STO7	35 07	100	÷	– 24	155	Pi	16-24	210	4	04
046	4	04	101	STO9	35 09	156	X²	53	211	2	02
047	RCL1	36 01	102	RCL3	36 03	157	x	– 35	212	.	– 62
048	÷	– 24	103	x	– 35	158	STO7	35 07	213	4	04
049	7	07	104	STO5	35 05	159	RCL2	36 02	214	x	– 35
050	+	– 55	105	GSB9	23 09	160	RCLC	36 13	215	RCL7	36 07
051	1	01	106	CHS	– 22	161	÷	– 24	216	x	– 35
052	1	01	107	RCLC	36 13	162	STO8	35 08	217	STO0	35 00
053	÷	– 24	108	+	– 55	163	8	08	218	R / b s	51
054	RCL7	36 07	109	STO4	35 04	164	RCL1	36 01			
055	x	– 35	110	R/S	51	165	÷	– 24			

Table 40 is the HP-67/97 program used to calculate Z_0 and w. **Table 41** identifies the storage registers used, and **table 42** describes how the program is controlled.

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

table 41. Register contents for HP-67/97 program for calculating w and Z_0 for a stripline over a plane:

STO 0	Z_0	STO 7	INTERIM
STO 1	k	STO 8	INTERIM
STO 2	h	STO 9	$\Delta w/h$
STO 3	t	STO A	$\Delta w'$
STO 4	w	STO B	$\Delta w/t$
STO 5	Δw	STO C	w'
STO 6	w'/h	STO D	h/w'

table 42. HP-67/97 program control for calculating w and Z_0 for a stripline over a plane:

enter Z_0	press A
enter ϵ_r	press B
enter h	press C
enter t	press D
enter w	press E

Enter any four of the above; select one of the following parameters:

$1 - w$
$2 - Z_0$

and press fa.

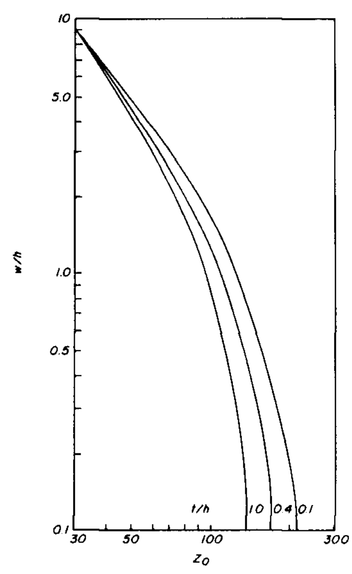


fig. 19. Z_0 versus w/h for selected values of t/h for a stripline over a plane, $\epsilon_r = 1$.

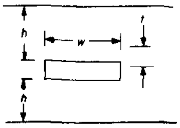
table 43. Values of Z_0 for w/h versus t/h for various values of ϵ_r for a stripline over a plane:

w/h	t/h 0.1	0.2	0.4	1.0
	$\epsilon_r = 1.0$			
0.1	212.83	190.9	166.47	135.65
0.4	161.66	151.47	138.21	118.19
0.8	137.49	123.38	115.17	101.71
1.0	124.98	113.56	106.73	95.26
4	56.92	54.75	53.31	50.60
8	34.3	33.56	33.04	32.04
10	28.79	28.27	27.90	27.19
	$\epsilon_r = 4$			
0.1	137.60	126.19	112.69	94.68
0.4	100.17	95.59	89.26	79.01
0.8	78.11	75.59	71.94	65.57
1.0	70.88	68.84	65.87	60.58
4	31.21	30.85	30.29	29.22
8	18.36	18.24	18.05	17.68
10	15.23	15.20	15.07	14.81
	$\epsilon_r = 4.6$			
0.1	130.145	119.501	106.856	89.932
0.4	94.533	90.279	84.411	74.853
0.8	73.616	71.281	67.907	61.996
1.0	66.766	64.887	62.140	57.240
4	29.288	28.955	28.445	27.460
8	17.195	17.084	16.912	16.571
10	14.306	14.230	14.111	13.875
	$\epsilon_r = 8$			
0.1	102.94	94.87	85.17	72.05
0.4	74.28	71.12	66.73	59.50
0.8	57.62	55.90	53.40	48.98
1.0	52.18	50.80	48.77	45.12
4	22.64	22.40	22.03	21.31
8	13.21	13.13	13.01	12.76
10	10.97	10.92	10.83	10.66
	$\epsilon_r = 12$			
0.1	85.76	79.16	71.21	60.39
0.4	61.69	59.14	55.58	49.68
0.8	47.76	46.38	44.36	40.78
1.0	43.22	42.12	40.48	37.53
4	18.65	18.46	18.16	17.59
8	10.86	10.79	10.69	10.50
10	9.01	8.96	8.90	8.76
	$\epsilon_r = 16$			
0.1	75.04	69.33	62.42	53.01
0.4	53.89	51.69	48.62	43.52
0.8	41.69	40.50	38.76	35.67
1.0	37.71	36.76	35.35	32.81
4	16.23	16.06	15.81	15.32
8	9.43	9.38	9.29	9.13
10	7.82	7.79	7.73	7.61

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

The HP-67/97 program was written in this manner to provide a built-in self-check. No graphs are provided for this configuration except for $\epsilon_r = 1$ in **fig. 19**. This is because their number is too numerous to present all of the variables. **Table 43**, for which the value of Z_0 is given for useful values of w/h versus t/h, also provides for values of ϵ_r of 1, 4, 8, 12, and 16. From these data additional graphs can be prepared covering specific ranges of interest.

stripline centered between parallel planes



Previously, the impedance of a stripline centered between parallel planes could be determined only from the work published in reference 6 and a subsequent distillation in reference 4. However, H.A. Wheeler, in 1978 (reference 2), provided an empirically derived formulation permitting direct synthesis with excellent accuracy. This is done in much the same way as for a stripline over a plane previously discussed.

$$\frac{\Delta w}{t} = \frac{1}{\pi}\,\ell n \frac{e}{\sqrt{\left(\frac{1}{\frac{4h}{t}+1}\right)^2 + \left(\frac{1}{4\pi\frac{w'}{t} - 0.26}\right)^m}} \quad \textbf{(50)}$$

$$\frac{w'}{h} = \frac{16}{\pi}\,\frac{\sqrt{(e^{4\pi r} - 1) + 1.568}}{(e^{4\pi r} - 1)} \quad \textbf{(51)}$$

$$w = w' - w \quad \textbf{(52)}$$

where

$$r = \frac{\sqrt{\epsilon_r}\,Z_0}{377} \quad \textbf{(53)}$$

$$m = \frac{6}{3 + \frac{t}{h}} \quad \textbf{(54)}$$

table 44. Method of calculating stripline width:

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

table 45. Method of calculating stripline Z_0:

1. Determine $\frac{\Delta w}{t}$ (from **eq. 55**).
2. Determine w' (from **eq. 56**).
3. Determine Z_0 (from **eq. 57**).

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

$$\frac{\Delta w}{t} = \frac{\ell n}{\pi} \frac{e}{\sqrt{\left(\frac{1}{\frac{4h}{t}+1}\right)^2 + \left(\frac{1}{4\pi\frac{w}{t} + 1.1}\right)^m}} \quad \textbf{(55)}$$

$$w' = w + \Delta w \quad \textbf{(56)}$$

$$Z_0 = \frac{30}{\sqrt{\epsilon_r}}\,\ell n \left[1 + \frac{1}{2}\left(\frac{16h}{\pi w'}\right)\left[\left(\frac{16h}{\pi w'}\right) + \sqrt{\left(\frac{16h}{\pi w'}\right)^2 + 6.27}\right]\right] \quad \textbf{(57)}$$

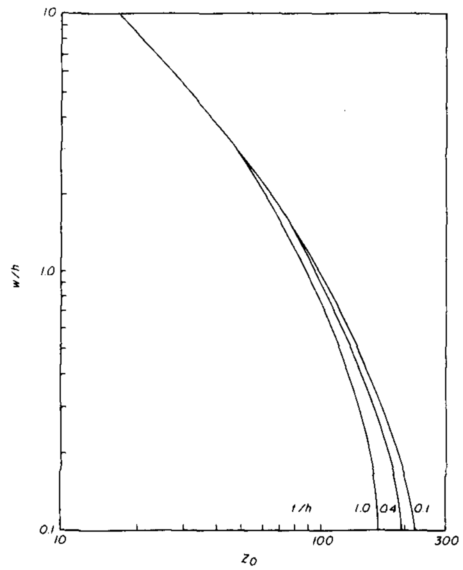


fig. 20. Z_0 versus w/h for values of t/h for a stripline between parallel planes, $\epsilon_r = 1$.

where m is defined in **eq. 54**.

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

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

Fig. 20 displays w/h versus various values of t/h and the resulting Z_0 for $\epsilon_r = 1$; that is, air. **Table 49** provides the same data for various values of ϵ_r, which are not plotted.

table 46. HP-67/97 program for calculating w and Z_0 for a stripline between ground planes:

step	HP-97 key	HP-97 code	step	HP-97 key	HP-97 code	step	HP-97 key	HP-97 code	step	HP-97 key	HP-97 code
001	*LBLA	21 11	052	÷	– 24	103	R/S	51	154	STO9	35 09
002	STO0	35 00	053	1	01	104	*LBL9	21 09	155	1	01
003	RTN	24	054	6	06	105	RCL5	36 05	156	6	06
004	*LBLB	21 12	055	x	– 35	106	3	03	157	Pi	16-24
005	DSP4	– 63 04	056	Pi	16-24	107	+	– 55	158	÷	– 24
006	√X	54	057	÷	– 24	108	1/X	52	159	RCL3	36 03
007	STO1	35 01	058	STO8	35 08	109	6	06	160	x	– 35
008	RTN	24	059	RCL3	36 03	110	x	– 35	161	RCL9	36 09
009	*LBL8	21 08	060	x	– 35	111	STO6	35 06	162	÷	– 24
010	RCL0	36 00	061	STO9	35 09	112	RTN	24	163	X^2	53
011	x	– 35	062	RCL4	36 04	113	*LBL2	21 02	164	6	06
012	3	03	063	÷	– 24	114	RCL8	36 13	165	.	– 62
013	7	07	064	.	– 62	115	RCL4	36 04	166	2	02
014	7	07	065	2	02	116	÷	– 24	167	7	07
015	÷	– 24	066	6	06	117	1	01	168	+	– 55
016	STO2	35 02	067	–	– 45	118	.	– 62	169	√X	54
017	RTN	24	068	Pi	16-24	119	1	01	170	STOA	35 11
018	*LBLC	21 13	069	4	04	120	–	– 55	171	RCL3	36 03
019	STO3	35 03	070	x	– 35	121	Pi	16-24	172	RCL9	36 09
020	RTN	24	071	x	– 35	122	4	04	173	÷	– 24
021	*LBLD	21 14	072	1/X	52	123	x	– 35	174	STOE	35 15
022	STO4	35 04	073	RCL6	36 06	124	1/X	52	175	1	01
023	RCL3	36 03	074	Y^x	31	125	GSB9	23 09	176	6	06
024	÷	– 24	075	STOA	35 11	126	RCL6	36 06	177	Pi	16-24
025	STO5	35 05	076	RCL3	36 03	127	Y^x	31	178	÷	– 24
026	GSB9	23 09	077	4	04	128	STOA	35 11	179	x	– 35
027	R/S	51	078	x	– 35	129	RCL3	36 03	180	RCLA	36 11
028	*LBLa	21 16 11	079	RCL4	36 04	130	4	04	181	+	– 55
029	STOI	35 46	080	÷	– 24	131	x	– 35	182	STOA	35 11
030	GSB1	23 45	081	1	01	132	RCL4	36 04	183	RCLE	36 15
031	*LBLE	21 15	082	+	– 55	133	÷	– 24	184	1	01
032	STOC	35 13	083	1/X	52	134	1	01	185	6	06
033	RTN	24	084	X^2	53	135	+	– 55	186	Pi	16-24
034	*LBL1	21 01	085	RCLA	36 11	136	1/X	52	187	÷	– 24
035	GSB8	23 08	086	+	– 55	137	X^2	53	188	x	– 35
036	Pi	16-24	087	√X	54	138	RCLA	36 11	189	2	02
037	4	04	088	1/X	52	139	+	– 55	190	÷	– 24
038	x	– 35	089	1	01	140	√X	54	191	RCLA	36 11
039	x	– 35	090	e^x	33	141	1/X	52	192	x	– 35
040	e^x	33	091	x	– 35	142	1	01	193	1	01
041	1	01	092	LN	32	143	e^x	33	194	+	– 55
042	–	– 45	093	Pi	16-24	144	x	– 35	195	LN	32
043	STO7	35 07	094	÷	– 24	145	LN	32	196	3	03
044	1	01	095	STOB	35 12	146	Pi	16-24	197	0	00
045	.	– 62	096	RCL4	36 04	147	÷	– 24	198	x	– 35
046	5	05	097	x	– 35	148	STOB	35 12	199	RCL1	36 01
047	6	06	098	STOC	35 13	149	RCL4	36 04	200	÷	– 24
048	8	08	099	CHS	– 22	150	x	– 35	201	STO0	35 00
049	+	– 55	100	RCL9	36 09	151	STOD	35 14	202	R/S	51
050	√X	54	101	+	– 55	152	RCLC	36 13			
051	RCL7	36 07	102	STOD	35 14	153	+	– 55			

table 47. Register contents for HP-67/97 program for calculating w and Z_0 for stripline between ground planes:

STO 0	Z_0	STO 8	w'/h
STO 1	$\sqrt{\epsilon_r}$	STO 9	w'
STO 2	r	STO A	INTERIM CALC
STO 3	h	STO B	$\Delta w/t$
STO 4	t	STO C	w
STO 5	t/h	STO D	Δw
STO 6	m	STO E	h/w'
STO 7	$e^{4\pi r}$		

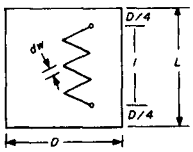
table 48. HP-67/97 program control for calculating w and Z_0 for a stripline between ground planes:

enter Z_0	press A
enter ϵ_r	press B
enter h	press C
enter t	press D
enter w	press E

Enter any four of the above; select one of the following parameters,

w	press 1
Z_0	press 2

and press fa.



helical resonator

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

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

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

A sample problem was run. The line Z_0 was specified at 70 ohms at 144 MHz, and all the resonator parameters were determined: $D = 0.97$ *inch*, $d = 0.53$ *inch*, $L = 1.46$ *inches*, $n = 13.57$ *turns*, $Q\mu$ *circular* $= 583$, and $Q\mu$ *square* $= 700$. Where square and circular, refer to the outside cavity configuration.

table 52. Register contents for HP-67/97 program for calculating helical-resonator parameters.

STO 1	Z_0
STO 2	F
STO 3	D
STO 4	d
STO 5	L
STO 6	n
STO 7	$Q\mu$ circular
STO 8	$Q\mu$ square
STO 9	PITCH

table 49. Values of Z_0 for w/h versus t/h for various values of ϵ_r for a stripline between parallel planes:

w/h	t/h 0.1	0.2	0.4	1.0
$\epsilon_r = 1.0$				
0.1	229.34	221.95	206.47	166.70
0.4	151.45	149.38	144.46	127.64
0.8	112.06	111.05	108.57	99.43
1.0	99.79	99.00	97.06	89.77
4	38.33	38.21	37.93	36.78
8	21.14	21.12	21.02	20.66
10	17.29	17.26	17.21	16.97
$\epsilon_r = 4$				
0.1	114.67	110.97	103.24	83.35
0.4	75.72	74.69	72.23	63.82
0.8	56.03	55.53	54.29	49.72
1.0	49.89	49.50	48.53	44.88
4	19.16	19.11	18.96	18.39
8	10.57	10.55	10.51	10.33
10	8.64	8.63	8.60	8.48
$\epsilon_r = 8$				
0.1	81.08	78.47	73.00	58.94
0.4	53.54	52.82	51.10	45.13
0.8	39.62	39.26	38.39	35.15
1.0	35.28	35.00	34.32	31.74
4	13.55	13.51	13.41	13.00
8	7.47	7.46	7.43	7.31
10	6.11	6.10	6.08	6.00
$\epsilon_r = 12$				
0.01	94.71	85.72	73.46	53.84
0.04	79.58	75.25	67.52	51.71
0.1	66.21	64.07	59.60	48.12
0.4	43.72	43.12	41.70	36.85
0.8	32.35	32.06	31.34	28.70
1.0	28.81	28.58	28.02	25.91
4	11.07	11.03	10.95	10.62
8	6.10	6.09	6.07	5.97

table 50. Method of calculating helical-resonator parameters:

1. Specify Z_0 (ohms) and frequency (MHz).
2. Calculate D, d, L, n, $Q\mu$ circular, $Q\mu$ square, and coil pitch from the equations below.

$$D = \frac{9800}{F Z_0}$$

$$d = 0.55D$$

$$L = 1.5D$$

$$n = \frac{1900}{F D}$$

$$Q\mu \text{ circular} = 50\sqrt{F D}$$

$$Q\mu \text{ square} = 1.2\, Q\mu$$

$$\text{coil pitch} = \frac{D^2 F}{2300} = \frac{L \cdot D/2}{n}$$

table 51. HP-67/97 program for calculating helical resonator parameters:

step	HP-97 key	HP-97 code	step	HP-97 key	HP-97 code
001	*LBLA	21 11	041	x	-35
002	STO1	35 01	042	1/X	52
003	RTN	24	043	1	01
004	*LBLB	21 12	044	9	09
005	STO2	35 02	045	0	00
006	RTN	24	046	0	00
007	*LBLa	21 16 11	047	x	-35
008	STOI	35 46	048	STO6	35 06
009	GSB1	23 45	049	R/S	51
010	*LBL1	21 01	050	*LBL5	21 05
011	RCL1	36 01	051	RCL2	36 02
012	RCL2	36 02	052	$\sqrt{X}$	54
013	x	-35	053	RCL3	36 03
014	1/X	52	054	x	-35
015	9	09	055	5	05
016	8	08	056	0	00
017	0	00	057	x	-35
018	0	00	058	STO7	35 07
019	x	-35	059	R/S	51
020	STO3	35 03	060	*LBL6	21 06
021	R/S	51	061	RCL7	36 07
022	*LBL2	21 02	062	1	01
023	RCL3	36 03	063	.	-62
024	.	-62	064	2	02
025	5	05	065	x	-35
026	5	05	066	STO8	35 08
027	x	-35	067	R/S	51
028	STO4	35 04	068	*LBL7	21 07
029	R/S	51	069	RCL3	36 03
030	*LBL3	21 03	070	X^2	53
031	RCL3	36 03	071	RCL2	36 02
032	1	01	072	x	-35
033	.	-62	073	2	02
034	5	05	074	3	03
035	x	-35	075	0	00
036	STO5	35 05	076	0	00
037	R/S	51	077	÷	-24
038	*LBL4	21 04	078	STO9	35 09
039	RCL2	36 02	079	R/S	51
040	RCL3	36 03			

table 53. HP-67/97 program control for calculating helical-resonator parameters:

enter Z_0	press A
enter F_{MHz}	press B
Enter both of the above; select one of the following parameters:	
D	press 1
d	press 2
L	press 3
n	press 4
$Q\mu$ circular	press 5
$Q\mu$ square	press 6
Pitch	press 7
and press fa.	

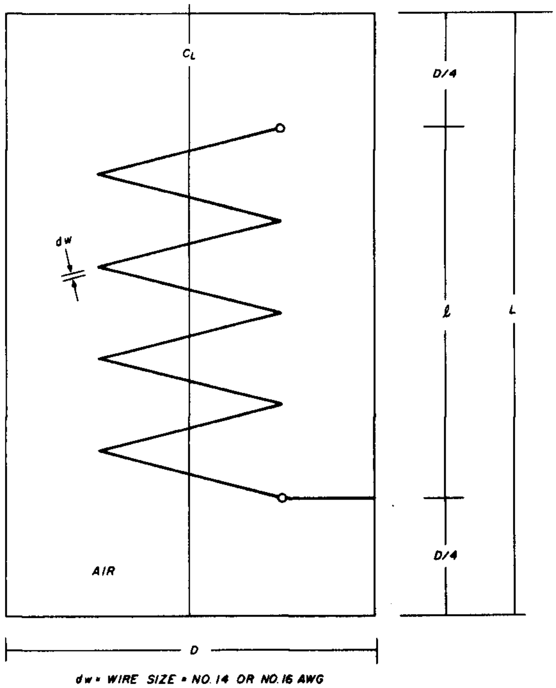


fig. 21. Helical resonator configuration.

acknowledgments

Comments by S. Harrison, WB6PKA, Dr. R.M. Searing, and T.C. McDermott, III, N5EG, are gratefully acknowledged. The most valuable contributions were provided by B.L. Reardon, to whom the author is singularly indebted.

references

2. H.A. Wheeler, "Transmission Line Properties of a Stripline Between Parallel Planes," *IEEE Professional Group on Microwave Theory and Techniques*, Volume MIT 26 No. 11, November, 1978, pages 866-876.
3. H.A. Wheeler, "Transmission Line Properties of a Strip on a Dielectric Sheet on a Plane," *IEEE Transactions on Microwave Theory and Techniques*, Volume MIT 25, August, 1977, pages 631-647.
4. *Reference Data for Radio Engineers*, ITT Corporation, 5th Edition, 1968 (included in subsequent editions).
5. S.B. Cohn, *Microwave Journal*, November, 1969, page 22.
6. S.B. Cohn, "Problems in Strip Transmission Lines," *IRE Professional Group on Microwave Theory and Techniques*, Volume MIT 3, March, 1955, pages 119-126.
7. M.V. Schnieder, "Microstrip Lines for Microwave Integrated Circuits," *Bell System Technical Journal*, Volume 48, May, 1969, pages 1421-1444.
8. D.S. Evans, *et. al.*, *UHF Handbook*, Radio Society of Great Britain, 3rd Edition, London, England, 1976, pages 3-7.
9. Anatol I. Zverev, *Handbook of Filter Synthesis*, John Wiley and Sons, 1967.

bibliography

Bahl, Dr. K.J., "Use Exact Methods for Microstrip Design," *Microwaves*, December, 1978, pages 61-62.
Fisk, J.R., W1HR, "Microstrip Transmission Lines," *ham radio*, January, 1978, page 28.
Gardiol, F.E., "HP-65 Program computes Microstrip Impedance," *Microwaves*, December, 1977, pages 186-187.
"Letters to the Editor," *Microwave Systems News*, December, 1978, pages 13-14.
Murdock, B.K., *Handbook of Electronics Design and Analysis Procedures Using Programmable Calculators*, Van Nostrand Reinhold, 1979.

ham radio

UNADILLA

FULL POWER - QUALITY

HAM ANTENNA ACCESSORIES

at your dealer

LONDON:	AMCOMM 01 804 1166
VICTORIA:	Scalar 725 9677
CONCEPCION:	Telecom Trans Chile 25471
BUENOS AIRES:	Multi-Radio 773-1266
COL. ANAHUAC:	Radiac 2-50-32-40
HELSINKI:	Erikoismediat (90) 611258
AUSTRIA	Renox Telex: 76021
FRANCE	SFL (90) 5339 40
GERMANY	Williges (0421) 504021

the Big Signal
W2AU
Balun

HAMS - call for our free catalog PC-80

DEALERS - join over 400 dealers world-wide. Call us today for no-risk deal.

HAMFEST MANAGERS - UNADILLA cooperates! Call us.

US - TOLL-FREE 1-800-448-1666
NY/Hawaii/Alaska/Canada - COLLECT 1-315-437-3953
TWX - 710-541-0493

Ask for Bonnie, or Emily.

For over 20 years, the choice of Hams, *Armed Forces* and Commercial Communications - world-wide.

the Old reliable
W2VS Traps

"HELICAN-10"

10-Meter
Indoor
Helix
Antenna

- Lo-Pass Filter 2000W
- Quad Parts
- Baluns / Traps
- Insulators
- Wire & Cable
- Connectors
- Antenna Kits

UNADILLA / REYCO Division Microwave Filter Co., Inc., E. Syracuse, NY 13057

HUSTLER ANTENNAS

5BTV	5-Band trap vertical 10-80 m., reg. $139.95	$125.95
4BTV	4-Band trap vertical 10-40 m., reg. $109.95	98.96
BM-1	Bumper mount, reg. $18.95	17.06
MO-1	Mast, fold-over, deck mounting, reg. $22.95	20.66
MO-2	Mast, fold-over, bumper mount, reg. $22.95	20.66
RM-75	Resonator, 75 meters, 400 watt, reg. $18.95	17.06
RM-40	Resonator, 40 meters, 400 watt, reg. $16.95	15.26
RM-40S	Super resonator, 40 meters, KW, reg. $24.95	22.46
RM-20	Resonator, 20 meters, 400 watt, reg. $14.95	13.46
RM-20S	Super resonator, 20 meters, KW, reg. $21.95	19.76
RM-15	Resonator, 15 meters, 400 watt, reg. $10.95	9.86
RM-10	Resonator, 10 meters, 400 watt, reg. $10.95	9.86
CG-144	Mobile 2 meter colinear, w/o mount, reg. $28.95	26.06
CGT-144	2 meter colinear w/trunk mount, reg. $45.95	41.36

PALOMAR ENGINEERS

		Price	Shpg.
R-X	Noise bridge	$ 55.00	$2.00
VLF	Converter	59.95	2.00
IK	Toriod balun, 3 KW SSB, 1:1 or 4:1	32.50	2.00
2K	Toriod balun, 6 KW SSB, 1:1 or 4:1	42.50	2.00
IC	Keyer, battery operated	117.50	3.00
Loop Antenna, plug-in units, 160/80, BCB, VLF		47.50	2.00
Loop Amplifier		67.50	2.00
Tuner — 10-60 meters, built-in noise bridge		299.95	6.50
CW Filter, 8 pole IC		39.95	2.00

ALSO IN STOCK

Antenna Components • Larsen Antennas
Centurion International Rubber Duck Antennas

WRITE FOR A FREE COPY OF OUR CATALOG

MASTER CHARGE **VISA**

All items F.O.B. Lincoln, $1.00 minimum shipping. Prices subject to change without notice. Nebraska residents please add 3% tax.

G & C Communications

730 Cottonwood Lincoln, Nebraska 68510

ANTENNA BOOKS by Bill Orr, W6SAI

ALL ABOUT CUBICAL QUAD ANTENNAS

The cubical quad antenna is considered by many to be the best DX antenna because of its simple, lightweight design and high performance. In Bill Orr's latest edition of this well known book, you'll find quad designs for everything from the single element to the multi-element monster quad, plus a new, higher gain expanded quad (X-Q) design. There's a wealth of supplementary data on construction, feeding, tuning, and mounting quad antennas. It's the most comprehensive single edition on the cubical quad available. 112 pages. ©1977.

☐ **RP-CQ** **Softbound $4.75**

THE RADIO AMATEUR ANTENNA HANDBOOK

by William I. Orr, W6SAI and Stuart Cowan, W2LX

If you are pondering what new antennas to put up, we recommend you read this very popular book. It contains lots of well illustrated construction projects for vertical, long wire, and HF/VHF beam antennas. But, you'll also get information not usually found in antenna books. There is *an honest judgment of antenna gain figures*, information on the best and worst antenna locations and heights, a long look at the quad vs. the yagi antenna, information on baluns and how to use them, and some new information on the increasingly popular Sloper and Delta Loop antennas. The text is based on proven data plus practical, on-the-air experience. We don't expect you'll agree with everything Orr and Cowan have to say, but we are convinced that **The Radio Amateur Antenna Handbook** will make a valuable and often consulted addition to any Ham's library. 190 pages. ©1978.

☐ **RP-AH** **Softbound $6.95**

BEAM ANTENNA HANDBOOK

Here's recommended reading for anyone thinking about putting up a yagi beam this year. It answers a lot of commonly asked questions like: What is the best element spacing? Can different yagi antennas be stacked without losing performance? Do monoband beams outperform tribanders? Lots of construction projects, diagrams, and photos make reading a pleasurable and informative experience. 198 pages. ©1977.

☐ **RP-BA** **Softbound $5.95**

Please add $1.00 to cover shipping and handling.

HAM RADIO'S BOOKSTORE
GREENVILLE, N. H. 03048

ramsey the first name in Counters !

9 DIGITS 600 MHz $129.95 WIRED

PRICES

CT-90 wired, 1 year warranty	$129.95
CT-90 Kit, 90 day parts warranty	109.95
AC-1 AC adapter	3.95
BP-1 Nicad pack + AC Adapter/Charger	12.95
OV-1, Micro-power Oven time base	49.95
External time base input	14.95

The CT-90 is the most versatile, feature packed counter available for less than $300.00! Advanced design features include; three selectable gate times, nine digits, gate indicator and a unique display hold function which holds the displayed count after the input signal is removed! Also, a 10mHz TCXO time base is used which enables easy zero beat calibration checks against WWV. Optionally; an internal nicad battery pack, external time base input and Micro-power high stability crystal oven time base are available. The CT-90, performance you can count on!

SPECIFICATIONS:

Range:	20 Hz to 600 MHz
Sensitivity:	Less than 10 MV to 150 MHz Less than 50 MV to 500 MHz
Resolution:	0.1 Hz (10 MHz range) 1.0 Hz (60 MHz range) 10.0 Hz (600 MHz range)
Display:	9 digits 0.4" LED
Time base:	Standard-10.000 mHz, 1.0 ppm 20-40°C. Optional Micro-power oven-0.1 ppm 20-40°C
Power:	8-15 VAC @ 250 ma

7 DIGITS 525 MHz $99.95 WIRED

SPECIFICATIONS:

Range:	20 Hz to 525 MHz
Sensitivity:	Less than 50 MV to 150 MHz Less than 150 MV to 500 MHz
Resolution:	1.0 Hz (5 MHz range) 10.0 Hz (50 MHz range) 100.0 Hz (500 MHz range)
Display:	7 digits 0.4" LED
Time base:	1.0 ppm TCXO 20-40°C
Power:	12 VAC @ 250 ma

The CT-70 breaks the price barrier on lab quality frequency counters. Deluxe features such as; three frequency ranges - each with pre-amplification, dual selectable gate times, and gate activity indication make measurements a snap. The wide frequency range enables you to accurately measure signals from audio thru UHF with 1.0 ppm accuracy - that's .0001%! The CT-70 is the answer to all your measurement needs, in the field, lab or ham shack.

PRICES:

CT-70 wired, 1 year warranty	$99.95
CT-70 Kit, 90 day parts warranty	84.95
AC-1 AC adapter	3.95
BP-1 Nicad pack + AC adapter/charger	12.95

7 DIGITS 500 MHz $79.95 WIRED

PRICES:

MINI-100 wired, 1 year warranty	$79.95
MINI-100 Kit, 90 day part warranty	59.95
AC-Z Ac adapter for MINI-100	3.95
BP-Z Nicad pack and AC adapter/charger	12.95

Here's a handy, general purpose counter that provides most counter functions at an unbelievable price. The MINI-100 doesn't have the full frequency range or input impedance qualities found in higher price units, but for basic RF signal measurements, it can't be beat! Accurate measurements can be made from 1 MHz all the way up to 500 MHz with excellent sensitivity throughout the range, and the two gate times let you select the resolution desired. Add the nicad pack option and the MINI-100 makes an ideal addition to your tool box for "in-the-field" frequency checks and repairs.

SPECIFICATIONS:

Range:	1 MHz to 500 MHz
Sensitivity:	Less than 25 MV
Resolution:	100 Hz (slow gate) 1.0 KHz (fast gate)
Display:	7 digits, 0.4" LED
Time base:	2.0 ppm 20-40°C
Power:	5 VDC @ 200 ma

8 DIGITS 600 MHz $159.95 WIRED

NEW READ RECEIVER FREQUENCY

SPECIFICATIONS:

Range:	20 Hz to 600 MHz
Sensitivity:	Less than 25 mv to 150 MHz Less than 150 mv to 600 MHz
Resolution:	1.0 Hz (60 MHz range) 10.0 Hz (600 MHz range)
Display:	8 digits 0.4" LED
Time base:	2.0 ppm 20-40°C
Power:	110 VAC or 12 VDC

The CT-50 is a versatile lab bench counter that will measure up to 600 MHz with 8 digit precision. And, one of its best features is the Receive Frequency Adapter, which turns the CT-50 into a digital readout for any receiver. The adapter is easily programmed for any receiver and a simple connection to the receiver's VFO is all that is required for use. Adding the receiver adapter in no way limits the operation of the CT-50, the adapter can be conveniently switched on or off. The CT-50, a counter that can work double-duty!

PRICES:

CT-50 wired, 1 year warranty	$159.95
CT-50 Kit, 90 day parts warranty	119.95
RA-1, receiver adapter kit	14.95
RA-1 wired and pre-programmed (send copy of receiver schematic)	29.95

DIGITAL MULTIMETER $99.95 WIRED

PRICES:

DM-700 wired, 1 year warranty	$99.95
DM-700 Kit, 90 day parts warranty	79.95
AC-1, AC adaptor	3.95
BP-3, Nicad pack +AC adapter/charger	19.95
MP-1, Probe kit	2.95

The DM-700 offers professional quality performance at a hobbyist price. Features include: 26 different ranges and 5 functions, all arranged in a convenient, easy to use format. Measurements are displayed on a large 3½ digit, ½ inch LED readout with automatic decimal placement, automatic polarity, overrange indication and overload protection up to 1250 volts on all ranges, making it virtually goof-proof! The DM-700 looks great, a handsome, jet black, rugged ABS case with convenient retractable tilt bail makes it an ideal addition to any shop.

SPECIFICATIONS:

DC/AC volts:	100uV to 1 KV, 5 ranges
DC/AC current:	0.1uA to 2.0 Amps, 5 ranges
Resistance:	0.1 ohms to 20 Megohms, 6 ranges
Input impedance:	10 Megohms, DC/AC volts
Accuracy:	10.1% basic DC volts
Power:	4 'C' cells

AUDIO SCALER

For high resolution audio measurements, multiplies UP in frequency.

- Great for PL tones
- Multiplies by 10 or 100
- 0.01 Hz resolution!

$29.95 Kit $39.95 Wired

ACCESSORIES

Telescopic whip antenna - BNC plug	$ 7.95
High impedance probe, light loading	15.95
Low pass probe, for audio measurements	15.95
Direct probe, general purpose usage	12.95
Tilt bail, for CT 70, 90, MINI-100	3.95
Color burst calibration unit, calibrates counter against color TV signal	14.95

COUNTER PREAMP

For measuring extremely weak signals from 10 to 1,000 MHz. Small size, powered by plug transformer-included.

- Flat 25 db gain
- BNC Connectors
- Great for sniffing RF with pick-up loop

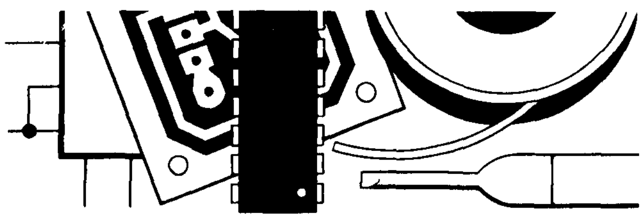
$34.95 Kit $44.95 Wired

ramsey electronics INC.
2575 BAIRD RD., PENFIELD, NY 14526

PHONE ORDERS
CALL 716-586-3950

TERMS Satisfaction guaranteed - examine for 10 days, if not pleased, return in original form for refund. Add 5% for shipping + insurance to a maximum of $10. Overseas add 15%. COD add $2. Orders under $10, add $1.50. NY residents add 7% tax.

the weekender



add fm to your receiver

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

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

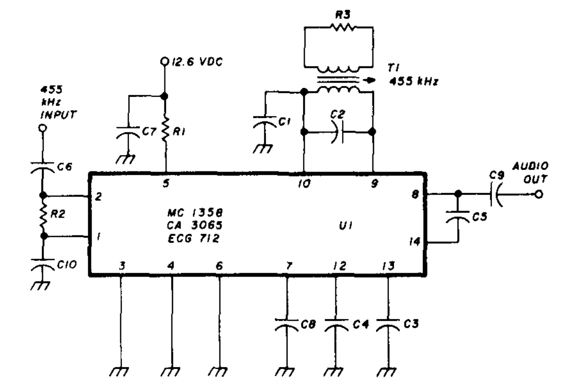
Described here is a conversion that can be made to any receiver using a 455-kHz i-f to add true fm to its current capabilities. The circuit can be built on a piece of vector board approximately two inches (50 mm) square, allowing it to fit nicely in even the smallest transceiver.

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

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

basic operation

The 455-kHz i-f input to the IC is acquired from the last 455-kHz i-f amplifier. The fm signal is detected and set to the i-f by transformer T1. The audio is fed



C1	20 pF	R2,3	560 ohm 1/4 watt	Note: If the i-f transformer does not have its own resonating capacitor across the primary, C2 must be added, the value of which varies depending on the transformer.
C2	see text	T1	455 kHz sub-miniature i-f transformer	
C3	0.001 μF			
C4-9	0.01 μF	U1	IC MC 1358, CA 3065, ECG 712	
C10	0.05 μF			
R1	47 ohm 1/2 watt			

fig. 1. Schematic of the conversion circuit for adding fm to an a-m receiver.

to an audio driver with more than enough gain to properly drive your existing audio amplifier.

construction

The use of a low-profile IC socket doesn't affect

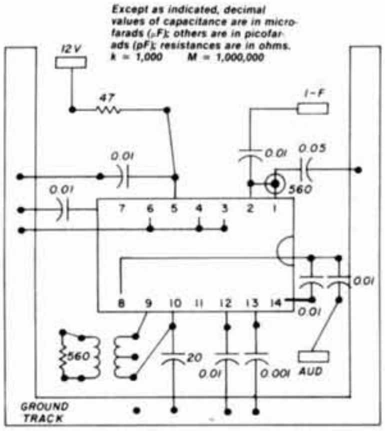


fig. 2. Parts placement on Vector™ board.

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

installation

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

1. Connect the 455-kHz i-f input to the base of the last i-f amplifier transistor.

2. The audio output pad of the fm board connects to the top of the volume control pot. The existing lead to this point must be removed or switched off so as to not receive fm and the existing receiver mode simultaneously.

3. Connect 12 Vdc and ground from the receiver to the conversion board.

adjustment

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

closing comments

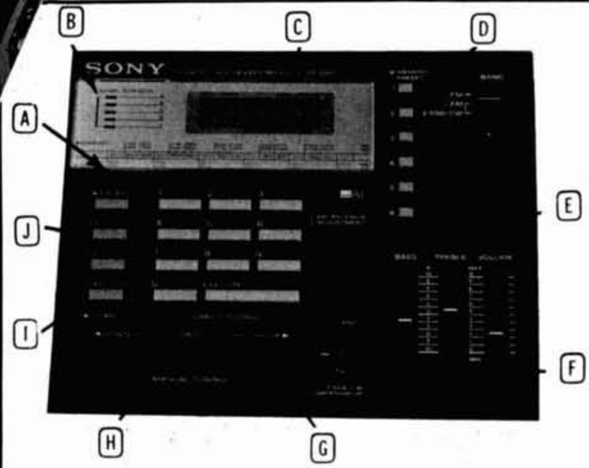
I have installed several of these fm conversions and have had complete success with each.

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

ham radio

INTRODUCING SONY'S NEW DIGITAL DIRECT ACCESS RECEIVER!

only **$299.95** plus $5.00 shipping



A Enter Button
B Signal Strength Indicator
C Liquid Crystal Display
D Memory Preset Buttons
E Antenna Adjustment Dial
F SSB/CW Compensator
G Execute Bar
H Manual Tuning Buttons
I Scan Button
J High/Low Limit Buttons

Revolutionary Direct Access Digital Shortwave Scanner

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

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

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

DUAL PLL SYNTHESIZER CIRCUITRY covers entire 150 KHz to 29.999 MHz band. PLL_1 circuit has 100 KHz step while PLL_2 handles 1 KHz step, both of which are controlled by separate quartz crystal oscillators for precise, no-drift tuning. **DUAL CONVERSION SUPERHETERODYNE** circuitry assures superior AM reception and high image rejection characteristics. The 10.7 MHz IF of the FM band is utilized as the 2nd IF of the AM band. A new type of crystal filter made especially for this purpose realizes clearer reception than commonly used ceramic filters. **ALL FET FRONT END** for high sensitivity and interference rejection. Intermodulation, cross modulation, and spurious interference are effectively rejected. **FET RF AMP** contributes to superior image rejection, high sensitivity, and good signal to noise ratio. Both strong and weak stations are received with minimal distortion.

EXTENDED SPECTRUM CONTINUOUS TUNING

OPERATIONAL FEATURES

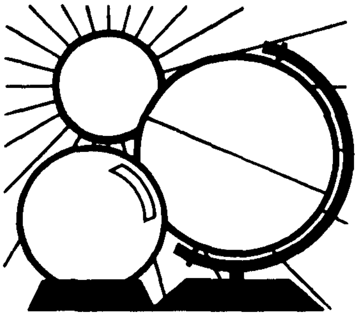
INSTANT FINGERTIP TUNING with the calculator-type key board enables the operator to have instant access to any frequency in the LW, MW, SW, and FM bands. And the LCD digital frequency display confirms the exact, drift-free signal being received. **AUTOMATIC SCANNING** of the above bands. Continuous scanning of any desired portion of the band is achieved by setting the "L_1" and "L_2" keys to define the range to be scanned. The scanner can stop automatically on strong signals, or it can be done manually. **MANUAL SEARCH** is similar to the manual scan mode and is useful for quick signal searching. The "UP" and "DOWN" keys let the tuner search for you. The "FAST" key increases the search rate for faster signal detection. **MEMORY PRESETS.** Six memory keys hold desired stations for instant one-key tuning in any mode (AM, SSB/CW, and FM), and also, the "L_1" and "L_2" keys can give you two more memory slots when not used for scanning. **OTHER FEATURES:** Local, normal, DX sensitivity selector for AM; SSB/CW compensator; 90 min. sleep timer; AM Ant. Adjust.

SPECIFICATIONS

CIRCUIT SYSTEM: Fm Superheterodyne; AM Dual conversion superheterodyne. **SIGNAL CIRCUITRY:** 4 IC's, 11 FET's, 23 Transistors, 16 Diodes. **AUXILIARY CIRCUITRY:** 5 IC's, 1 LSI, 5 LED's, 25 Transistors, 9 Diodes. **FREQUENCY RANGE:** FM 76-108 MHz; AM 150-29,999 KHz. **INTERMEDIATE FREQUENCY:** FM 10.7 MHz.; AM 1st 66.35 MHz., 2nd 10.7 MHz. **ANTENNAS:** FM telescopic, ext. ant. terminal; AM telescopic, built-in ferrite bar, ext. ant. terminal. **POWER:** 4.5 VDC/120 VAC **DIMENSIONS:** 12¼ (W) X 2¼ (H) X 6¾ (D). **WEIGHT:** 3 lb. 15 oz. (1.8 kg)

SPECTRONICS, INC.
1009 GARFIELD ST. OAK PARK, IL. 60304
PHONE **(312) 848-6777**

More Details? CHECK—OFF Page 110



DX FORECASTER

Garth Stonehocker, KØRYW

weather affects DX, right?

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

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

In looking for the rare DX, you may want to make the best use of your time by tracking the storms to give you the best chance at quiet noise conditions. Remember, too, the DX station's operating times and frequencies. An article in the November, 1980, issue of *CQ* lists the foreign national holidays (consider when the DX is home from work), and a *QST* article (January, 1975) points out the best DX frequencies in each band.

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

band-by-band summary

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

Ten, fifteen, and twenty meters will be full of signals from morning into early evening almost every day and to most areas of the world. The openings will be shorter on the higher bands and concentrated more near noon for the path of interest. High solar flux values and geomagnetic disturbance will favor these bands for transequatorial contacts. Noise effects are not too noticeable.

Forty, eighty, and one-sixty meters are the night Dxer's bands. The bands are open beginning just before sunset and lasting until just as the sun comes up on the path of interest. Except for daytime short-skip signal strengths, high solar flux values don't affect these bands much. Geomagnetic disturbances, which will be more evident near the equinox, cause much signal attenuation and fading on polar paths. The effects of these disturbances are less on these bands, although noise will be spasmodic and very noticeable on these lower-frequency bands.

ham radio

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	10	20	10	15	10	10	10*	10
0100	5:00	10	20	10	15*	10	10	10	10
0200	6:00	10	20	15	10	10	10	10	15
0300	7:00	10	20	15	10	10	10	10	15
0400	8:00	10	40	20	15	15*	10	10	15
0500	9:00	—	—	20*	15	15	10	10	20
0600	10:00	—	20	20	15	15	10	10	20
0700	11:00	—	—	20	15	15	15	10	20
0800	12:00	20	—	20	20	20	15	15*	20
0900	1:00	20	—	20	20	20	15	15	—
1000	2:00	20	—	—	20	20	15	15	—
1100	3:00	20	—	—	20	20	15	20	—
1200	4:00	20	40*	—	15	20	20	20	20
1300	5:00	20	20	—	15	—	20	20	20
1400	6:00	20	20	15	10	20	20	20	20
1500	7:00	20	20	15	10	20	20*	15	20
1600	8:00	20*	15	15	10	—	15	15	20
1700	9:00	15	15	15*	10	—	15	—	20
1800	10:00	15	10	10	10	15	10	—	20
1900	11:00	15	10	10	10	15	10	—	20
2000	12:00	—	10	10	10	10	10	10	20
2100	1:00	—	20	10	10	10	10	10*	15*
2200	2:00	10	20	10	10	10	10	10	10
2300	3:00	10	20	10	15	10	10	10*	10

MARCH

MID USA

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

EASTERN USA

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

SEMICONDUCTORS SURPLUS

2822 North 32nd Street, #1 • Phoenix, Arizona 85008 • Phone 602-956-9423

(O RY

	Description	Price
8	1K x 8 Eprom	$ 5.00
6/2516	2K x 8 5V single supply	9.99
4/9114	1K x 4 Static	5.00
7	4K x 1 Dynamic Ram	2.99
7/4116	16K x 1 Dynamic Ram	5.00
2-6	32K Eprom	39.95

.U.'s, Etc.

800P	Microprocessor	9.99
8B21P	PIA	6.99
845P	CRT Controller	25.00
850P	ACIA	4.99
852P	SSDA	5.00
8-1	Microprocessor	5.00
0A	Microprocessor	5.00
A	Microprocessor	10.99
	Microprocessor	8.99
A	PIO	9.99
	SIO/0	22.50
	SIO/I	22.50
2	8 Bit input/output part	3.99
1	Communication Interface	6.99
602/AY5-1013	UART	6.99
1000NL	Four Bit Microprocessor	4.99
482B	PSAT	5.99
7	DMA Controller	8.99
1	64 x 4 FIFO	3.00
316/F3817	Clock with alarm	5.99
1		60.00
8	8 Bit Microcomputer with programmable/erasable EPROM	60.00
408L/6	6 Bit D/A	3.25
2502		9.99
2601		9.99

STAL FILTERS
o 001-19880 Same as 2194F
7 MHz narrow band
B bandwidth 15KHz min.
dB bandwidth 60 KHz min.
dB bandwidth 150 KHz min.
imate 50 dB insertion loss 1 dB max.
ple 1 dB max. Ct. 0+/-5 pf 3600 Ohms
$3.99 each

454 Same as MRF458
.95 each

12.5 VDC, 3-30 MHz
80 Watts output, 12 dB gain

MRF472
12.5 VDC, 27 MHz
4 Watts output, 10 dB gain
$1.69 each

CARBIDE Circuit Board Drill Bits
for PCB Boards
5 mix for $5.00

MURATA CERAMIC FILTERS

SFD 455D	455 KHz	$2.00
SFB 455D	455 KHz	1.60
CFM 455E	455 KHz	5.50
SFE 10.7 MA	10.7 MHz	2.99

ATLAS CRYSTAL FILTERS FOR ATLAS HAM GEAR
5.52 - 2.7/8
5.595 - 2.7/8/U
5.645 - 2.7/8
5.595 - .500/4/CW
5.595 - 2.7 USB
5.595 - 2.7/8/L
5.595 - 2.7 LSB
9.0 - USB/CW

YOUR CHOICE
$12.99 each

J310 N-CHANNEL J - FET 450 MHz
Good for VHF/UHF Amplifier,
Oscillator and Mixers. 3/$1.00

AMPHENOL COAX RELAY
26 VDC Coil SPDT #360-11892-13
100 watts Good up to 18 Ghz
$19.99 each

78M05 Same as 7805 but only ½ Amp @ 5 VDC 49¢ each or 10/$3.00

NEW TRANSFORMERS

F-18X	6.3 VCT @ 6Amps	$6.99 each
F-46X	24V @ 1Amp	5.99
F41X	25.2VCT @ 2Amps	6.99
P-8380	10VCT @ 3Amps	7.99
P-8604	20VCT @ 1Amp	4.99
P-8130	12.6VCT @ 2Amps	4.99
K-32B	28VCT @ 100 MA	4.99
E30554	Dual 17V @ 1Amp ea.	6.99

EIMAC FINGER STOCK #Y-302
36 in. long x ½ in. $4.99 each

NO ORDERS UNDER $10

More Details? CHECK—OFF Page 110

SEMICONDUCTORS SURPLUS

2822 North 32nd Street, #1 • Phoenix, Arizona 85008 • Phone 602-956-9423

857JAN	$ 2.50
949	3.60
947	15.00
950	4.60
375	8.00
553	1.57
818	5.00
866	1.00
866JAN	2.50
866JANTX	4.00
925	10.00
948	2.00
950	25.00
959	3.00
960JANTX	10.00
4072	1.60
4427	1.10
4429	7.00
4877	1.00
4959	2.00
4976	15.00
070	8.00
071	15.00
108	4.00
109	1.50
179	1.00
583	4.00
589	6.00
590	8.00
591	11.00
635	5.44
636	11.60
637	20.00
641	5.00
643	14.00
645	10.00
842	8.00
849	20.00
942	40.00
946	14.00
862	50.00
080	7.00
081	10.00
082	11.00
083	13.00
084	14.00
095	11.00
096	20.00

2N6097	$28.00
2N6166	38.00
2N6368	22.99
2N6439	40.00
A210/MRF517	2.00
BLY38	5.00
40280/2N4427	1.10
40281/2N3920	7.00
40282/2N3927	10.48

NE555V TIMERS
39¢ each or 10/$3.00

NEW DUAL COLON LED
69¢ each or
10/$5.00

HEP170 1000 PIV
2.5 Amps 25¢ each or
100/$15.00

HIGH VOLTAGE CAPS
420 MFD @ 400 VDC OR
600 MFD @ 400 VDC
$6.99 each

NEW ROTRON BISCUIT FANS
Model BT2A1 115 VAC
$12.99 each

TORIN TA700 FANS NEW
Model A30340
230 VAC @ .78 Amps
Will also work on 115 VAC
$29.99 each

DOOR KNOB CAPS

470 pf @ 15 KV	$3.99	each
Dual 500 pf @ 15 KV	5.99	each
680 pf @ 6 KV	3.99	each
800 pf @ 15 KV	3.99	each
1000 pf @ 20 KV	5.00	each
2700 pf @ 40 KV	5.99	each

NEW & USED BCD SWITCHES
3 switch with end plates
$8.99 New $6.95 Used

ORDERING INSTRUCTIONS

Check, money order, or credit cards welcome. (Master Charge and VISA only) No personal checks or certified personal checks for foreign countrys accepted. Money order or cashiers check in U.S. funds only. Letters of credit are not acceptable.

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

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

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

PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE. Prices superseade all previously published. Some items offered are limited to small quantities and are subject to prior sale.

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

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

JUMBO LED's

Red	8/$1.00
Clear	6/$1.00
Yellow	6/$1.00
Green	6/$1.00
Amber	6/$1.00

MEDIUM LED's

Red	6/$1.00
Green	6/$1.00

NEW GE OPTO COUPLERS 4N26
69¢ each or 10/$5.00

MICRO-MINI WATCH CRYSTALS
32.768 Hz $3.00 each

NEW 2'' ROUND SPEAKERS
100 Ohm coil 99¢ each

PLASTIC TO-3 SOCKETS 4/$1.00

NO ORDERS UNDER $10

More Details? CHECK—OFF Page 110

the ham notebook

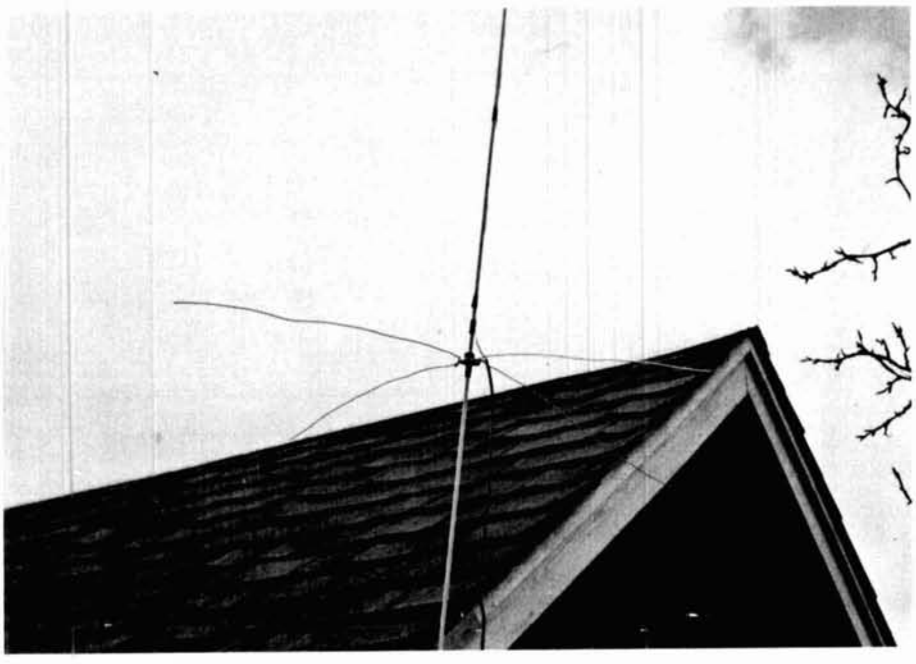
inexpensive five-eighth wave ground plane

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

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

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

Bob Baird, W7CSD



the best way to get an antenna into a tree

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

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

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

The advantages of this system are these:

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

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

3. The small weight rarely tangles in the trees.

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

Alan Hack, WA5VLX

antenna bridge calculations

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

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

Paul Manacek, K6GK

```
5    Print, "Smith Chart Rotation"        ↑ = "UP ARROW"
6    Print; Print
8    Input "Enter next freq. in mhz";F
1Ø   ZO*5Ø
12   Input "Enter noise bridge 'RP' Reading";R
15   Input "Enter noise bridge 'C' reading in picos";C
17   V=.66
20   L=6Ø
35   R1=.006388
45   X= -159155/(F*C)
50   A=(R*X↑2)/(R↑2+X↑2)
60   B=(X*R↑2)/(R↑2+X↑2)
65   Input "Enter value of series extender (Ø if not used)"
     ;SE
75   Print
80   A1=A-SE
85   Print "The line input Z (RG,XG)="A1,B
90   A2=SQR((A1+ZO)↑2+(B↑2))
95   B2=SQR((A1-ZO)↑2+(B↑2))
100  Print "the swr is",(A2+B2)/(A2-B2)
110  K=R1*(L/V)
120  XK= Tan (K*F)
130  RG=A1
140  XG=B
150  RO=ZO
160  A=(XG-RO*XK
170  B=(RO+XG*XK)
180  D=RG*XK
190  N= -D
200  X=((RG*B)+(A*N))/(B*B+N*N)
210  Y=((B*A)-(RG*N))/(B*B+N*N)
220  Z=X*RO
230  J=RO*Y
240  Print
250  Print "Antenna Z (No-Loss Line) is";Z,J
260  A2=SQR((Z+RO)↑2+(J↑2))
270  B2=SQR((Z-RO)↑2+(J↑2))
280  Print "The SWR is", (A2+B2)/A2-B2)
290  Print
300  DB=.8
310  N=8.686
320  E=2.718282
330  A=DB/N
340  B=K*F
350  D=E↑(4*A)=1+2*E↑(2*A)*Cos(2*B)
360  RA=((E↑(4*A)-1))/B
370  B1=2*E↑(2*A)*Sin(2*B)
380  A2=D
390  P=A2*A2
400  M=(A2+B1)/(A2*A2)
410  Print
420  Print "Complex Attenuation Factors (RA,XA)=";RA,M
430  Print
440  Print "Next rotation is for Lossy Lines": Print
450  Input "Enter RG from top of screen";RS
460  Input "Enter XG";XG
470  Input "Enter RA";RA
480  Input "Enter XA";XA
490  A4=(RS-RA*RO)
500  B4=(RO-RS*RA+XG*XA)
510  D4=RA*XG
520  G4=RS*XA
530  H4=C4
540  I4=D4+G4
550  L4=RO*XA
560  M4=O4
570  N4=XG-L4
580  O4=A4+M4
590  P4=N4
600  Q4=B4-H4
610  T4=I4
620  V4=((O4*Q4)+(P4*T4))/(Q4*Q4+T4*T4)
630  W4=((Q4*P4)-(O4*T4))/(Q4*Q4+T4*T4)
640  Y4=(V4*RO
650  Z4=RO*W4
660  Print:Print
670  Print "Antenna Z, (lossy line) is",Y4,Z4
680  Print
690  A3=SQR((Y4+RO)↑2+(Z4↑2))
700  B3=SQR((Y4-RO)↑2+(Z4↑2))
710  Print "The Swr, with losses, is",(A3+B3)/(A3-B3)
720  Print:Print
730  Run 8
```

CALL TOLL FREE
1-800-426-7741

The Northwest's Largest Ham Store

WASHINGTON RESIDENTS CALL 1-800-562-6818

ALASKA RESIDENTS CALL COLLECT 1-206-784-7337

AEA MORSEMATIC

- Dual Microcomputers provide many features.
- Approximately 500 character memory with unique "soft-partitioning."
- Morse trainer mode with programmable speed-up.
- Beacon mode for VHF DX scheduling.
- Automatic serial number sequencing.
- For too many features to describe; use it and you will believe it!

AEA ISOPOLE VHF ANTENNAS

Finally — a properly decoupled antenna with superior performance at a reasonable cost. Raise more repeaters or increase your simplex distance!

- 144 or 220 MHz bands.
- Achieve maximum attainable gain for a twin 5/8 wavelength antenna.
- Patterns independent of mounting or feedline length.
- Greater than 9 MHz band width.
- Completely weather protected matching network and RF connections.
- Easiest to assemble. Mounts on standard TV master (NOT SUPPLIED).

FLUKE® D800/D802 DIGITAL MULTIMETERS

Measures AC and DC voltage and current, resistance and diode test. Conductance also included in D802. Basic DC accuracy 0.5% D800, 0.1% D802. Complete with test leads, battery and manual.

Only
$125 (D800)
$179 (D802)

C-COMM
6115-15th AVE. N.W.
SEATTLE, WA. 98107
(206) 784-7337

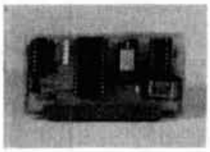
Dealers For: AEA, ALLIANCE, ALPHA, AVANTI, BENCHER, B&W, CDE, CUSHCRAFT, DAIWA, DENTRON, DRAKE, FLUKE, HUSTLER, HYGAIN, ICOM, INLINE, KLM, LARSEN, LUNAR, MFJ, NPC, NYE, ROHN, SHURE, TEMPO, TELEX, TEN-TEC, VIBROPLEX, YAESU, AND MORE.

Mon. thru Sat. 9:00 a.m. to 5:30 p.m.

Prices and specifications subject to change without notice or obligation

---

trans com inc.



1021 Touch Tone Decoder

The 1021 Touch Tone decoder is ideal for repeater control. Design your own or use with our 102 DTMF Controller.

Features:
- ★ Decodes All 16 Digits
- ★ Binary and Strobe outputs as well as 16 discreet outputs
- ★ 5VDC or 7-20VDC operation
- ★ Current consumption of 4 mA@5VDC
- ★ Measure 3.5"x1.9"x.4"
- ★ Dialing speed to 20 PPS

PRICED AT $154.95

401 Sub-Audible Tone Encoder For the ICOM IC2A/AT

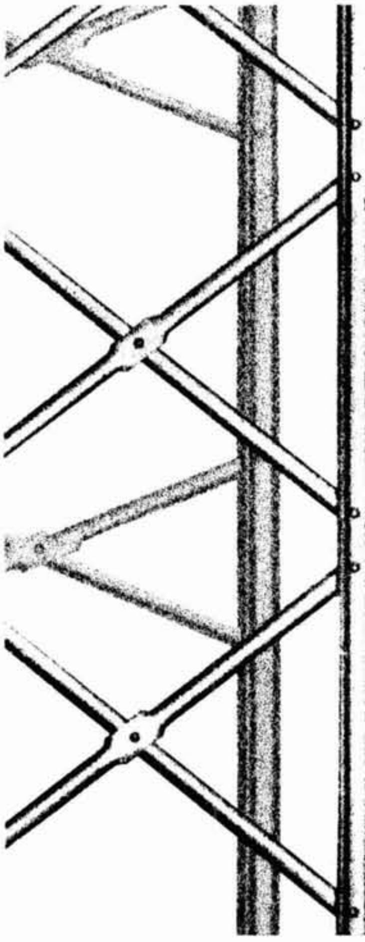
The model 401 features:
- ★ Fits IC2A/AT and most other hand held radios
- ★ Compatible with PL, CG, and most other CTCSS systems
- ★ Fully tuneable from 76.0 Hz to 251 Hz
- ★ Operating voltage is 7-15VDC@4mA
- ★ Adjustable tone level, 0-2 VPP
- ★ Small size 1.0"x.6"x.3".

PRICED AT $29.95

Send check or money order. Use VISA or Master Charge. IL residents add 5¼% state tax plus $2.00 S&H.
To order or for more information contact:

trans com inc.

1104A Ridge Ave., Lombard, IL 60148
(312) 932-1491



Rohn 'BX' TOWERS

- ☐ For Home TV, Ham Radio and CB.
- ☐ Up to 18 sq. ft. antenna capacity.
- ☐ Available to 64' in 8' sections.
- ☐ All riveted construction — no welds.
- ☐ Beaded channel leg for added strength.
- ☐ All steel — galvanized for added life.
- ☐ Can be used with Concrete Base Stubs, Cylinder Base or Hinged Concrete Base.

UNR-Rohn
Division of UNR Industries, Inc.
6718 West Plank Road, P.O. Box 2000
Peoria, Illinois 61656
U.S.A.

flea market

RATES Noncommercial ads 10¢ per word; commercial ads 60¢ per word **both payable in advance**. No cash discounts or agency commissions allowed.

HAMFESTS Sponsored by non-profit organizations receive one free Flea Market ad (subject to our editing). Repeat insertions of hamfest ads pay the non-commercial rate.

COPY No special layout or arrangements available. Material should be typewritten or clearly printed (not all capitals) and must include full name and address. We reserve the right to reject unsuitable copy. **Ham Radio** cannot check each advertiser and thus cannot be held responsible for claims made. Liability for correctness of material limited to corrected ad in next available issue.

DEADLINE 15th of second preceding month.

SEND MATERIAL TO: Flea Market, Ham Radio, Greenville, N. H. 03048.

CW/SSB FILTERS: IC audio install in any radio, sharp CW, stagger tuned SSB — $15, $32. SASE info: W8CBR, 80 W. Mennonite, Aurora, OH 44202.

QSLs & RUBBER STAMPS — Top Quality! Card Samples and Stamp Info — 50¢ — Ebbert Graphics 5R, Box 70, Westerville, Ohio 43081.

MOTOROLA RADIOS WANTED: I need micors, motracs, mocom 70's, H.T.'s, and bases . . . anything Motorola newer than 12 years. I pay all shipping. Len Rusnak, WA3TJO 301-441-1221.

CRYSTALS FM 2 METERS STILL AVAILABLE! Crystals for equipment on our parts list, $4.50 each. For equipment list, send self addressed stamped envelope. SAVOY ELECTRONICS, P.O. Box 5727, Ft. Lauderdale, FL 33310 — Tel. (305) 563-1333.

WANTED: Motorola micor base stations. 406-420 MHz. AK7B, 4 Ajax Pl., Berkeley, CA 94708.

TUBE TESTER, dynamic plate conductance, Jackson Elec. Inst. model 648S, new with latest roll chart, $75.00 or best offer. F.O.B. Fort Pierce, FL, F. Pierce, 403 Susan Dr., W4OZS.

HELP! A Baptist church affiliated youth summer camp needs Ham help. 2 Meter and HF radios are urgently needed to provide emergency communications from an Appalachian mountain site to the nearest phone, which is five miles away. Donated equipment is tax deductible. Contact Richard Bailey, Amity, PA 15311. (412) 225-1265.

WANTED: Collins 455 kHz mechanical filters, F455 variety. Give me bandwidth, condition and price. W9JTO, Paul Sexauer, 515 Lee Road, West Chicago, IL 60185.

MANUALS for most ham gear 1937/1970. Send 25¢ for "Manual Catalog." H.I., Inc., Box H864, Council Bluffs, Iowa 51502.

SATELLITE TELEVISION: Information on building or buying your earth station. Six pages of what's needed, where to get it, costs, etc. $4.00 to Satellite Television, RD #3, Oxford, NY 13830.

ATLAS DD6-C and 350XL Digital Dial/Frequency Counters. $175.00 plus $3.00 UPS. AFC! Stop VFO drift. See June 79 HR. $65.00 plus $3.00 UPS. Mical Devices, P. O. Box 343, Vista, CA 92083.

WANTED: Help in completing the largest collection of Hallicrafter equipment in the world. Urgently needed are receivers with aluminum colored panels, back lighted plastic dials with "airplane" hands, early transmitters, unusual accessories, etc. Chuck Dachis, WD5EOG, "The Hallicrafter Collector," 4500 Russell Drive, Austin, Texas 78745.

WANTED: Cushman Communications Service Monitors, working or non-working units. Also need plug-in modules, manuals, parts, etc., will pay cash or take over payments. Also need RF voltmeters; WB8IJX, Fred L. Slaughter, 5844 Grisell Road, Oregon, OH 43618. Phone (419) 698-8597.

WANTED: L5B and CW xtal filters for a TR6. Jim Gysan, W1VYB, (617) 922-3850.

ELECTRONIC BARGAINS, CLOSEOUTS, SURPLUS! Parts, equipment, stereo, industrial, educational. Amazing values! Fascinating items unavailable in stores or catalogs anywhere. Unusual FREE catalog. ETCO-012, Box 762, Plattsburgh, NY 12901. SURPLUS WANTED.

ANTIQUE RADIO EQUIPMENT: Hallicrafters "Sky-Buddy" receiver in fair condition and Hallicrafters speaker model R-42 in excellent condition (designed for use with SX-42). Best offer, contact Bob Schrader, WØPVL, 1521 N. Webster, Liberal, KS 67901.

MOBILE IGNITION SHIELDING provides more range with no noise. Available most engines. Many other suppression accessories. Literature, Estes Engineering, 930 Marine Dr., Port Angeles, WA 98362.

YAESU FT-277R transceiver (mint) $200.00, Galaxy Comm IC transceiver w/P.S. unit for R390A rvr. David Johanson, 423 N. 3rd St., Fort Dodge, IA 50501 (515) 955-7185.

ETCH IT YOURSELF PRINTED CIRCUIT KIT, Photo-Positive Method — No darkroom required. All the supplies for making your own boards, direct from magazine article in less than 2 hours. Only $24.95, S.A.S.E. for details: Excel Circuits Co., 4412 Fernlee, Royal Oak, MI 48073.

ANNOUNCING A New Ham Radio Recognition and Reference Volume. "WHO'S WHO IN AMATEUR RADIO". Details SASE, Users International Radio Clubs, 606 Brack Rd., Ft. Pierce, FL 33450.

HAM RADIO REPAIR — Professional lab, personal service. "Grid" Gridley, W4GJO. April thru October: Rt. 2, Box 138B, Rising Fawn, Georgia 30738. (404) 657-7841. November thru March: 212 Martin Drive, Brooksville, Florida 33512. (904) 799-2769.

FOR SALE: One Hallicrafter HT-40 Transmitter. Write W9HVZ in Lancaster, WI 53813.

YAESU FRG-7 $200., Icom 230 $150., Midland 13-509 $150., Wilson Handytalky 1402 $75. WA6JYU (415) 897-3987.

LINEAR AMPLIFIER PLAN BOOK II, 13 plans, 1.6 to 400 MHz, 15 to 1000 watts, 92 pages, $11.95, CB modification kits, crystals, de-scramblers, other titles, electronic flea market and more in our catalog, $1.00 refundable. A.P. Systems, P.O. Box 263HR, Newport, R.I. 02840.

WILSON WE-800 synthesized 2 meter xcvr, wall charger, flex antenna, Larsen NMO-150 quarter wave antenna and quick release bracket for $240.00, post paid. Ed Roth, WA5YXK, 207 Forest Hill Dr., Warner Robins, GA 31093.

BUY-SELL-TRADE. Send $1.00 for catalog. Give name address and call letters. Complete stock of major brands new and reconditioned amateur radio equipment. Call for best deals. We buy Collins, Drake, Swan, etc. Associated Radio, 8012 Conser, Overland Park, KS 66204. (913) 381-5900.

When it comes to *AMATEUR RADIO QSL's . . .*

it's the

ONLY BOOK!

US or DX Listings

1981 callbooks

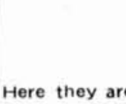
NOW READY!

Here they are! The latest editions. World-famous Radio Amateur Callbooks, the most respected and complete listing of radio amateurs. Lists calls, license classes, address information. Loaded with special features such as call changes, prefixes of the world, standard time charts, world-wide QSL bureaus, and more. The U.S. Edition features over 400,000 listings, with over 100,000 changes from last year. The Foreign Edition has over 300,000 listings, over 90,000 changes. Place your order for the new 1981 Radio Amateur Callbooks, available now.

	Each	Shipping	Total
☐ US Callbook	$17.95	$2.55	$20.50
☐ Foreign Callbook	$16.95	$2.55	$19.50

Order both books at the same time for $37.45 including shipping.

Order from your dealer or directly from the publisher. All direct orders add $2.55 for shipping. Illinois residents add 5% sales tax.



SPECIAL LIMITED OFFER!
Amateur Radio Emblem Patch
only $2.50 postpaid

Pegasus on blue field, red lettering. 3" wide x 3" high. Great on jackets and caps. Sorry, no call letters.

ORDER TODAY!

RADIO AMATEUR **callbook** INC.
Dept. F
925 Sherwood Drive
Lake Bluff, IL 60044, USA

ICOM, KENWOOD OWNERS — Separate, Very Informative Newsletters. Details SASE U.I.R.C 606 Brack Road, Fort Pierce, FL 33450.

MIRROR-IN-THE-LID, and other pre-1946 television set wanted. Paying 500+ for any complete RCA "TRK" series, or General Electric "HM" series set. Also looking for 12AP4, MW-31-3 picture tubes, parts, literature on pre-war television. Arnold Chase, WA1RYZ, 9 Rushleigh Road, West Hartford, Conn. 06117 (203) 521-5280.

AMATEUR REPAIR: Professional service, reasonable rates, ALL brands. USA KDK repair center. Amateur Radio Repair Center, 1020 Brookstown Ave., Suite 5, Winston-Salem, NC 27101 (919) 725-7500.

YAESU YO-100 monitor scope with manual and original carton, $145. Comdel RF speech processor, connects between mike and rig, $85. John Skubick, K8JS, 791-106 Ave., Naples, FL 33940.

ATLAS 350XL, DD6 Readout, VFO 350, PS350, Mobile mount. System in excellent condition. $859. AE5E, Bill, (713) 898-1743.

500 QSL's, $10. Catalogue, 743 Harvard, St. Louis, MO 63130.

VERY in-ter-est-ing! Next 6 issues $2. Ham Trader "Yellow Sheets", POB356, Wheaton, IL 60187.

DX, YOU BET! THE DX BULLETIN — Best weekly DX info in the world. For FREE sample copy, send business-size SASE to: The DX Bulletin, 306 Vernon Avenue, Vernon, Connecticut 06066.

STOP LOOKING for a good deal on amateur radio equipment — you've found it here — at your amateur radio headquarters in the heart of the Midwest. Now more than ever where you buy is as important as what you buy. We are factory-authorized dealers for Kenwood, Drake, Yaesu, Collins, Wilson, Ten-Tec, ICOM, DenTron, MFJ, Tempo, Regency, Hy-Gain, Mosley, Alpha, CushCraft, Swan and many more. Write or call us today for our low quote and try our personal and friendly Hoosier Service. HOOSIER ELECTRONICS, P.O. Box 2001, Terre Haute, Indiana 47802. (812) 238-1456.

UPGRADE SUCCESSFULLY! Pass FCC Exams! TRS-80 owners, I'll show you how! KE7C, H-2665 Busby Road, Oak Harbor, WA 98277. SASE please.

CB TO 10 METER PROFESSIONALS: Your rig or buy ours — AM/SSB/CW. Certified Communications, 4138 So. Ferris, Fremont, Michigan 49412; (616) 924-4561.

TRANSMITTER TECHNICIANS — Voice of America has overseas positions available at supervisory and operating levels for experienced transmitter technicians. Duties include operation and maintenance of high power VOA transmitters and related facilities. Applicants must have 3 to 5 years "hands-on" experience in technical operation of broadcast, TV or military fixed-station transmitters. Must be available on a worldwide basis to serve in VOA's radio relay station system. U.S. citizenship required. Starting salary commensurate with qualifications, plus housing and overseas allowances. Full federal fringe benefits apply. Qualified candidates should send standard Federal application form SF-171 to International Communication Agency, MGT/PDE, 1776 Pennsylvania Ave., Washington, D.C. 20547. An Equal Opportunity Employer.

QSL'S: No stock designs! Your art or ours; photos, originals, 50¢ for samples & details (refundable). Certified Communications, 4138 So. Ferris, Fremont, Michigan 49412.

NEED HELP for your Novice or General ticket? Recorded audio-visual theory instruction. No electronic background required. Free information. Amateur License, P.O. Box 6015, Norfolk, VA 23508.

QSL'S WITH CLASS! Unbeatable quality, reasonable price. Samples: 50¢ refundable. QSLs Unlimited, 1472 S.W. 13th St., Boca Raton, FL 33432.

CB TO 10-METER CONVERSIONS. SSB/AM/CW. Let a specialist convert your rig, or buy one complete. Write Conversion Engineering, Box 183, Sandwich, Massachusetts 02563.

MAKE HAM RADIO FUN! Supplement your learning programs with a motivational hypnosis cassette. Tape #3, Learning the Code; Tape #4, Breaking the Speed Barrier; Tape #7, Electronics Theory. Free catalog. For tapes send $10.95 to John Wolf Hypnosis Center, P.O. Box 497, Hayden, Idaho 83835.

"CADILLAC" of QSL'S — FAST 100 · $9.95 — Our Design. Send $1.00 for Samples-Refundable. MAC'S SHACK, P.O. Box 43175, Seven Points, Texas 75143.

HAMS FOR CHRIST — Reach other Hams with a Gospel Tract sure to please. Clyde Stanfield, WA6HEG, 1570 N. Albright, Upland, CA 91786.

NEW FROM GLB

A complete line of *QUALITY* 50 thru 450 MHz TRANSMITTER AND RECEIVER KITS. Only two boards for a complete receiver. 4 pole crystal filter is standard. Use with our *CHANNELIZER* or your crystals. Priced from $69.95. Matching transmitter strips. Easy construction, clean spectrum, *TWO WATTS* output, unsurpassed audio quality and built in *TONE PAD INTERFACE.* Priced from $29.95.

SYNTHESIZER KITS from 50 to 450 MHz. Prices start at $119.95.

Now available in KIT FORM — GLB Model 200 MINI-SIZER.

Fits any HT. Only 3.5 mA current drain. Kit price $159.95 Wired and tested. $239.95

Send for FREE 16 page catalog.
We welcome Mastercharge or VISA

GLB ELECTRONICS
1952 Clinton St., Buffalo, N. Y. 14206

GO MOBILE WITH YOUR H.T.!

Handi-Tek Regulator ALLOWS CONTINUOUS HAND-HELD OPERATION FROM AUTO DC OR BASE SUPPLY WITH NO NI-CAD DRAIN. MODEL K - TR2400 MODEL Y - FT-207R, MK II, MK IV MODEL T - SIMPLE MOD FOR TEMPO S-1, S-2, S-5. GUARANTEED. $19.95 PPD IN USA. CAL ADD $1.20 ORDER DIRECT OR SEND FOR SPECS...

HANDI-TEK
P.O. BOX 2205, LA PUENTE, CA 91746

SPECIAL! PCS-3000

AZDEN

only $315.00
Includes T.T. Pad

You'll have more fun and excitement on 2 meter FM with the AZDEN PCS 3000 because of its popular, state-of-the-art convenience features such as micro-computer controlled full band scan and memory functions, CMOS PL digital synthesized, detachable control head, excellent receiver sensitivity, 25 watts out and much more.

Free U.P.S. — 90 day factory warranty

N.P.S. Inc. WA3IFQ
1138 Boxwood Rd. • Jenkintown, PA 19046
1-215-884-6010

DISTINCTIVE QSL's — Largest selection, lowest prices, top quality photo and completely customized cards. Make your QSL's truly unique at the same cost as a standard card, and get a better return rate! Free samples, catalogue. Stamps appreciated. Stu Goodman, K2RPZ Print, P.O. Box 412, Rocky Point, NY 11778 (516) 744-6260.

FREE SAMPLE Ham Radio Insider Newsletter! Send large S.A.S.E., W5YI, Box #10101-H, Dallas, Texas 75207.

MAGAZINE SAMPLES! For a free list of over 135 magazines offering a sample copy, send a stamped, addressed envelope to: Publisher's Exchange, P.O. Box 1368, Dept. 26A, Plainfield, NJ 07061.

Coming Events
ACTIVITIES
"Just What the Doctor Ordered!"

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

MARYLAND: Greater Baltimore Hamboree and Computerfest on March 29 at the Maryland State Fairgrounds, Timonium, Maryland. Gates open at 8:00. Admission is $3.00. Speakers, demonstrations, indoor flea market, outdoor tailgating, large indoor show area for dealers/commercial displays plus prizes, free parking and much more. Exit 16-A of I-83, two miles north of I-695 near Baltimore. Talk-in on 146.07/67 and 146.34/94. More information and table reservations: G.B.H. & C., 2136 Pine Valley Dr., Timonium, Maryland 21093 or (301) 321-1404.

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

NEBRASKA: The Hamboree 5 on March 21 at the Marina Inn in So. Sioux City. Doors open at 9:00. Exhibits, Flea Market, contests, programs, dinner banquet and more. More info: Dick Pitner, WØFZO or Glen Holder, KØTFT. Advanced registration: Jerry Smith, WØDUN, Box 14, Akron, Iowa 51001.

NEW HAMPSHIRE: Auctionfest '81 on March 21 sponsored by the Interstate Repeater Society, P.O. Box 94, Nashua, NH 03106. Location: Hilton in Merrimack. Doors open at 9:00 AM. Vendor exhibits and more. $5.00 and $75.00 for Flea Market rooms. Auction begins at 11:00 AM. For accommodations, reservations, more information: write WB1FRE.

NEW JERSEY: Chestnut Ridge Radio Club's Ham Radio and Computer Flea Market on April 4 from 9:00 to 3:00 at the Educational Building, Saddle River Reform Church, East Saddle River at Weiss Road in Upper Saddle River, New Jersey. No admission fee. Tables are $10.00 and tailgating is $5.00. Contact Jack Meagher, W2EHD, (201) 768-8360 or Neil Abitabilo, WA2EZN (201) 767-3575.

NEW JERSEY: Annual Flemington, N.J. Hamfest Saturday, March 21 from 8:30 to 3:00 at the Hunterdon Central High School Field House. 20,000 square feet of heated indoor area. Gigantic flea market, 200 tables, major manufacturers, informative seminars. Bring the XYL, kids and friends. Flemington is a tourist area. Talk in 146.52, 147.375, 147.015, 224.12. Admission $3.00 donation. For reservations or info call 201-788-4080 or write Cherryville Repeater Assn. c/o W2FCW, Box 76, Farview Ave., Annandale, N.J. 08801.

NEW JERSEY: The Old Bridge Radio Association's first annual auction of ham radio, electronic, and computer gear on March 1 at the Cheesequake Firehouse, Routes 35 and 9, in Old Bridge. Exhibition begins at 11 AM, sale at noon. Refreshments available. More info, call Fred at (210) 257-8753.

NORTH CAROLINA: The 1981 Charlotte Hamfest on March 21 and 22 at the Charlotte Civic Center. The Hamfest and the North Carolina State ARRL Convention will bring more than 8,000 hams and their wives for this electronic feast. For more info: Rick Richardson, KA4EHU, 4609 Montclair Ave., Charlotte, NC 28211.

OHIO: The third annual Lake County Amateur Radio Association Lake County Hamfest on March 29 at Madison High School, Madison. Admission: $2.50 in advance and $3.00 at the door. Free parking, all displays are indoors, plus much more. Talk-in on 147.81/21. Information and reservations: SASE Lake County Hamfest Committee, 5555 Anaconda Rd., Mentor, Ohio 44060. (216) 953-9784.

More Details? CHECK—OFF Page 110

PENNSYLVANIA: Penn Wireless Association, Inc. will hold its Tradefest '81 on March 29 at the National Guard Armory, Southhampton Rd. and Roosevelt Blvd., (Rte. #1) ½ mile south of the Pennsylvania Turnpike exit #28. General admission is $3.00. Prizes, refreshments, displays and surprises. Talk-in on 146.115/715 and .52. Contact Thomas Gallagher, WB3DJF, P.O. Box 734, Langhorne, Pennsylvania 19047.

TEXAS: Midland Amateur Radio Club's annual swapfest on March 14 from 1:00 to 7:00 and March 15 starting at 8:00. Doorprizes and more. Pre-registration is $4.50 or $5.00 at the door. Talk-in on 146.16/146.76.

WISCONSIN: The Madison Area Repeater Association's ninth annual Madison Swapfest on April 5 at the Dane County Exposition Center Forum Building in Madison. Exhibits, flea market, door prizes and more. $2.50 in advance and $3.00 at the door. Talk-in on 146.16/.76. Reservations and information: M.A.R.A., P.O. Box 3403, Madison, Wisconsin 53704.

SWEDEN: The International Radio Amateur Meeting in Goteborg on April 4 and 5. All interested hams are invited. Includes shows, exhibitions, lectures, special displays plus more. The Swedish Maritime Mobile Radio Club and the Scandinavian Amateur Radio Teletype Group are having their annual meetings. Exhibitors and hams outside of Sweden are also welcome.

OPERATING EVENTS

MARCH 21st - 22nd: Tennessee QSO Party from 2100Z (the 21st) to 0500Z (the 22nd) and from 1400Z to 2200Z on the 22nd. Tennessee stations give signal report and county. Out of state, give signal report and state, province or country. Same station on different bands allowed. CW frequencies: Approximately 50 from bottom of each band. Phone: 3980, 7280, 14280, 21380, 28680. Novices within their own bands. Deadline for logs: May 1, 1981. Send business sized SASE with log. More info: SASE Dave Goggio, W4OGG, 1419 Favell Dr., Memphis, Tennessee 38116.

MARCH 21st - 23rd: B.A.R.T.G. Spring RTTY Contest 1981. From 0200 GMT Saturday until 0200 GMT Monday. Total contest is 48 hours, but no more than 30 hours of operation is permitted. 18 hours of non-operating time may be taken at any time, but no less than 3 hours at a time. Must be summarized. Bands: 3.5, 7.0, 14.0, 21.0 and 28.0 MHz. Amateur bands. More info or logs (deadline: May 31st) SASE to Ted Double, G8CDW, 89, Linden Gardens, Enfield, Middlesex ENGLAND, EN1 4DX.

MARCH 28th AND 29th: YL ISSB QSO Party 1981. CW from 0001 GMT on the 28th to 2359 GMT on the 29th. Two 6 hour rest periods required. Phone from 0001 GMT on April 18th to 2359 GMT on the 19th. Two 6 hour rest periods required. YL/OM and DX/WK teams allowed. CW frequencies: 3665, 7070, 14070, 21070; Phone: 3925, 7290, 14332, 21373, 28673. Listen for DX on 3765 and 7090. More info: SASE to Lyle F. Shaw, KC4LF, 6329 Fairway Blvd., Apollo Beach, Florida 33570.

MARCH 28th AND 29th: Spring VHF QSO Party sponsored by the Ramapo Mountain ARC from 1800Z Saturday until 0400Z on Sunday. Exchange signal report and ARRL section. FM operation not permitted below 450 MHz. Use ARRL VHF QSO Party or similar forms or SASE to R.M.A.R.C. for entry forms and/or more information. Deadline: April 27th. Ramapo Mountain ARC, P.O. Box 364, Oakland, NJ 07436.

CENTURY 21 ARC — Low power — QRP'ers — CW nets — Contests — Awards — SASE KA4EBW.

ATTENTION FIREFIGHTERS! A firefighter net is being formed and will be operating on 10 meters. Times are 1500Z, 2100Z and 0100Z. The frequency is 28.7 MHz. More information: SASE and four first class stamps to Claude L. Fant, Jr., KA8HBU, 328 Harrison Ave., Hamilton, Ohio 45023. You will be sent a list of firefighters in the net and other information.

AWARD INFORMATION: The "10-K" and "20-K" award, formerly issued by the CHC, is available from WA6CPP, 13779 North Wells Lane, Lodi, California 95240. Work 10 (or 20) stations in the outlying territories and possessions with the miscellaneous K calls (KG4, KC6, KP6, etc.). Send log data and #10 SASE to WA6CPP. Send 3 units postage for return in mailing tube. DX stations send 2 IRC, CPP will supply the envelope. Limited supply.

OCTOBER 23, 1980 - OCTOBER 23, 1981: The New Bern Amateur Radio Club is sponsoring "The Swiss Bear Award." This award is given for working three different amateur stations in the New Bern area within the above time period. Extracts from logs for QSO's, along with a SASE or two IRC's (for DX stations) should be sent to: New Bern Amateur Radio Club, Inc., P.O. Box 2483, New Bern, NC 28560. Certificate depicting "The Swiss Bear" will be awarded stating that the station has met the requirements for this award.

MHz electronics

1900 MHz to 2500 MHz DOWN CONVERTER
This receiver is tunable over a range of 1900 to 2500 mc and is intended for amateur radio use. The local oscillator is voltage controlled (i.e.) making the i-f range approximately 54 to 88 mc (Channels 2 to 7).

PC BOARD WITH DATA	$19.99
PC BOARD WITH CHIP CAPACITORS 13	$44.99
PC BOARD WITH ALL PARTS FOR ASSEMBLY	$69.99
PC BOARD WITH ALL PARTS FOR ASSEMBLY PLUS 2N6603	$89.99
PC BOARD ASSEMBLED AND TESTED	$99.99
PC BOARD WITH ALL PARTS FOR ASSEMBLY, POWER SUPPLY AND ANTENNA	$159.99
POWER SUPPLY ASSEMBLED AND TESTED	$49.99
YAGI ANTENNA 4' LONG APPROX. 20 TO 23 dB GAIN	$59.99
YAGI ANTENNA 4' WITH TYPE (N, BNC, SMA Connector)	$64.99
2300 MHz DOWN CONVERTER Includes converter mounted in antenna, power supply, plus 90 DAY WARRANTY	$259.99
OPTION #1 MRF902 in front end. (7 dB noise figure)	$299.99
OPTION #2 2N6603 in front end. (5 dB noise figure)	$359.99
2300 MHz DOWN CONVERTER ONLY 10 dB Noise Figure 23 dB gain in box with N conn. Input F conn. Output	$149.99
7 dB Noise Figure 23 dB gain in box with N conn. Input F conn. Output	$169.99
5 dB Noise Figure 23 dB gain in box with SMA conn. Input F conn. Output	$189.99
DATA IS INCLUDED WITH KITS OR MAY BE PURCHASED SEPARATELY	$15.00

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

★ INTRODUCING THE HOWARD/COLEMAN TVRO CIRCUIT BOARDS ★

(Satellite Receiver Boards)

DUAL CONVERSION BOARD $25.00
This board provides conversion from the 3.7-4.2 band first to 900 MHz where gain and bandpass filtering are provided and, second, to 70 MHz. The board contains both local oscillators, one fixed and the other variable, and the second mixer. Construction is greatly simplified by the use of Hybrid IC amplifiers for the gain stages. Bare boards cost $25 and it is estimated that parts for construction will cost $270. (Note: The two Avantek VTO's account for $225 of this cost.)

47 pF CHIP CAPACITORS $6.00
For use with dual conversion board. Consists of 6 — 47 pF.

70 MHz IF BOARD $25.00
This circuit provides about 43 dB gain with 50 ohm input and output impedance. It is designed to drive the HOWARD/COLEMAN TVRO Demodulator. The on-board band pass filter can be tuned for bandwidths between 20 and 35 MHz with a passband ripple of less than ½ dB. Hybrid ICs are used for the gain stages. Bare boards cost $25. It is estimated that parts for construction will cost less than $40.

.01 pF CHIP CAPACITORS $7.00
For use with 70 MHz IF Board. Consists of 7 — .01 pF.

DEMODULATOR BOARD 40.00
This circuit takes the 70 MHz center frequency satellite TV signals in the 10 to 200 millivolt range, detects them using a phase locked loop, deemphasizes and filters the result and amplifies the result to produce standard NTSC video. Other outputs include the audio subcarrier, a DC voltage proportional to the strength of the 70 MHz signal, and AFC voltage centered at about 2 volts DC. The bare boards cost $40 and total parts cost less than $30.

SINGLE AUDIO $15.00
This circuit recovers the audio signals from the 6.8 MHz frequency. The Miller 9051 coils are tuned to pass the 6.8 MHz subcarrier and the Miller 9052 coil tunes for recovery of the audio.

DUAL AUDIO $25.00
Duplicate of the single audio but also covers the 6.2 range.

DC CONTROL $15.00
This circuit controls the VTO's, AFC and the S Meter.

TERMS:
WE REGRET WE NO LONGER ACCEPT BANK CARDS.
PLEASE SEND POSTAL MONEY ORDER, CERTIFIED CHECK, CASHIER'S CHECK OR MONEY ORDER.
PRICES SUBJECT TO CHANGE WITHOUT NOTICE. WE CHARGE 15% FOR RESTOCKING ON ANY ORDER.
ALL CHECKS AND MONEY ORDERS IN US FUNDS ONLY.
ALL ORDERS SENT FIRST CLASS OR UPS.
ALL PARTS PRIME AND GUARANTEED.
WE WILL ACCEPT COD ORDERS FOR $25.00 OR OVER, ADD $2.50 FOR COD CHARGE.
PLEASE INCLUDE $2.50 MINIMUM FOR SHIPPING OR CALL FOR CHARGES.
WE ALSO ARE LOOKING FOR NEW AND USED TUBES, TEST EQUIPMENT, COMPONENTS, ETC.
WE ALSO SWAP OR TRADE.

(602) 242-8916
2111 W. Camelback
Phoenix, Arizona 85015

NEW — TOLL-FREE NO. 800-528-0180 — please, orders only!

MHz electronics

FAIRCHILD VHF AND UHF PRESCALER CHIPS

95H90DC	350 MHz Prescaler Divide by 10/11	$9.50
95H91DC	350 MHz Prescaler Divide by 5/6	9.50
11C90DC	650 MHz Prescaler Divide by 10/11	16.50
11C91DC	650 MHz Prescaler Divide by 5/6	16.50
11C83DC	1 GHz Divide by 248/256 Prescaler	29.90
11C70DC	600 MHz Flip/Flop with reset	12.30
11C58DC	ECL VCM	4.53
11C44DC/MC4044	Phase Frequency Detector	3.82
11C24DC/MC4024	Dual TTL VCM	3.82
11C06DC	UHF Prescaler 750 MHz D Type Flip/Flop	12.30
11C05DC	1 GHz Counter Divide by 4	50.00
11C01FC	High Speed Dual 5-4 Input NO/NOR Gate	15.40

TRW BROADBAND AMPLIFIER MODEL CA615B

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

CARBIDE — CIRCUIT BOARD DRILL BITS FOR PC BOARDS

Size: 35, 42, 47, 49, 51, 52	$2.15
Size: 53, 54, 55, 56, 57, 58, 59, 61, 63, 64, 65	1.85
Size: 66	1.90
Size: 1.25 mm, 1.45 mm	2.00
Size: 3.20 mm	3.58

CRYSTAL FILTERS: TYCO 001-19880 same as 2194F

10.7 MHz Narrow Band Crystal Filter
3 dB bandwidth 15 kHz min. 20 dB bandwidth 60 kHz min. 40 dB bandwidth 150 kHz min.
Ultimate 50 dB: Insertion loss 1.0 dB max. Ripple 1.0 dB max. Ct. 0 + / − 5 pf 3600 ohms. $5.95

MURATA CERAMIC FILTERS

Models:	SFD-455D 455 kHz	$3.00
	SFB-455D 455 kHz	2.00
	CFM-455E 455 kHz	7.95
	SFE-10.7 10.7 MHz	5.95

TEST EQUIPMENT — HEWLETT PACKARD — TEKTRONIX — ETC.

Hewlett Packard:		
491C	TWT Amplifier 2 to 4 Gc 1 watt 30 dB gain	$1150.00
608C	10 to 480 mc .1 uv to .5 V into 50 ohms Signal Generator	500.00
608D	10 to 420 mc .1 uV to .5 V into 50 ohms Signal Generator	500.00
612A	450 to 1230 mc .1 uV to .5 V into 50 ohms Signal Generator	750.00
614A	900 to 2100 mc Signal Generator	500.00
616A	1.8 to 4.2 Gc Signal Generator	400.00
616B	1.8 to 4.2 Gc Signal Generator	500.00
618A	3.8 to 7.2 Gc Signal Generator	400.00
618B	3.8 to 7.2 Gc Signal Generator	500.00
620A	7 to 11 Gc Signal Generator	400.00
623B	Microwave Test Set	900.00
626A	10 to 15 Gc Signal Generator	2500.00
695A	12.4 to 18 Gc Sweep Generator	900.00
Alltech:		
473	225 to 400 mc AM/FM Signal Generator	750.00
Singer:		
MF5/VR-4	Universal Spectrum Analyzer with 1 kHz to 27.5 mc Plug In	1200.00
Keltek:		
XR630-100	TWT Amplifier 8 to 12.4 Gc 100 watts 40 dB gain	9200.00
Polarad:		
2038/2436/1102A	Calibrated Display with an SSB Analysis Module and a 10 to 40 mc Single Tone Synthesizer	1500.00

RF TRANSISTORS

TYPE	PRICE	TYPE	PRICE	TYPE	PRICE
2N1561	$15.00	2N5590	$8.15	MM1550	$10.00
2N1562	15.00	2N5591	11.85	MM1552	50.00
2N1692	15.00	2N5637	22.15	MM1553	56.50
2N1693	15.00	2N5641	6.00	MM1601	5.50
2N2632	45.00	2N5642	10.05	MM1602/2N5842	7.50
2N2857JAN	2.52	2N5643	15.82	MM1607	8.65
2N2876	12.35	2N6545	12.38	MM1661	15.00
2N2880	25.00	2N5764	27.00	MM1669	17.50
2N2927	7.00	2N5842	8.78	MM1943	3.00
2N2947	18.35	2N5849	21.29	MM2605	3.00
2N2948	15.50	2N5862	51.91	MM2608	5.00
2N2949	3.90	2N5913	3.25	MM8006	2.23
2N2950	5.00	2N5922	10.00	MMCM918	20.00
2N3287	4.30	2N5942	46.00	MMT72	1.17
2N3294	1.15	2N5944	8.92	MMT74	1.17
2N3301	1.04	2N5945	12.38	MMT2857	2.63
2N3302	1.05	2N5946	14.69	MRF245	33.30
2N3304	1.48	2N6080	7.74	MRF247	33.30
2N3307	12.60	2N6081	10.05	MRF304	43.45
2N3309	3.90	2N6082	11.30	MRF420	20.00
2N3375	9.32	2N6083	13.23	MRF450	11.85
2N3553	1.57	2N6084	14.66	MRF450A	11.85
2N3755	7.20	2N6094	7.15	MRF454	21.83
2N3818	6.00	2N6095	11.77	MRF458	20.68
2N3866	1.09	2N6096	20.77	MRF502	1.08
2N3866JAN	2.80	2N6097	29.54	MRF504	6.95
2N3866JANTX	4.49	2N6136	20.15	MRF509	4.90
2N3924	3.34	2N6166	38.60	MRF511	8.15
2N3927	12.10	2N6439	45.77	MRF901	5.00
2N3950	26.86	2N6459/PT9795	18.00	MRF5177	21.62
2N4072	1.80	2N6603	12.00	MRF8004	1.60
2N4135	2.00	2N6604	12.00	PT4186B	3.00
2N4261	14.60	A50-12	25.00	PT4571A	1.50
2N4427	1.20	BFR90	5.00	PT4612	5.00
2N4957	3.62	BLY568C	25.00	PT4628	5.00
2N4958	2.92	BLY568CF	25.00	PT4640	5.00
2N4959	2.23	CD3495	15.00	PT8659	10.72
2N4976	19.00	HEP76/S3014	4.95	PT9784	24.30
2N5090	12.31	HEPS3002	11.30	PT9790	41.70
2N5108	4.03	HEPS3003	29.88	SD1043	5.00
2N5109	1.66	HEPS3005	9.95	SD1116	3.00
2N5160	3.49	HEPS3006	19.90	SD1118	5.00
2N5179	1.05	HEPS3007	24.95	SD1119	3.00
2N5184	2.00	HEPS3010	11.34	TRWMRA2023-1.5	42.50
2N5216	47.50	HEPS5026	2.56	40281	10.90
2N5583	4.55	HP35831E/		40282	11.90
2N5589	6.82	HXTR5104	50.00	40290	2.48
		MM1500	32.20		

CHIP CAPACITORS

We can supply any value chip capacitors you may need.

1pf	27pf	220pf	1200pf
1.5pf	33pf	240pf	1500pf
2.2pf	39pf	270pf	1800pf
2.7pf	47pf	300pf	2200pf
3.3pf	56pf	330pf	2700pf
3.9pf	68pf	360pf	3300pf
4.7pf	82pf	390pf	3900pf
5.6pf	100pf	430pf	4700pf
6.8pf	110pf	470pf	5600pf
8.2pf	120pf	510pf	6800pf
10pf	130pf	560pf	8200pf
12pf	150pf	620pf	.010mf
15pf	160pf	680pf	.012mf
18pf	180pf	820pf	.015mf
22pf	200pf	1000pf	.018mf

PRICES

1 to 10	$1.49
11 - 50	1.29
51 - 100	.89
101 - 1,000	.69
1,001 up	.49

HAMLIN SOLID STATE RELAYS

120 Vac at 40 Amps.
Input Voltage 3 to 32 Vdc.

240 Vac at 40 Amps.
Input Voltage 3 to 32 Vdc.
Your Choice $4.99

ATLAS CRYSTAL FILTERS FOR ATLAS HAM GEAR

5.52-2.7/8
5.595-2.7/8/U
5.595-.500/4/CW
5.595-2.7LSB
5.595-2.7USB
5.645-2.7/8
9.0USB/CW

YOUR CHOICE $24.95

NEW — TOLL-FREE NO. 800-528-0180 — please, orders only!

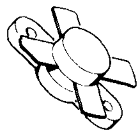
MHz electronics

MOTOROLA Semiconductor The RF Line

MRF454 $21.83

NPN SILICON RF POWER TRANSISTORS

. . . designed for power amplifier applications in industrial, commercial and amateur radio equipment to 30 MHz.



- Specified 12.5 Volt, 30 MHz Characteristics –
  Output Power = 80 Watts
  Minimum Gain = 12 dB
  Efficiency = 50%

MRF472 $2.50

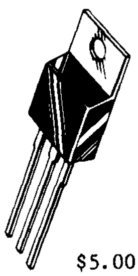
NPN SILICON RF POWER TRANSISTOR

. . . designed primarily for use in large-signal output amplifier stages. Intended for use in Citizen-Band communications equipment operating at 27 MHz. High breakdown voltages allow a high percentage of up-modulation in AM circuits.

- Specified 12.5 V, 27 MHz Characteristics –
  Power Output = 4.0 Watts
  Power Gain = 10 dB Minimum
  Efficiency = 65% Typical

MRF475

NPN SILICON RF POWER TRANSISTOR



$5.00

. . . designed primarily for use in single sideband linear amplifier output applications in citizens band and other communications equipment operating to 30 MHz.

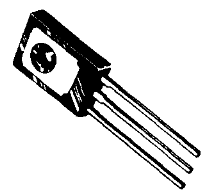
- Characterized for Single Sideband and Large-Signal Amplifier Applications Utilizing Low-Level Modulation.
- Specified 13.6 V, 30 MHz Characteristics –
  Output Power = 12 W (PEP)
  Minimum Efficiency = 40% (SSB)
  Output Power = 4.0 W (CW)
  Minimum Efficiency = 50% (CW)
  Minimum Power Gain = 10 dB (PEP & CW)
- Common Collector Characterization

MRF458 $20.68

NPN SILICON RF POWER TRANSISTOR

. . . designed for power amplifier applications in industrial, commerical and amateur radio equipment to 30 MHz.

- Specified 12.5 Volt, 30 MHz Characteristics –
  Output Power = 80 Watts
  Minimum Gain = 12 dB
  Efficiency = 50%
- Capable of Withstanding 30:1 Load VSWR @ Rated P_{out} and V_{CC}



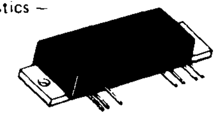
MHW710 - 2 $46.45

440 to 470MC

UHF POWER AMPLIFIER MODULE

. . . designed for 12.5 volt UHF power amplifier applications in industrial and commercial FM equipment operating from 400 to 512 MHz.

- Specified 12.5 Volt, UHF Characteristics –
  Output Power = 13 Watts
  Minimum Gain = 19.4 dB
  Harmonics = 40 dB



- 50 Ω Input/Output Impedance
- Guaranteed Stability and Ruggedness
- Gain Control Pin for Manual or Automatic Output Level Control
- Thin Film Hybrid Construction Gives Consistent Performance and Reliability

Tektronix Test Equipment

B	Wideband High Gain Plug In	$ 51.00
CA	Dual Trace Plug In	120.00
K	Fast Rise DC Plug In	63.00
N	Sampling Plug In	200.00
R	Transistor Risetime Plug In	116.00
W	High Gain Differential Comparator Plug In	283.00
TU-2	Test Load Plug In for 530/540/550 Main Frames	50.00
1A2	Wideband Dual Trace Plug In	216.00
1S1	Sampling Unit With 350PS Risetime DC to 1GHZ	730.00
2A61	AC Differential Plug In	133.00
3S3	Dual Trace Sampling DC to 1GHZ Plug In	250.00
3S76	Dual Trace Sampling DC to 875MHZ Plug IN	250.00
3T77A	Sampling Sweep Plug In	250.00
3L10	Spectrum Analyzer 1 to 36MHZ Plug IN	1000.00
50	Amplifier Plug In	50.00
51	Sweep Plug In	50.00
53B	Wideband High Gain Plug In	25.00
53/54B	Wideband High Gain Plug In	45.00
53/54C	Dual Trace Plug In	112.50
53/54D	High Gain DC Differential Plug In	38.00
53/54G	Wideband DC Differential Plug In	68.00
53/54L	Fast Rise High Gain Plug In	68.00
84	Test Plug In For 580/581 Main Frames	75.00
107	Square Wave Generator .4 to 1MHZ	48.00
RM122	Preamplifier 2Hz to 40KHZ	63.00
123	AC Coupled Preamplifier	25.00
131	Current Probe Amplifier	50.00
184	Time Mark Generator	363.00
R240	Program Control Unit	150.00
280	Trigger Countdown Unit	84.00
455	Portable Dual Trace 50MHZ Scope	2000.00
465	Portable Dual Trace 100MHZ Scope	2500.00
503	DC to 450KHZ Scope Rack Mount	250.00
535A	DC to 15MHZ Scope Rack Mount	263.00
543	DC to 33MHZ Scope	300.00
561	DC to 10MHZ Scope Rack Mount	150.00
561A	DC to 10MHZ Scope Rack Mount	200.00

Scopes with Plug-in's

561A	DC to 10MHZ Scope with a 3S76 Dual Trace DC to 875MHZ Sampling Plug In and a 3T77A Sweep Plug In. Rack Mount	600.00
565	DC to 10MHZ Dual Beam Scope with a 2A63 Diff. and a 2A61 Diff. Plug In's	900.00
581	DC to 80MHZ Scope with a 82 Dual Trace High Gain Plug In	650.00

Tubes

2E26	$ 5.00	4CX350FJ	$116.00	6146W	12.00
3-500Z	102.00	4CX1000A	300.00	6159	10.60
3-1000Z	268.00	4CX1500B	350.00	6161	75.00
3B28/866A	5.00	4CX15000A	750.00	6293	18.50
3X2500A3	150.00	4E27	50.00	6360	6.95
4-65A	45.00	4X150A	41.00	6907	40.00
4-125A	58.50	4X150D	52.00	6939	14.75
4-250A	68.50	4X150G	74.00	7360	12.00
4-400A	71.00	572B/T160L	39.00	7984	10.40
4-1000A	184.00	6LF6	5.00	8072	49.00
5-500A	145.00	6LQ6	5.00	8106	2.00
4CX250B	65.00	811A	12.95	8156	7.85
4CX250F/G	55.00	813	29 00	8226	127.70
4CX250K	113.00	5894/A	42.00	8295/PL172	328.00
4CX250R	92.00	6146	5.00	8458	25.75
4CX300A	147.00	6146A	6.00	8560A/AS	50.00
4CX350A	107.00	6146B/8298A	7.00	8908	9.00
				8950	9.00

NEW — TOLL-FREE NO. 800-528-0180 — please, orders only!

MHz electronics

MICROWAVE COMPONENTS

ARRA

2416	Variable Attenuator	$ 50.00
3614-60	Variable Attenuator 0 to 60dB	75.00
KU520A	Variable Attenuator 18 to 26.5 GHz	100.00
4684-20C	Variable Attenuator 0 to 180dB	100.00
6684-20F	Variable Attenuator 0 to 180dB	100.00

General Microwave

Directional Coupler 2 to 4GHz 20dB Type N	75.00

Hewlett Packard

H487B	100 ohms Neg. Thermistor Mount (NEW)	150.00
H487B	100 ohms Neg. Thermistor Mount (USED)	100.00
477B	200 ohms Neg. Thermistor Mount (USED)	100.00
X487A	100 ohms Neg. Thermistor Mount (USED)	100.00
X487B	100 ohms Neg. Thermistor Mount (USED)	125.00
J468A	100 ohms Neg. Thermistor Mount (USED)	150.00
478A	200 ohms Neg. Thermistor Mount (USED)	150.00
J382	5.85 to 8.2 GHz Variable Attenuator 0 to 50dB	250.00
X382A	8.2 to 12.4 GHz Variable Attenuator 0 to 50dB	250.00
394A	1 to 2 GHz Variable Attenuator 6 to 120dB	250.00
NK292A	Waveguide Adapter	65.00
K422A	18 to 26.5 GHz Crystal Detector	250.00
8436A	Bandpass Filter 8 to 12.4 GHz	75.00
8439A	2 GHz Notch Filter	75.00
8471A	RF Detector	50.00
H532A	7.05 to 10 GHz Frequency Meter	300.00
G532A	3.95 to 5.85 GHz Frequency Meter	300.00
J532A	5.85 to 8.2 GHz Frequency Meter	300.00
809A	Carriage with a 444A Slotted Line Untuned Detector Probe and 809B Coaxial Slotted Section 2.6 to 18 GHz	175.00

Merrimac

AU-25A/	801115 Variable Attenuator	100.00
AU-26A/	801162 Variable Attenuator	100.00

Microlab/FXR

X638S	Horn 8.2 - 12.4 GHz	60.00
601-B18	X to N Adapter 8.2 - 12.4 GHz	35.00
Y610D	Coupler	75.00

Narda

4013C-10/	22540A Directional Coupler 2 to 4 GHz 10db Type SMA	90.00
4014-10/	22538 Directional Coupler 3.85 to 8 GHz 10dB Type SMA	90.00
4014C-6/	22876 Directional Coupler 3.85 to 8 GHz 6dB Type SMA	90.00
4015C-10/	22539 Directional Coupler 7.4 to 12 GHz 10dB Type SMA	95.00
4015C-30/	23105 Directional Coupler 7 to 12.4 GHz 30dB Type SMA	95.00
3044-20	Directional Coupler 4 to 8 GHz 20dB Type N	125.00
3040-20	Direcitonal Coupler 240 to 500 MC 20dB Type N	125.00
3043-20/	22006 Directional Coupler 1.7 to 4 GHz 20dB Type N	125.00
3003-10/	22011 Directional Coupler 2 to 4 GHz 10dB Type N	75.00
3003-30/	22012 Directional Coupler 2 to 4 GHz 30dB Type N	75.00
3043-30/	22007 Directional Coupler 1.7 to 3.5 GHz 30dB Type N	125.00
22574	Directional Coupler 2 to 4 GHz 10dB Type N	125.00
3033	Coaxial Hybrid 2 to 4 GHz 3dB Type N	125.00
3032	Coaxial Hybrid 950 to 2 GHz 3 dB Type N	125.00
784/	22380 Variable Attenuator 1 to 90dB 2 to 2.5 GHz Type SMA	550.00
22377	Waveguide to Type N Adapter	35.00
720-6	Fixed Attenuator 8.2 to 14.4 GHz 6 dB	50.00
3503	Waveguide	25.00

PRD

U101	12.4 to 18 GHz Variable Attenuator 0 to 60dB	300.00
X101	8.2 to 12.4 GHz Variable Attenuator 0 to 60dB	200.00
C101	Variable Attenuator 0 to 60dB	200.00
205A/367	Slotted Line with Type N Adapter	100.00
195B	8.2 to 12.4 GHz Variable Attenuator 0 to 50dB	100.00
185BS1	7.05 to 10 GHz Variable Attenuator 0 to 40dB	100.00
196C	8.2 to 12.4 GHz Variable Attenuator 0 to 45dB	100.00
170B	3.95 to 5.85 GHz Variable Attenuator 0 to 45dB	100.00
588A	Frequency Meter 5.3 to 6.7 GHz	100.00
140A,C,D,E	Fixed Attenuators	25.00
109J,I	Fixed Attenuators	25.00
WEINSCHEL ENG.	2692 Variable Attenuator +30 to 60dB	100.00

COMPUTER I.C. SPECIALS

MEMORY	DESCRIPTION	PRICE
2708	1K x 8 EPROM	$ 7.99
2716/2516	2K x 8 EPROM 5Volt Single Supply	20.00
2114/9114	1K x 4 Static RAM 450ns	6.99
2114L2	1K x 4 Static RAM 250ns	8.99
2114L3	1K x 4 Static RAM 350ns	7.99
4027	4K x 1 Dynamic RAM	3.99
4060/2107	4K x 1 Dynamic RAM	3.99
4050/9050	4K x 1 Dynamic RAM	3.99
2111A-2/8111	256 x 4 Static RAM	3.99
2112A-2	256 x 4 Static RAM	3.99
2115AL-2	1K x 1 Static RAM 55ns	4.99
6104-3/4104	4K x 1 Static RAM 320ns	14.99
7141-2	4K x 1 Static RAM 200ns	14.99
MCM6641L20	4K x 2 Static RAM 200ns	14.99
9131	1K x 1 Static RAM 300ns	10.99

C.P.U.'s ECT.

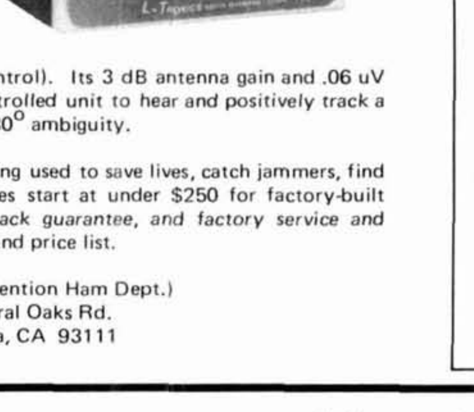
MC6800L	Microprocessor	13.80
MCM6810AP	128 x 8 Static RAM 450ns	3.99
MCM68A10P	128 x 8 Static RAM 360ns	4.99
MCM68B10P	128 x 8 Static RAM 250ns	5.99
MC6820P	PIA	8.99
MC6820L	PIA	9.99
MC6821P	PIA	8.99
MC68B21P	PIA	9.99
MCM6830L7	Mikbug	14.99
MC6840P	PTM	8.99
MC6845P	CRT Controller	29.50
MC6845L	CRT Controller	33.00
MC6850L	ACIA	10.99
MC6852P	SSDA	5.99
MC6852L	SSDA	11.99
MC6854P	ADLC	22.00
MC6860CJCS	0-600 BPS Modem	29.00
MC6862L	2400 BPS Modem	14.99
MK3850N-3	F8 Microprocessor	9.99
MK3852P	F8 Memory Interface	16.99
MK3852N	F8 Memory Interface	9.99
MK3854N	F8 Direct Memory Access	9.99
8008-1	Microprocessor	4.99
8080A	Microprocessor	8.99
Z80CPU	Microprocessor	14.99
6520	PIA	7.99
6530	Support For 6500 series	15.99
2650	Microprocessor	10.99
TMS1000NL	Four Bit Microprocessor	9.99
TMS4024NC	9 x 64 Digital Storage Buffer (FIFO)	9.99
TMS6011NC	UART	9.99
MC14411	Bit Rate Generator	11.99
AY5-4007D	Four Digit Counter/Display Drivers	8.99
AY5-9200	Repertory Dialler	9.99
AY5-9100	Push Button Telephone Diallers	7.99
AY5-2376	Keyboard Encoder	19.99
AY3-8500	TV Game Chip	5.99
TR1402A	UART	9.99
PR1472B	UART	9.99
PT1482B	UART	9.99
8257	DMA Controller	9.99
8251	Communication Interface	9.99
8228	System Controller & Bus Driver	5.00
8212	8 Bit Input/Output Port	5.00
MC14410CP	2 of 8 Tone Encoder	9.99
MC14412	Low Speed Modem	14.99
MC14408	Binary to Phone Pulse Converter	12.99
MC14409	Binary to Phone Pulse Converter	12.99
MC1488L	RS232 Driver	1.00
MC1489L	RS232 Receiver	1.00
MC1405L	A/D Converter Subsystem	9.00
MC1406L	6 Bit D/A Converter	7.50
MC1408/6/7/8	8 Bit D/A Converter	4.50
MC1330P	Low Level Video Detector	1.50
MC1349/50	Video IF Amplifier	1.17
MC1733L	LM733 OP Amplifier	2.40
LM565	Phase Lock Loop	2.50

NEW — TOLL-FREE NO. 800-528-0180 — please, orders only!

More Details? CHECK—OFF Page 110

Rx for a Bad Day

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



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

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

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

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

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

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

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

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

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

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

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

HAMVENTION	or	Bob Roettele, W8UNV
P.O. Box 44		Awards Chairman
Dayton, Ohio 45401		1299 Hanes Road
Attention: Awards Committee		Xenia, Ohio 45385

7400

SN7400N	.25	SN7472N	.29	SN74156N	.79
SN7401N	.20	SN7473N	.35	SN74157N	.69
SN7402N	.25	SN7474N	.35	SN74160N	.89
SN7403N	.25	SN7475N	.49	SN74161N	.89
SN7404N	.25	SN7476N	.35	SN74162N	.89
SN7405N	.29	SN7479N	5.00	SN74163N	.89
SN7406N	.35	SN7480N	.50	SN74164N	.89
SN7407N	.35	SN7482N	.99	SN74165N	.89
SN7408N	.29	SN7483N	.69	SN74166N	1.25
SN7409N	.29	SN7485N	.89	SN74167N	2.79
SN7410N	.25	SN7486N	.35	SN74170N	1.95
SN7411N	.29	SN7489N	1.75	SN74172N	4.95
SN7412N	.35	SN7490N	.49	SN74173N	1.39
SN7413N	.40	SN7491N	.59	SN74174N	.99
SN7414N	.69	SN7492N	.45	SN74175N	.89
SN7416N	.29	SN7493N	.45	SN74176N	.79
SN7417N	.29	SN7494N	.69	SN74177N	.79
SN7420N	.25	SN7495N	.69	SN74179N	1.49
SN7421N	.29	SN7496N	.69	SN74180N	.79
SN7422N	.45	SN7497N	3.00	SN74181N	2.25
SN7423N	.29	SN74100N	1.49	SN74182N	.79
SN7425N	.29	SN74107N	.35	SN74184N	2.49
SN7426N	.29	SN74109N	.39	SN74185N	2.49
SN7427N	.25	SN74116N	1.95	SN74190N	1.25
SN7429N	.39	SN74121N	.39	SN74191N	1.25
SN7430N	.25	SN74122N	.55	SN74192N	.89
SN7432N	.29	SN74123N	.59	SN74193N	.89
SN7437N	.25	SN74125N	.49	SN74194N	.89
SN7438N	.40	SN74126N	.49	SN74195N	.69
SN7439N	.25	SN74132N	.75	SN74196N	.89
SN7440N	.20	SN74136N	.75	SN74197N	.89
SN7441N	.89	SN74141N	.99	SN74198N	1.49
SN7442N	.59	SN74142N	3.25	SN74199N	1.49
SN7443N	1.10	SN74143N	3.49	SN74221N	1.25
SN7444N	1.10	SN74144N	3.49	SN74251N	.99
SN7445N	.89	SN74145N	.79	SN74276N	1.95
SN7446N	.79	SN74147N	1.95	SN74279N	.79
SN7447N	.69	SN74148N	1.29	SN74283N	1.49
SN7448N	.79	SN74150N	1.25	SN74284N	3.95
SN7450N	.20	SN74151N	.69	SN74285N	3.95
SN7451N	.20	SN74152N	.69	SN74365N	.69
SN7453N	.20	SN74153N	.79	SN74366N	.69
SN7454N	.20	SN74154N	1.25	SN74367N	.69
SN7459A	.25	SN74155N	.79	SN74368N	.69
SN7460N	.20			SN74390N	1.49
SN7470N	.29			SN74393N	1.49

74LS

74LS00	.29	74LS92	.75	74LS192	1.15
74LS01	.29	74LS93	.75	74LS193	1.15
74LS02	.29	74LS95	.99	74LS194	1.15
74LS03	.29	74LS96	1.15	74LS195	1.15
74LS04	.35	74LS107	.45	74LS197	1.19
74LS05	.35	74LS109	.45	74LS221	1.19
74LS08	.29	74LS112	.45	74LS240	1.95
74LS09	.35	74LS113	.45	74LS241	1.95
74LS10	.29	74LS114	.49	74LS242	1.95
74LS11	.35	74LS122	.89	74LS243	1.95
74LS12	.35	74LS123	1.25	74LS244	1.95
74LS13	.59	74LS125	.89	74LS245	2.95
74LS14	.99	74LS126	.55	74LS247	1.19
74LS15	.35	74LS132	.89	74LS248	1.19
74LS20	.29	74LS133	.89	74LS249	1.19
74LS21	.35	74LS136	.49	74LS251	1.49
74LS22	.35	74LS138	.89	74LS253	.99
74LS26	.35	74LS139	.89	74LS257	.89
74LS27	.35	74LS151	.89	74LS258	.99
74LS28	.35	74LS153	.89	74LS260	.69
74LS30	.29	74LS154	1.75	74LS266	.69
74LS32	.35	74LS155	1.19	74LS273	1.75
74LS33	.59	74LS156	1.19	74LS279	.75
74LS37	.45	74LS157	.89	74LS283	1.09
74LS38	.49	74LS158	.99	74LS290	.99
74LS40	.35	74LS160	1.15	74LS293	.99
74LS42	.89	74LS161	1.15	74LS298	1.25
74LS47	.89	74LS162	1.15	74LS352	1.49
74LS48	1.15	74LS163	1.15	74LS353	1.29
74LS49	1.15	74LS164	1.25	74LS365	.75
74LS51	.29	74LS165	1.25	74LS366	.75
74LS54	.29	74LS168	1.19	74LS367	.75
74LS55	.29	74LS169	1.19	74LS368	.75
74LS73	.45	74LS170	2.49	74LS373	1.95
74LS74	.45	74LS173	1.39	74LS374	1.95
74LS75	.59	74LS174	.99	74LS375	.89
74LS76	.45	74LS175	.99	74LS386	.69
74LS78	.49	74LS181	2.95	74LS393	2.49
74LS83	.89	74LS190	1.25	74LS399	2.49
74LS85	1.25	74LS191	1.25	74LS670	2.49
74LS86	.45			81LS95	1.95
74LS90	.59			81LS97	1.95

74S

74S00	.50	74S133	.55	74S244	3.25
74S02	.50	74S134	.69	74S251	1.45
74S03	.50	74S135	1.19	74S253	1.45
74S04	.55	74S136	1.75	74S257	1.35
74S05	.55	74S138	1.35	74S258	1.35
74S08	.50	74S139	1.35	74S260	.79
74S09	.50	74S140	1.15	74S280	2.95
74S10	.50	74S151	1.35	74S287*	4.95
74S11	.50	74S153	1.35	74S288*	4.95
74S15	.50	74S157	1.35	74S373	3.49
74S20	.50	74S158	1.35	74S374	3.49
74S22	.50	74S174	1.59	74S387*	5.95
74S30	.50	74S175	1.59	74S471*	19.95
74S32	.55	74S188	4.95	74S472*	19.95
74S40	.55	74S194	1.95	74S473*	19.95
74S51	.50	74S195	1.95	74S474*	21.95
74S64	.50	74S196	3.95	74S475*	21.95
74S65	.50	74S240	2.95	74S570*	7.95
74S74	.79	74S241	2.95	74S571*	7.95
74S86	.79	74S242	3.25	74S572*	19.95
74S112	.79	74S243	3.25	74S573*	19.95
74S113	.79			74S940	3.15
74S114	.79			74S941	3.15

* LIMITED AVAILABILITY ON THESE PROMS

CA—LINEAR

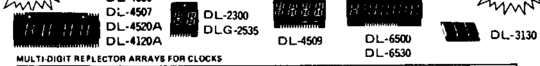
CA3013H	2.15	CA3081N	2.00	CA3089N	3.75
CA3023H	3.25	CA3082N	2.00	CA3096N	3.95
CA3039H	1.35	CA3083N	1.60	CA3130H	1.39
CA3046N	1.30	CA3086N	.85	CA3140H	1.25
CA3059N	3.25			CA3160H	1.25
CA3060N	3.25			CA3401N	.59
CA3080H	1.25			CA3600N	3.50

CD—CMOS

CD4000	.39	CD4041	1.49	CD4082	.39
CD4001	.39	CD4042	.99	CD4093	.99
CD4002	.39	CD4043	.89	CD4098	2.49
CD4006	1.19	CD4044	.89	CD4506	.75
CD4007	.25	CD4046	1.79	CD4507	.99
CD4009	.49	CD4047	2.50	CD4508	3.95
CD4010	.49	CD4048	1.35	CD4510	1.39
CD4011	.39	CD4049	.49	CD4511	1.29
CD4012	.25	CD4050	.69	CD4514	3.95
CD4013	.49	CD4051	1.19	CD4515	2.95
CD4014	1.39	CD4052	1.19	CD4516	1.49
CD4015	1.19	CD4053	1.19	CD4518	1.79
CD4016	.59	CD4056	2.95	CD4519	.89
CD4017	1.19	CD4059	9.95	CD4520	1.29
CD4018	.99	CD4060	1.49	CD4526	1.79
CD4019	.49	CD4066	.79	CD4528	1.79
CD4020	1.19	CD4068	.39	CD4529	1.95
CD4021	1.39	CD4069	.45	CD4543	2.79
CD4022	1.19	CD4070	.55	CD4562	11.95
CD4023	.29	CD4071	.49	CD4566	2.79
CD4024	.79	CD4072	.49	CD4583	2.49
CD4025	.23	CD4073	.39	CD4723	1.95
CD4026	2.95	CD4075	.39	CD4724	1.95
CD4027	.69	CD4076	1.39	MC14409	14.95
CD4028	.89	CD4081	.39	MC14410	14.95
CD4029	1.49			MC14411	14.95
CD4030	.49			MC14412	11.95
CD4035	.99			MC14419	4.95
CD4040	1.49			MC14433	13.95

LITRONIX DISPLAY SALE

LIMITED OFFER!! — WHILE THEY LAST!!



MULTI-DIGIT REFLECTOR ARRAYS FOR CLOCKS

PART NUMBER	CHAR. HT. (IN.)	POLARITY	DESCRIPTION	LIGHT OUTPUT (MCD) TYP	MIN	@mA	FORWARD VOLTAGE SEGMENT (V) If = 20mA TYP	MAX	CONTINUOUS FORWARD CURRENT PER SEGMENT (mA) MAX	PRICE
DL 4500 (Red) / DL 4507 (Red)		C.C. MPX		.	3 / 10					2.49 / 2.49
DLO 4507 (orng) / DLG 4507 (grn) / DL 4520A (red)	50	C.C. nonMPX	4 Digit 7 Segment With Colon And Auxiliary Indicators	8	5	10	1.7	2.0	30	4.95 / 4.95 / 2.49
DL 4120A (red)	1.0	C.C. nonMPX		1.8	8		3.4	4.0		4.95

MULTI-DIGIT REFLECTOR ARRAYS

DL 2300 (Red)	30	C.C MPX	7 Seg 2 Digit D.P. Right	2.5	1.1	20	1.7	2.0	30	.99
DLG 2638 (green)	50	C.A MPX	9 Seg 2 Digit		2.5	20		3.5	25	1.49
DL 4509 (Red)	50	C.C MPX	9 Seg. 4 Digit D.P. Right	8	5	10	1.7	2.0	30	2.49
DL 6500 (Red)	60	C.C MPX	7 Seg 6 Digit D.P. Right	8	6	10	1.7	2.0	30	2.95
DL 6530 (Red)	60	C.A MPX	7 Seg 6 Digit D.P. Right	.8	6	10	1.7	2.0	30	2.95
DL 3130 (Red)	1.0	C.A MPX	7 Seg 3 Digit D.P. Right	1.5	1.0	10	3.4	4.0	30	3.95

DISCRETE LEDS

XC556R	.200" red	5/$1	MV50	.085" red	6/$1	XC111R	.190" red	5/$1
XC556G	.200" green	4/$1	XC209R	.125" red	5/$1	XC111G	.190" green	4/$1
XC556Y	.200" yellow	4/$1	XC209G	.125" green	4/$1	XC111Y	.190" yellow	4/$1
XC556C	.200" clear	4/$1	XC209Y	.125" yellow	4/$1	XC111C	.190" clear	4/$1
XC22R	.200" red	5/$1	XC526R	.185" red	5/$1			
XC22G	.200" green	4/$1	XC526G	.185" green	4/$1			
XC22Y	.200" yellow	4/$1	XC526Y	.185" yellow	4/$1			
MV10B	.170" red	4/$1	XC526C	.185" clear	4/$1			

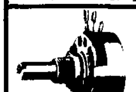
XC556 RED LED, METAL MTG. HDW. 2-4" LEADS.
RL-2 . . $.39 ea. or 3/$1.00

DISPLAY LEDS

C.A. — Common Anode C.C. — Common Cathode

Type	Polarity	Ht	Price	Type	Polarity	Ht	Price
MAN 1	C.A.—red	.270	2.95	DLG507	C.A.—green	.500	1.25
MAN 2	5x7 D.M.—red	.300	4.95	DL704	C.C.—red	.300	1.25
MAN 3	C.C.—red	.125	.25	DL707	C.A.—red	.300	1.25
MAN 52	C.A.—green	.300	1.25	DL728	C.C.—red	.500	1.49
MAN 54	C.C.—green	.300	1.25	DL741	C.A.—red	.600	1.25
MAN 71	C.A.—red	.300	.75	DL746	C.A.—red ± 1	.630	1.49
MAN 72	C.A.—red	.300	.75	DL747	C.A.—red	.600	1.49
MAN 74	C.C.—red	.300	1.25	DL750	C.C.—red	.600	1.49
MAN 82	C.A.—yellow	.300	.49	DLO847	C.A.—orange	.800	1.49
MAN 84	C.C.—yellow	.300	.99	DLO850	C.C.—orange	.800	1.49
MAN 3620	C.A.—orange	.300	.49	DL33B	C.C.—red	.110	.35
MAN 3630	C.A.—orange ± 1	.300	.99	FND358	C.C. ± 1	.357	.99
MAN 3640	C.C.—orange	.300	.99	FND359	C.C.	.357	.75
MAN 4610	C.A.—orange	.400	.99	FND503	C.C. (FND500)	.500	.99
MAN 6610	C.A.—orange—DD	.560	.99	FND507	C.A. (FND510)	.500	.99
MAN 6630	C.A.—orange ± 1	.560	.99	HDSP-3401	C.A.—red	.800	1.50
MAN 6640	C.C.—orange—DD	.560	.99	HDSP-3403	C.C.—red	.800	1.50
MAN 6650	C.C.—orange ± 1	.560	.99	5082-7751	C.A., R.H.D.—red	.430	1.25
MAN 6660	C.A.—orange	.560	.99	5082-7760	C.C., R.H.D.—red	.430	1.75
MAN 6710	C.A.—red—DD	.560	.99	5082-7300	4x7 sgl. dig. RHD	.600	22.00
MAN 6750	C.C.—red ± 1	.560	.99	5082-7302	4x7 sgl. dig. LHD	.600	22.00
MAN 6780	C.C.—red	.560	.99	5082-7304	Overnge. char. (±1)	.600	19.95
DLO304	C.C.—orange	.300	1.25	4N28	Photo Xsistor Opto-Isol.		.99
DLO307	C.A.—orange	.300	1.25	LIT-1	Photo Xsistor Opto-Isol.		.69
DLG500	C.C.—green	.500	1.25	MOC3010	Optically Isol. Triac Driver		1.25

POTENTIOMETERS



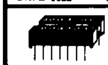
$2.95 each
2 Watt @ 70°C ± 10%
7/8" Slotted Shaft
Linear Taper
Meets Mil-R-94

Part No.		
CMU 1021	RV4NAY SD - 102A	1K
CMU 5021	RV4NAY SD - 502A	5K
CMU 1031	RV4NAY SD - 103A	10K
CMU 2531	RV4NAY SD - 253A	25K
CMU 5031	RV4NAY SD - 503A	50K
CMU 1041	RV4NAY SD - 104A	100K
CMU 1052	RV4NAY SD - 105A	1Meg

$1.35 each
3/4 Watt @ 70°C
15 turn pot. Linear taper. Printed circuit mount.

Part No.	Part No.	Part No.
830P- 50ohm	830P- 5K	830P-100K
830P-100ohm	830P-10K	830P-200K
830P-500ohm	830P-20K	830P-500K
830P-1K	830P-50K	830P-1Meg
830P-2K		

LOW PROFILE (TIN) SOCKETS



	1-24	25-49	50-100
8 pin LP	.17	.16	.15
14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.37	.36	.35
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
36 pin LP	.60	.59	.58
40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100
14 pin ST	.27	.25	.24
16 pin ST	.30	.27	.25
18 pin ST	.35	.32	.30
24 pin ST	.49	.45	.42
28 pin ST	.99	.90	.81
36 pin ST	1.39	1.26	1.15
40 pin ST	1.59	1.45	1.30

SOLDERTAIL (GOLD) STANDARD

	1-24	25-49	50-100
8 pin SG	.39	.35	.31
14 pin SG	.49	.45	.41
16 pin SG	.54	.49	.44
18 pin SG	.59	.53	.48
24 pin SG	.79	.75	.69
28 pin SG	1.10	1.00	.90
36 pin SG	1.65	1.40	1.26
40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100
8 pin WW	.59	.54	.49
10 pin WW	.69	.63	.58
14 pin WW	.79	.73	.67
16 pin WW	.85	.77	.70
18 pin WW	.99	.90	.81
20 pin WW	1.19	1.08	.99
22 pin WW	1.49	1.35	1.23
24 pin WW	1.39	1.26	1.14
28 pin WW	1.69	1.53	1.38
36 pin WW	2.19	1.99	1.79
40 pin WW	2.29	2.09	1.89

1/4 WATT RESISTOR ASSORTMENTS – 5%

ASST. 1	5 ea.	10 Ohm 12 Ohm 15 Ohm 18 Ohm 22 Ohm 27 Ohm 33 Ohm 39 Ohm 47 Ohm 56 Ohm	50 pcs.	$1.95
ASST. 2	5 ea.	68 Ohm 82 Ohm 100 Ohm 120 Ohm 150 Ohm 180 Ohm 220 Ohm 270 Ohm 330 Ohm 390 Ohm	50 pcs.	$1.95
ASST. 3	5 ea.	470 Ohm 560 Ohm 680 Ohm 820 Ohm 1K 1.2K 1.5K 1.8K 2.2K 2.7K	50 pcs.	$1.95
ASST. 4	5 ea.	3.3K 3.9K 4.7K 5.6K 6.8K 8.2K 10K 12K 15K 18K	50 pcs.	$1.95
ASST. 5	5 ea.	22K 27K 33K 39K 47K 56K 68K 82K 100K 120K	50 pcs.	$1.95
ASST. 6	5 ea.	150K 180K 220K 270K 330K 390K 470K 560K 680K 820K	50 pcs.	$1.95
ASST. 7	5 ea.	1M 1.2M 1.5M 1.8M 2.2M 2.7M 3.3M 3.9M 4.7M 5.6M	50 pcs.	$1.95
ASST. 8R		Includes Resistor Assts. 1-7 (350 pcs.)		$10.95 ea.

$10.00 Min. Order — U.S. Funds Only
Calif. Residents Add 6% Sales Tax
Postage — Add 5% plus $1 Insurance

Spec Sheets — 25¢
Send 41¢ Postage for your FREE 1981 JAMECO CATALOG

NEW 1981 CATALOG

Jameco ELECTRONICS

PHONE ORDERS WELCOME
(415) 592-8097

MAIL ORDER ELECTRONICS — WORLDWIDE
1355 SHOREWAY ROAD, BELMONT, CA 94002
3/81 PRICES SUBJECT TO CHANGE

INTERSIL

Part No.	Function		Price
7045IPI	CMOS Precision Timer		14.95
7045EV/Kit*	Stopwatch Chip, XTL		22.95
7106CPL	3½ Digit A/D (LCD Drive)		16.95
7106EV/Kit*	IC, Circuit Board, Display		34.95
7107CPL	3½ Digit A/D (LED Drive)		15.95
7107EV/Kit*	IC, Circuit Board, Display		28.95
7116CPL	3½ Digit A/D LCD Dis. HLD.		18.95
7117CPL	3½ Digit A/D LED Dis. HLD.		17.95
7201IDR	Low Battery Volt Indicator		2.25
7205IPG	CMOS LED Stopwatch/Timer		12.95
7205EV/Kit*	Stopwatch Chip, XTL		19.95
7206CJPE	Tone Generator		5.15
7206CEV/Kit*	Tone Generator Chip, XTL		9.95
7207AIPD	Oscillator Controller		6.50
7207AEV/Kit*	Freq. Counter Chip, XTL		11.10
7208IPI	Seven Decade Counter		17.95
7209IPA	Clock Generator		3.95
7215IPG	4 Func. CMOS Stopwatch CKT		13.95
7215EV/Kit*	4 Func. Stopwatch Chip, XTL		19.95
7216AIJI	8-Digit Univ. Counter C.A.		32.00
7216CIJI	8-Digit Freq. Counter C.A.		26.95
7216DIPI	8-Digit Freq. Counter C.C.		21.95
7217IJI	4-Digit LED Up/Down Counter		12.95
7218CIJI	8-Digit Univ. LED Drive		10.95
7224IPL	LCD 4½ Digit Up Counter DRI		11.25
7226AIJL	8-Digit Univ. Counter		31.95
7226AEV/Kit*	5 Function Counter Chip, XTL		74.95
7240IJE	CMOS Bin Prog. Timer/Counter		4.95
7242IJA	CMOS Divide-by-256 RC Timer		2.05
7250IJE	CMOS BCD Prog. Timer/Counter		6.00
7260IJE	CMOS BCD Prog. Timer/Counter		5.25
7555IPA	CMOS 555 Timer (8 pin)		1.45
7556IPD	CMOS 556 Timer (14 pin)		2.20
7611BCPA	CMOS Op Amp Comparator	5MV	2.25
7612BCPA	CMOS Op Amp Ext. Cmvr.	5MV	2.95
7621BCPA	CMOS Dual Op Amp Comp.	5MV	3.95
7631CCPE	CMOS Tri Op Amp Comp.	10MV	5.35
7641CCPD	CMOS Quad Op Amp Comp.	10MV	7.50
7642CCPD	CMOS Quad Op Amp Comp.	10MV	7.50
7660CPA	Voltage Converter		2.95
8069CCQ	50ppm Band—GAP Volt Ref. Diode		2.50
8211CPA	Volt Ref/Indicator		2.50
8212CPA	Volt Ref/Indicator		2.50

* INTERSIL'S EVALUATION KITS

74C

74C00	.39	74C106	.75	74C195	1.59
74C02	.39	74C107	1.89	74C221	1.95
74C04	.39	74C151	2.95	74C240	2.25
74C08	.39	74C154	3.95	74C244	2.25
74C10	.39	74C157	2.25	74C373	2.49
74C14	.75	74C160	1.69	74C374	2.59
74C20	.39	74C161	1.60	74C901	.89
74C30	.39	74C162	1.49	74C903	1.15
74C42	1.39	74C163	1.69	74C911	10.95
74C48	1.95	74C164	1.59	74C912	10.95
74C73	.79	74C173	1.39	74C915	1.69
74C74	.79	74C174	1.39	74C917	10.95
74C85	1.95	74C175	1.39	74C922	5.49
74C86	.99	74C192	1.69	74C923	5.75
74C89	6.95	74C193	1.69	74C925	7.50
74C90	1.29			74C926	7.50
74C93	1.29			80C95	.79
74C95	1.59			80C97	.79

LINEAR

LH0002CN	6.85	LM340T-5	1.25	NE570N	4.95
LM10CLH	4.50	LM340T-12	1.25	LM702H	.79
LM11CLH	4.75	LM340T-15	1.25	LM703CN	.89
LH0070-OH	6.05	LM341P-5	.75	LM709N	.29
TL071CP	.79	LM341P-12	.75	LM710N	.79
TL072CP	1.39	LM341P-15	.75	LM711N	.79
TL074CN	2.49	LM342P-5	.69	LM723N	.69
LH0082CD	35.80	LM342P-12	.69	LM733N	1.00
TL082CP	1.19	LM342P-15	.69	LM739N	1.19
TL084CN	2.19	LM348N	1.25	LM741CN	.35
LH0094CD	36.80	LM350K	5.75	MC1741SCG	3.00
LM300H	.99	LF351N	.60	LM747N	.79
LM301CN	.35	LF353N	1.00	LM748N	.59
LM302H	1.95	LF355N	1.10	LM1014N	2.75
LM304H	1.95	LF356N	1.10	LM1310N	1.95
LM305H	.99	LM358N	1.00	LM1458CN	.59
LM307CN	.45	LM359N	1.79	LM1488N	1.25
LM308CN	1.00	LM370N	4.49	LM1489N	1.25
LM309H	1.95	LM373N	3.25	LM1496N	1.95
LM309K	1.25	LM377N	2.95	LM1556V	1.75
LM310CN	1.75	LM380N	1.25	LM1800N	2.95
LM311H	.90	LM381N	1.95	LM1877N-9	3.25
LM312H	2.49	LM382N	1.79	LM1889N	3.20
LM317MP	1.15	LM384N	1.95	LM1896N	1.75
LM317T	1.75	LM386N-3	1.29	LM2002T	1.49
LM317K	3.95	LM387N	1.45	LM2877P	2.05
LM318CN	1.95	LM389N	1.35	LM2878P	2.25
LM319N	1.95	LM392N	.69	LM2896P-1	2.25
LM320K-5	1.35	LF398N	4.00	LM3189N	2.95
LM320K-12	1.35	LM399H	5.00	LM3900N	.69
LM320K-15	1.35	TL494CN	4.49	LM3905CN	1.25
LM320T-5	1.25	TL496CP	1.75	LM3909N	1.15
LM320T-12	1.25	NE510A	6.00	LM3914N	3.95
LM320T-15	1.25	NE529A	4.95	LM3915N	3.95
LM323K-5	5.95	NE531H	3.95	LM3916N	3.95
LM324N	.99	NE536H	6.00	RC4136N	1.25
LM329DZ	.65	NE540H	6.00	RC4151NB	3.95
LM331N	3.95	NE544N	4.95	RC4194TK	5.95
LM334Z	1.30	NE550A	1.30	RC4195TK	5.49
LM335Z	1.40	NE555V	.39	KB4428	4.25
LM336Z	1.75	LM556N	.99	KB4429	5.95
LM337T	1.95	NE564N	3.95	LM4500A	3.25
LM337MP	1.15	LM565N	1.25	ICL8038B	4.95
LM338K	6.95	LM566CN	1.95	LM13080N	1.29
LM339N	.99	LM567V	1.25	LM13600N	1.49
LM340K-5	1.35			75138N	1.95
LM340K-12	1.35			75450N	.89
LM340K-15	1.35			75451CN	.39

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

Value	1-9	10-99	100+	Value	1-9	10-99	100+
10 pf	.08	.06	.05	.001µF	.08	.06	.05
22 pf	.08	.06	.05	.0047µF	.08	.06	.05
47 pf	.08	.06	.05	.01µF	.08	.06	.05
100 pf	.08	.06	.05	.022µF	.09	.07	.06
220 pf	.08	.06	.05	.047µF	.09	.07	.06
470 pf	.08	.06	.05	.1µF	.15	.12	.10

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022mf	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (Solid) CAPACITORS

.1/35V	.39	.34	.29	1.5/35V	.41	.37	.29
.15/35V	.39	.34	.29	2.2/25V	.51	.45	.34
.22/35V	.39	.34	.29	3.3/25V	.53	.47	.37
.33/35V	.39	.34	.29	4.7/25V	.63	.56	.45
.47/35V	.39	.34	.29	6.8/25V	.79	.69	.56
.68/35V	.39	.34	.29	15/25V	1.39	1.25	.95
1.0/35V	.39	.34	.29	22/6V	.79	.69	.56

MINI. ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead				Radial Lead			
.47/50V	.16	.14	.10	.47/25V	.15	.13	.12
1.0/50V	.16	.14	.12	.47/50V	.16	.14	.13
3.3/50V	.17	.15	.11	1.0/16V	.15	.13	.12
4.7/25V	.18	.15	.11	1.0/25V	.16	.14	.13
10/25V	.18	.15	.11	1.0/50V	.17	.15	.14
10/50V	.19	.16	.12	4.7/16V	.15	.13	.12
22/25V	.19	.16	.12	4.7/25V	.16	.14	.13
22/50V	.24	.20	.18	4.7/50V	.17	.15	.14
47/25V	.25	.21	.19	10/16V	.15	.13	.12
47/50V	.29	.25	.23	10/25V	.16	.14	.13
100/25V	.28	.24	.22	10/50V	.17	.15	.14
100/50V	.41	.37	.34	47/50V	.25	.21	.18
220/25V	.39	.34	.33	100/16V	.19	.17	.14
220/50V	.49	.45	.41	100/25V	.25	.23	.21
470/25V	.54	.49	.45	100/50V	.37	.34	.30
1000/16V	.79	.69	.61	220/16V	.25	.21	.19
2200/16V	.89	.79	.69	470/25V	.35	.31	.27

HAM MART

Ham Radio's guide to help you find your loca

Arizona

POWER COMMUNICATIONS CORPORATION
1640 W. CAMELBACK ROAD
PHOENIX, AZ 85015
602-242-6030 or 242-8990
Arizona's #1 "Ham" Store. Kenwood, Yaesu, Icom and more.

California

C & A ELECTRONIC ENTERPRISES
2210 S. WILMINGTON AVE.
SUITE 105
CARSON, CA 90745
213-834-5868
Not The Biggest, But The Best — Since 1962.

JUN'S ELECTRONICS
3919 SEPULVEDA BLVD.
CULVER CITY, CA 90230
213-390-8003 Trades
714-463-1886 San Diego
The Home of the One Year Warranty — Parts at Cost — Full Service.

QUEMENT ELECTRONICS
1000 SO. BASCOM AVENUE
SAN JOSE, CA 95128
408-998-5900
Serving the world's Radio Amateurs since 1933.

SHAVER RADIO, INC.
1378 S. BASCOM AVENUE
SAN JOSE, CA 95128
408-998-1103
Azden, Icom, Kenwood, Tempo, Ten-Tec, Yaesu and many more.

Connecticut

HATRY ELECTRONICS
500 LEDYARD ST. (SOUTH)
HARTFORD, CT 06114
203-527-1881
Connecticut's Oldest Ham Radio Dealer

Delaware

DELAWARE AMATEUR SUPPLY
71 MEADOW ROAD
NEW CASTLE, DE 19720
302-328-7728
Icom, Ten-Tec, Swan, DenTron, Tempo, Yaesu, Azden, and more. One mile off I-95, no sales tax.

Florida

AGL ELECTRONICS, INC.
1898 DREW STREET
CLEARWATER, FL 33515
813-461-HAMS
West Coast's only full service Amateur Radio Store.

AMATEUR RADIO CENTER, INC.
2805 N.E. 2ND AVENUE
MIAMI, FL 33137
305-573-8383
The place for great dependable names in Ham Radio.

RAY'S AMATEUR RADIO
1590 US HIGHWAY 19 SO.
CLEARWATER, FL 33516
813-535-1416
Atlas, B&W, Bird, Cushcraft, DenTron, Drake, Hustler, Hy-Gain, Icom, K.D.K., Kenwood, MFJ, Rohn, Swan, Ten-Tec, Wilson.

Illinois

AUREUS ELECTRONICS, INC.
1415 N. EAGLE STREET
NAPERVILLE, IL 60540
312-420-8629
"Amateur Excellence"

ERICKSON COMMUNICATIONS, INC.
5456 N. MILWAUKEE AVE.
CHICAGO, IL 60630
Chicago — 312-631-5181
Outside Illinois — 800-621-5802
Hours: 9:30-5:30 Mon, Tu, Wed & Fri.; 9:30-9:00 Thurs; 9:00-3:00 Sat.

Indiana

THE HAM SHACK
808 NORTH MAIN STREET
EVANSVILLE, IN 47710
812-422-0231
Discount prices on Ten-Tec, Cubic, Hy-Gain, MFJ, Azden, Kantronics, Santec and others.

Kansas

ASSOCIATED RADIO
8012 CONSER, P. O. BOX 4327
OVERLAND PARK, KS 66204
913-381-5900
America's No. 1 Real Amateur Radio Store. Trade — Sell — Buy.

Maryland

THE COMM CENTER, INC.
LAUREL PLAZA, RT. 198
LAUREL, MD 20810
800-638-4486
Kenwood, Drake, Icom, Ten-Tec, Tempo, DenTron, Swan & Apple Computers.

Massachusetts

TEL-COM, INC.
675 GREAT ROAD, RT. 119
LITTLETON, MA 01460
617-486-3040
The Ham Store of New England You Can Rely On.

TUFTS RADIO ELECTRONICS
206 MYSTIC AVENUE
MEDFORD, MA 02155
617-391-3200
New England's friendliest ham store.

Minnesota

PAL ELECTRONICS INC.
3452 FREMONT AVE. NO.
MINNEAPOLIS, MN 55412
612-521-4662
Midwest's Fastest Growing Ham Store, Where Service Counts.

New Hampshire

EVANS RADIO, INC.
BOX 893, RT. 3A BOW JUNCTION
CONCORD, NH 03301
603-224-9961
Icom, DenTron & Yaesu dealer. We service what we sell.

Dealers: YOU SHOULD BE HERE TOO! Contact Ham Radio now for complete details.

Amateur Radio Dealer

New Jersey

RADIOS UNLIMITED
P. O. BOX 347
1760 EASTON AVENUE
SOMERSET, NJ 08873
201-469-4599
New Jersey's Fastest Growing Amateur Radio Center.

ROUTE ELECTRONICS 46
225 ROUTE 46 WEST
TOTOWA, NJ 07512
201-256-8555
Drake, Cubic, DenTron, Hy-Gain, Cushcraft, Hustler, Larsen, MFJ, Butternut, Fluke & Beckman Instruments, etc.

WITTIE ELECTRONICS
384 LAKEVIEW AVENUE
CLIFTON, NJ 07011
201-546-3000
Same location for 63 years. Full-line authorized Drake dealer. We stock most popular brands of Antennas and Towers.

New Mexico

PECOS VALLEY AMATEUR RADIO SUPPLY
112 W. FIRST STREET
ROSWELL, NM 88201
505-623-7388
Now stocking Ten-Tec, Lunar, Icom, Morsematic, Bencher, Tempo, Hy-Gain, Avanti and more at low, low prices. Call for quote.

New York

BARRY ELECTRONICS
512 BROADWAY
NEW YORK, NY 10012
212-925-7000
New York City's Largest Full Service Ham and Commercial Radio Store.

GRAND CENTRAL RADIO
124 EAST 44 STREET
NEW YORK, NY 10017
212-599-2630
Drake, Kenwood, Yaesu, Atlas, Ten-Tec, Midland, DenTron, Hy-Gain, Mosley in stock.

HARRISON RADIO CORP.
20 SMITH STREET
FARMINGDALE, NY 11735
516-293-7990
"Ham Headquarters USA" since 1925. Call toll free 800-645-9187.

RADIO WORLD
ONEIDA COUNTY AIRPORT
TERMINAL BLDG.
ORISKANY, NY 13424
TOLL FREE 1 (800) 448-9338
NY Res. 1 (315) 337-0203
Authorized Dealer — ALL major Amateur Brands.
We service *everything* we sell!
Warren K2IXN or Bob WA2MSH.

Ohio

UNIVERSAL AMATEUR RADIO, INC.
1280 AIDA DRIVE
COLUMBUS (REYNOLDSBURG), OH 43068
614-866-4267
Complete Amateur Radio Sales and Service. All major brands — spacious store near I-270.

Pennsylvania

HAMTRONICS, DIV. OF TREVOSE ELECTRONICS
4033 BROWNSVILLE ROAD
TREVOSE, PA 19047
215-357-1400
Same Location for 30 Years.

LaRUE ELECTRONICS
1112 GRANDVIEW STREET
SCRANTON, PENNSYLVANIA 18509
717-343-2124
Icom, Bird, Cushcraft, CDE, Ham-Keys, VHF Engineering, Antenna Specialists.

SPECIALTY COMMUNICATIONS
2523 PEACH STREET
ERIE, PA 16502
814-455-7674
Service, Parts, & Experience For Your Atlas Radio.

Virginia

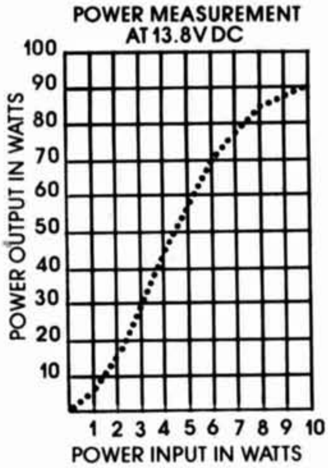
ELECTRONIC EQUIPMENT BANK
516 MILL STREET, N.E.
VIENNA, VA 22180
703-938-3350
Metropolitan D.C.'s One Stop Amateur Store. Largest Warehousing of Surplus Electronics.

90 WATT AMPLIFIER: $89.95!

V-J
POWER UP

SPECIAL PACKAGE DEAL *FACTORY DIRECT ONLY*

That's right — 90 watts of linear power for 2 meters class AB1 for FM & SSB for only $89.95. Also offering a 15 dB gain in-line preamp with integrated T/R relay. A $29.95 value, for only $20.00 when purchased with the VJ90L Amplifier.



POWER CHART

*ORDER TODAY TOLL FREE
(800) 231-9649

PRICING OFFER EXPIRES APRIL 1, 1981

VJ90L

Each VJ Product component is hand wired and individually tuned for maximum reliability and performance. VJ Products are guaranteed to be free of defects in parts or workmanship for 1 year from the date of purchase. POWER TRANSISTORS ARE EXCLUDED, BUT WARRANTED FOR 90 DAYS. Visa accepted. Immediate shipment guaranteed by VJ Products, Inc.

Please ship: ☐VJ90L @ $89.95 + $2.00 shipping
☐VJ90L & Preamp @ $109.95 + $3.50 shipping

Name ________ Call ________
Street ________
City ________ State ________ Zip ________
Send Check, M/O, or Visa # ________ Exp. Date ________

SERVING THE ELECTRONICS INDUSTRY SINCE 1965 V-J Products, Inc. 505 E. Shaw Street, Pasadena, Texas 77506 (713) 477-0134

FACSIMILE

COPY SATELLITE PHOTOS, WEATHER MAPS, PRESS!
The Faxs Are Clear — on our full size (18-1/2" wide) recorders. Free Fax Guide.

TELETYPE

RTTY MACHINES, PARTS, SUPPLIES

ATLANTIC SURPLUS SALES (212) 372-0349
3730 NAUTILUS AVE BROOKLYN, N.Y. 11224

VHF COMMUNICATIONS

is a quarterly radio amateur magazine specializing in VHF, UHF, and microwaves. An introductory annual subscription is $15.00. USA representative:

SELECTO Inc.
372 D Bel Marin Keys Blvd., Novato, CA 94947
Phone: (415) 883-2478 Telex: 171-046

!!!!!

(Radio not included)

BEAT YOUR BATTERIES!

OPERATE your SYNTHESIZED HT from any 13-30v D.C. source- Auto, Truck, Light Aircraft (12 or 28v system), Home Power Supply!
STEWART's New BATTERY-BEATER provides the proper REGULATED voltage for your rig and plenty of current for CONTINUOUS FULL POWER TRANSMIT! All day travel, all evening Simplex Net with NO QRT TO RE-CHARGE!

- NOT a battery charger but a FULL POWER SOURCE with Fused Circuit to protect your rig!
- RUGGED ALUMINUM CASE (except ICOM unit is built into IC-BP4 case for slide on/slide off power supply change!)
- YOUR NiCads REMAIN IN PLACE (except ICOM). Simply unplug for INSTANT PORTABILITY!
- DESIGNED by an engineer from NASA's Jet Propulsion Laboratory with components rated 50% beyond requirements!
- PRE-WIRED JACK (except ICOM) and detailed installation instructions supplied!
- 5 FT. power cord. VELCRO pads supplied to mount anywhere! 1 FULL YEAR WARRANTY!
- PRICE: All models- $25.00 Post Paid. Ca. Res. add $1.50 Tax. C.O.D.'s- You pay Postage and C.O.D. fees.
- NOW AVAILABLE for TEMPO S-1, S-2, S-5, KENWOOD TR-2400 (Retains Memory!), and ICOM IC-2A/T!
- PHONE: 1-213-357-7875 Collect for C.O.D.

STEWART QUADS P.O. Box 2335 IRWINDALE, CA. 91706

"LOOK"

THIS BIG G IS THE SYMBOL OF METROLINA'S FASTEST GROWING HAM DEALER

800-845-6183

G.I.S.M.O.
2305 CHERRY ROAD
ROCK HILL, S.C. 29730

Service Department
Call 803-366-7158

Alaska Microwave Labs
4335 E. 5TH STREET
ANCHORAGE, ALASKA 99504
(907) 338-0340

NEW ! GaAs FETS

MGF 1400 NF 2.0DB AT 4GHZ MAG 15DB $28.50

MGF 1412 NF .8DB AT 4GHZ MAG 18DB $75.00

TRANSISTORS	
MRF901 FT4.5GHZ	$3.00
BFR90 FT5.0GHZ	$3.00
NEC 02137 FT4.5GHZ	$3.25
HOT CARRIER DIODES	
MBD101 UHF—MICROWAVE	$1.50
ND4131 4GHZ NF—5.75 DB	$19.00
4GHZ NF— 6.5 DB	$2.00
CHIP CAPACITORS	
1.2, 2.2, 3.3, 4.7, 6.8, 10, 18, 22, 27, 47, 100, 120, 180, 220, 270, 330, 390, 470, 560, 680, 820, 1000, 1200, 1800, 3900, 8200	$ .60
RF - IF I.C.	
MWA—110 RF—IF AMPLIFIER I.C. 1 TO 400 MC 14 DB GAIN TYP 3 TERMINAL IN, OUT, & GROUND	$7.95
DUAL GATE MOSFET	
RCA 40673	$1.50
COAX CONNECTORS	
SMA CHASSIS MOUNT SQUARE FLANGE	$5.90
SMA PLUG FOR RG—58	$6.57
SMA PLUG FOR RG—174	$6.57
TYPE N CHASSIS MOUNT SQUARE FLANGE	$3.20
TYPE N PLUG FOR RG—9/RG—8	$3.69
FEED-THRU CAPACITORS	
500 Pf	$ .50
TEFLON CIRCUIT BOARD	
APPROX 3.5" x 5.0" x .010	$5.50
APPROX 3.5" x 5.0" x .0312	$6.50
CHIP RESISTORS	
50 OHM ½ WATT	$1.50
PISTON TRIMMERS	
Triko 201—01M .5—3Pf( )1—8Pf( )	$2.50

OPEN AT 8PM EST
CLOSED AT 8PM PST

IF YOU DO NOT SEE WHAT YOU WANT ASK

ORDERS ARE POSTAGE PAID
COD—VISA—MASTERCHARGE

Aye!

Larsen's clan of Kūlrod® Antennas deliver top performance and value!

Performance and value are built into every Larsen Antenna because of craftsmanship that accepts no compromise.

Making mobile antennas, mounts and accessories is Larsen's *only* business. All of the company's research, engineering and production efforts are directed to making the best antennas money can buy. The end result is the exclusive Kūlrod by Larsen. A Kūlrod antenna delivers maximum radiation efficiency instead of losing power to heat.

Larsen's antenna clan includes low band, high band, quarter wave, VHF, UHF, mobile, fixed base and Kūlduckies for hand-helds. And Larsen offers every type of permanent and temporary vehicle mount — including a magnetic model that's a real grabber.

So whatever band you operate on, if your antenna is a Larsen you'll HEAR the difference!

Larsen Antennas

P.O. Box 1686
Vancouver, WA 98668
Phone: (206) 573-2722

In Canada, write to:
Canadian Larsen Electronics, Ltd.
283 E. 11th Ave., Unit 101
Vancouver, B.C. V5T 2C4
Phone: (604) 872-8517

®Kūlrod is a Registered Trademark of Larsen Electronics, Inc.
™Kūlduckie is a Trademark of Larsen Electronics, Inc.

NEW products

mini-speaker

Firestik's Speak-Easy mini-speaker is an acoustically tuned, wide-range air compression speaker that's small in size (2¼ × 2 inches) yet offers 300 to 10,000 Hz of audio response for crisp and clean sound. The Speak-Easy speaker is molded in an indoor/outdoor shockproof case and is easily mounted anywhere on cars, trucks, motorcycles, vans, airplanes, or RVs. In addition, it is exceptionally weathertight and resistant to corrosion. Mechanical features include a pulse dissipating disk, grill filter, a half-inch voice coil and a 1¾-inch magnet. Every Speak-Easy speaker comes complete with a 6½-inch coaxial cord with a 3.5 mm plug, fully adjustable mounting bracket, and hardware for quick and easy installation. For more information on this new product, write to Firestik Antenna Company, 2614 East Adams, Phoenix, Arizona 85034.

BASIC coding form

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

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

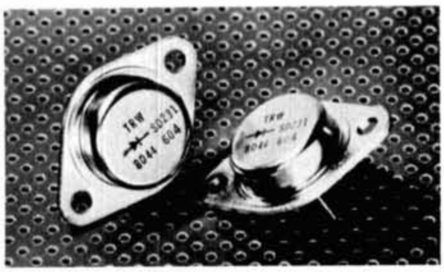
The reverse of the 8½ × 11 inch form is precision-ruled for thirty horizontal program lines, each divided by eighty vertical columns. Program lines are numbered in standard 10-300 line numbers in the margin for spotting at a glance. Vertical columns, left to right across the 11-inch width of the sheet, are numbered 1-80 for easy identification of available spaces in a standard TRS-80 pocket computer input memory. A program using all available steps and memories can be listed on the form's thirty lines by packing for maximum efficiency. Using shorter line contents, a very elaborate program can be listed on two sheets from a pad. The form can be used with any computer in the BASIC language.

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

dual Schottkys

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

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



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

micro-miniature sub-audible tone encoder

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

1981 Radio Shack catalog

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

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

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

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

medium power Darlingtons by Motorola

Motorola has announced a new series of complementary TO-92 Darlington transistors, designed specifically for preamplifier applications requiring a high dc current gain and an input impedance of several megohms. The low-cost, plastic-packaged transistors are available with breakdown voltage ratings of 40, 50, and 60 volts, a dc current gain of 10,000, and excellent current-gain linearity from 1 mA to 100 mA. Contact Motorola Semiconductor Products, Inc., P.O. Box 20912, Phoenix, Arizona 85036.

miniature frequency standard

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

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

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

H.H. Smith catalog

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

O.D. and 3/8-inch O.D. in aluminum, brass, and nylon, as well as in male/female configurations.

Herman H. Smith, Inc., produces more than 20,000 electronics components and hardware at its main plant and maintains conveniently located regional warehouses which supply major industrial electronic distributors and OEM users in the U.S. and Canada. Contact H.H. Smith, Inc., 812 Snediker Avenue, Brooklyn, New York 11207.

soldering iron stand

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

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

COAX-SEAL for protecting connectors

Keep the name COAX-SEAL in mind the next time you need a means to keep moisture and corrosion out of your coax fittings. It's not too often a new product line crosses our desk that has caused as much excitement as this one. One wonders why COAX-SEAL hasn't appeared sooner. It has been used commercially for eight years and is just now finding its way into the Amateur market.

COAX-SEAL is a pliable, plastic material that can be wound over coax fittings of any size or shape then hand-molded to give a long-lasting, flexible waterproof and dustproof seal. This new material stays flexible at temperatures from −25 to 350 F (−32 to 176.8 C).

COAX-SEAL maintains its sealing qualities regardless of movement of the coax. It also adheres to polyvinyl or vinyl outer coax jackets. The material allows quick decoupling of a coax fitting and also re-sealing of the fitting using the same material. Application is by hand — simply roll off approximately 6 inches (15 cm) of COAX-SEAL, remove backing paper, wrap starting at outer covering and work toward fitting, allowing a one-half overlap as you go. After the wrap is completed, gently knead to form a smooth surface and to force out any air.

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

dummy load

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

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

1021 DTMF receiver

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

nick-free wire stripper

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

short circuit

optional sidetone

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

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

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

Although left as an exercise, here's a hint for converting hexadecimal numbers to decimal: For a three-digit hex number, multiply the first digit by 16^2. Add (second digit × 16) plus third digit.

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

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

contributed by
Bill Skeen, W6WR

updating the HW-2036

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

Advertisers check-off

...for literature, in a hurry — we'll rush your name to the companies whose names you **"check-off"**

Place your check mark in the space between name and number. **Ex: Ham Radio ✓ 234**

AEA ___ 677
AP Products ___ 896
ARCsoft ___ 905
Ace Comm. ___ 850
Alaska Microwave ___ 826
Alliance ___ 700
Aluma ___ 589
Amateur Elect. ___ 659
Amidon ___ 005
Applied Inv. ___ 862
Associated Radio ___ 892
Atlantic Surplus *
Barker ___ 015
Barry *
Bencher ___ 629
Ben Franklin ___ 864
Bilal ___ 817
Budwig ___ 233
Butternut *
C. Comm ___ 688
Clipper Corp. ___ 508
Comm. Concepts ___ 797
Comm. Spec. ___ 330
Curtis Electro ___ 034
Cushcraft *
DCO ___ 324
DX Bulletin *
DX Eng. ___ 222
Dayton Ham. *
Debco ___ 900
Dielectric ___ 899
Drake *
EGE ___ 901
ETCO ___ 856
E. T. O. *
Encomm ___ 888
Erickson Comm. *
Fair Radio ___ 048
Firestik Ant. ___ 906
G & C Comm. ___ 754
G.I.S.M.O. ___ 691
GLB ___ 552
Gem Quad ___ 295
Greenray Ind. ___ 907
Grove ___ 848
Hal Comm. ___ 057
Hal-Tronix ___ 254
H. R. B. ___ 150
H. R. Magazine *
Ham Shack ___ 879
Hamtronics, N.Y. ___ 246
Handi-Tek ___ 893
Hatry ___ 889
Heath ___ 060
Henry ___ 062
Hildreth ___ 283
Icom *
Int'l Crystal ___ 066
Jameco ___ 333
Jan ___ 067
Jensen ___ 293
Jones ___ 626
K & S ___ 903
Kantronics *
Kengore ___ 538
Kenwood *
L-Tronics *
Larsen ___ 078
Lunar ___ 577
Lufel ___ 904
MFJ ___ 082
MHz Elec. ___ 415
Madison ___ 431
Microcraft ___ 774
Microwave Filter ___ 637
Mid-Com ___ 479
J. W. Miller ___ 745
Motorola
Semiconductor ___ 599
N.P.S. ___ 866
NRI Schools *
OK Machine *
Oak Hill Academy A.R.S. *
P.C. Elec. ___ 766
Palomar Eng. *
Payne ___ 867
Callbook ___ 100
Radio Kit ___ 801
Radio Shack *
Radio World *
Radio Warehouse *
Ramsey ___ 442
S-F A.R.S. ___ 640
Securitron ___ 461
Selecto ___ 895
Semiconductors
Surplus ___ 512
Shure ___ 771
Slep ___ 535
H.H. Smith ___ 908
Spectronics *
Spec. Int. ___ 108
Stewart Quads ___ 890
TRW ___ 473
Telrex *
Ten-Tec *
Trans Com ___ 891
Trans Comm. ___ 552
UNR-Rohn ___ 410
Universal Comm. ___ 885
Universal Elect. ___ 653
V-J Products ___ 855
Van Gorden ___ 737
Vanguard Labs ___ 716
Vocom ___ 857
Webster
Assoc. ___ 423
Western Elec. *
Yaesu ___ 127

*Please contact this advertiser directly.

Limit 15 inquiries per request.

March, 1981

Please use before April 30, 1981

Tear off and mail to
HAM RADIO MAGAZINE – "check off"
Greenville, N. H. 03048

NAME ....

CALL ....

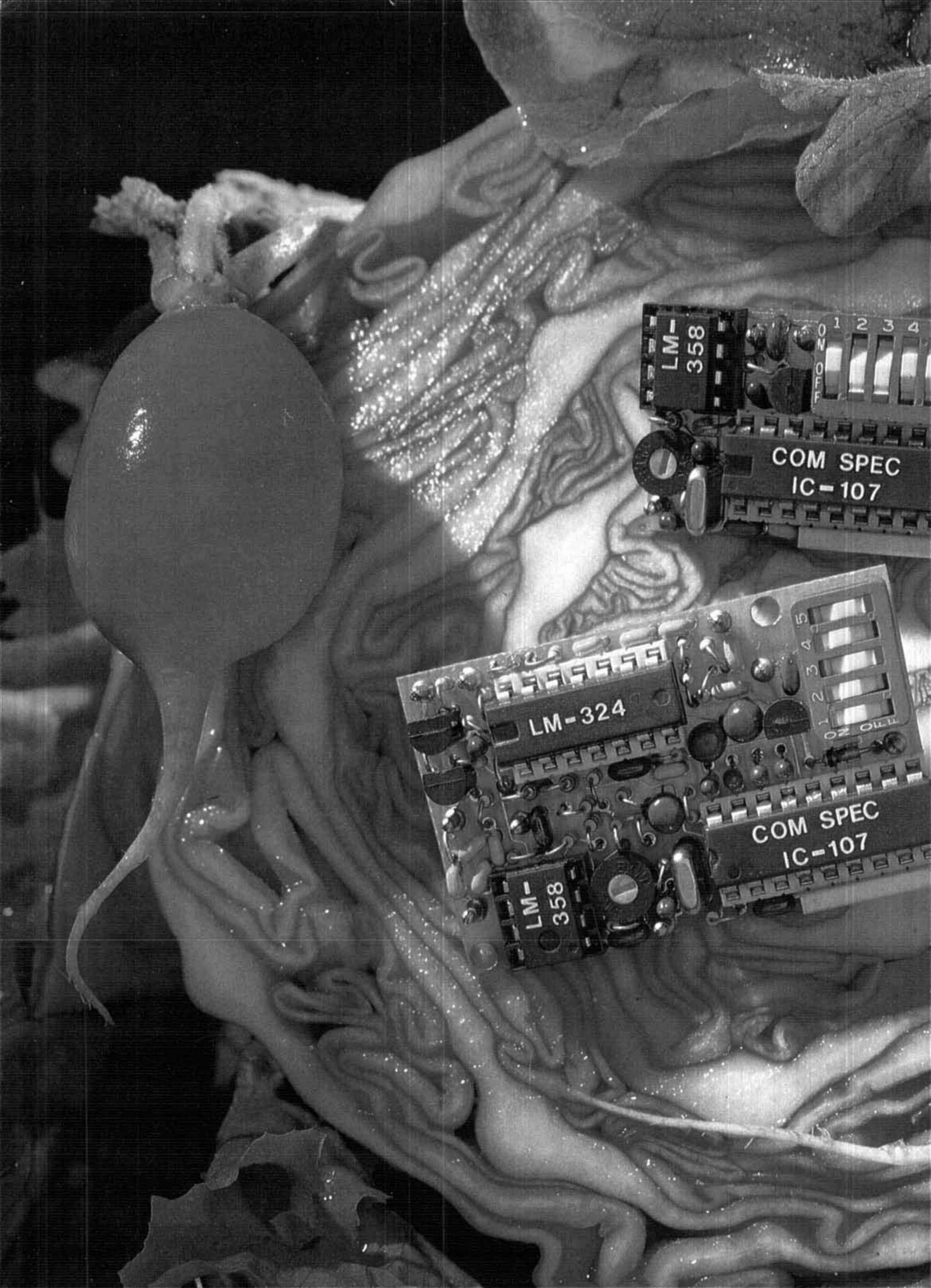
STREET ....

CITY ....

STATE .... **ZIP** ....

Advertisers index

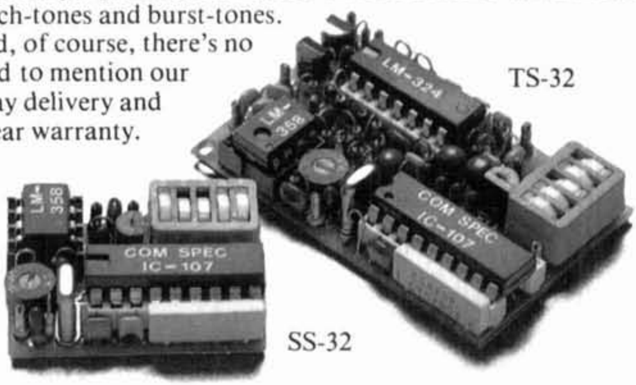
More Details? CHECK—OFF Page 110


LM-358
COM SPEC
IC-107
LM-324
COM SPEC
IC-107
LM-358

A fresh idea!

Our new crop of tone equipment is the freshest thing growing in the encoder/decoder field today. All tones are instantly programmable by setting a dip switch; no counter is required. Frequency accuracy is an astonishing ± .1 Hz over all temperature extremes. Multiple tone frequency operation is a snap since the dip switch may be remoted. Our SS-32 encode only model is programmed for all 32 CTCSS tones or all test tones, touch-tones and burst-tones.

And, of course, there's no need to mention our 1 day delivery and 1 year warranty.



TS-32

SS-32

TS-32 Encoder-Decoder

- Size: 1.25″ x 2.0″ x .40″
- High-pass tone filter included that may be muted
- Meets all new RS-220-A specifications
- Available in all 32 EIA standard CTCSS tones

SS-32 Encoder

- Size: .9″ x 1.3″ x .40″
- Available with either Group A or Group B tones

Frequencies Available:

Group A			
67.0 XZ	91.5 ZZ	118.8 2B	156.7 5A
71.9 XA	94.8 ZA	123.0 3Z	162.2 5B
74.4 WA	97.4 ZB	127.3 3A	167.9 6Z
77.0 XB	100.0 1Z	131.8 3B	173.8 6A
79.7 SP	103.5 1A	136.5 4Z	179.9 6B
82.5 YZ	107.2 1B	141.3 4A	186.2 7Z
85.4 YA	110.9 2Z	146.2 4B	192.8 7A
88.5 YB	114.8 2A	151.4 5Z	203.5 M1

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

Group B							
TEST-TONES:	TOUCH-TONES:		BURST-TONES:			
600	697	1209	1600	1850	2150	2400
1000	770	1336	1650	1900	2200	2450
1500	852	1477	1700	1950	2250	2500
2175	941	1633	1750	2000	2300	2550
2805			1800	2100	2350	

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

Wired and tested: TS-32 **$59.95**, SS-32 **$29.95**

COMMUNICATIONS SPECIALISTS

426 West Taft Avenue, Orange, California 92667
(800) 854-0547 / California: (714) 998-3021

The Warranty and Beyond

or How You Get the Back-Up That Doesn't Back Down In 91 Days.

ENCOMM, INC. LIMITED WARRANTY

Encomm, Inc. warrants this product against defects in material and workmanship for a period of 90 days from the date of purchase by the original purchaser. Encomm, Inc. will at its option repair or replace any and all defective parts, assemblies or entire units as it deems proper, free of charge for both the parts and the labor necessary to correct any defects in material or workmanship for the 90 day period.

The purchaser is responsible for the transportation costs of returning the equipment to and from Encomm, Inc. or its designated repair center for purposes of obtaining the warranty service described in this form.

EXTENDED SERVICE PERIOD

FOR A PERIOD OF TWO (2) YEARS FROM DATE OF PURCHASE THE ORIGINAL PURCHASER MAY OBTAIN EXTENDED SERVICE ON ALL THE SEMICONDUCTOR COMPONENTS USED IN THIS UNIT NOT INCLUDING FINAL TRANSISTORS. FAILURES CAUSED BY IMPROPER INSTALLATION, STATIC DISCHARGE, ABUSE, OR UNAUTHORIZED ALIGNMENT ARE NOT INCLUDED. **MAXIMUM CHARGE FOR THIS SERVICE WILL BE ONE HOUR AT** THE THEN CURRENT ENCOMM, INC. SHOP RATE.

The above warranty does not include incidental or consequential damages and Encomm, Inc. disclaims any liability for any such damages. All implied warranties, if any, are limited in duration to the above stated 90 day warranty period. Some states do not allow the exclusion of limitation on incidental or consequential damages or on how long an implied warranty lasts, so the above limitations may not apply to you.

The completion and return of the enclosed registration form is a condition precedent to the warranty coverage and the above undertaking to repair. This warranty gives you specific legal rights and you may also have other rights which may vary from state to state.

The Santec HT-1200 is approved under FCC Part 15 and exceeds FCC regulations limiting spurious emissions.

Encomm, Inc.
2000 Avenue G
Suite 800
Plano, TX 75074

☐ Please send me more information about the Santec HT-1200 and a list of Authorized Santec Dealers.

NAME ______ CALL ______

ADDRESS ______

CITY ______ STATE ______ ZIP ______

YOU MAY SEND A DUPLICATE OF THIS FORM.

Radio World

CENTRAL NEW YORK'S MOST COMPLETE HAM DEALER

Featuring Kenwood, Yaesu, Icom, Drake, Ten-Tec, Swan, Dentron, Alpha, Robot, MFJ, Tempo, Astron, KLM, Hy Gain, Mosley, Larsen, Cushcraft, Hustler, Mini Products, Bird, Mirage, Vibroplex, Bencher, Info-Tech, Universal Towers, Callbook, ARRL, Astatic, Shure. *We service everything we sell!*

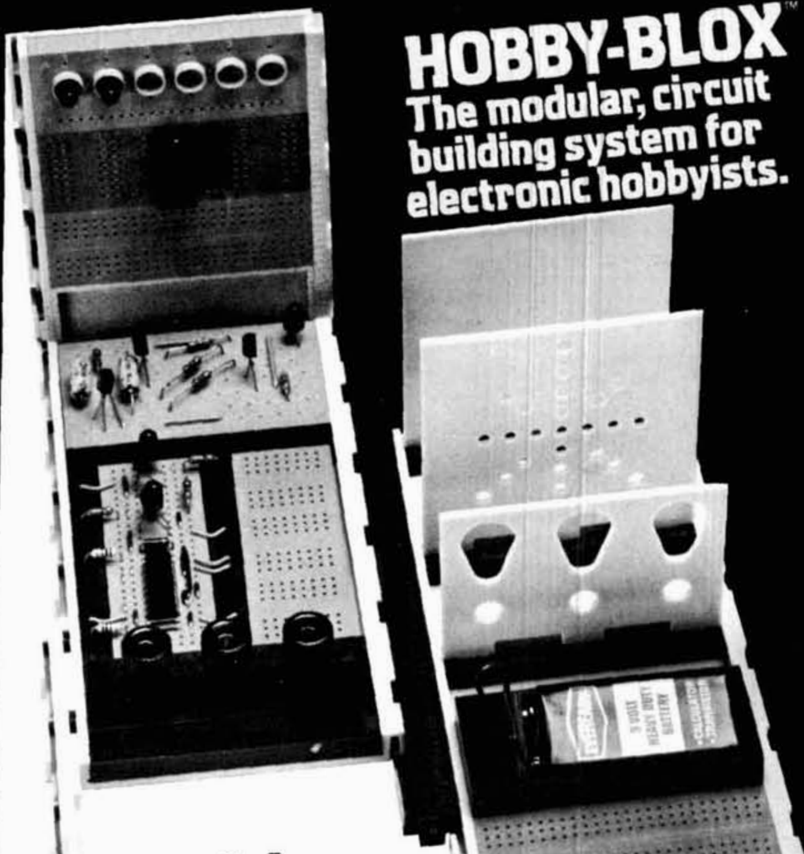
Write or call for quote. **You Won't Be Disappointed.**

We are just a few minutes off the NYS Thruway (I-90) Exit 32

OUT OF STATE CALL TOLL FREE
800-448-9338

ONEIDA COUNTY AIRPORT TERMINAL BUILDING
ORISKANY, NEW YORK 13424
N.Y. Res. Call (315) 337-0203

Warren - K2IXN
Bob - WA2MSH



HOBBY-BLOX™

The modular, circuit building system for electronic hobbyists.

Be careful. Your hobby is about to become an obsession.

The 14 modular units in the solderless, Hobby-Blox™ system are color-coded and cross-indexed. Projects go faster, easier.

For the beginner, there are two starter packs. One for integrated circuits, one for discrete components. Each has its own 10 project booklet.

Once you get into Hobby-Blox, look out. You're going to get hooked.

For a free catalog and the name of your nearest Hobby-Blox dealer, call Toll Free 800 321-9668. In Ohio call collect (216) 354-2101.

Patents Pending
©AP PRODUCTS INCORPORATED 1980

A P PRODUCTS INCORPORATED
9450 Pineneedle Drive
P.O. Box 603
Mentor, Ohio 44060
(216) 354-2101
TWX: 810-425-2250

In Europe, contact A P PRODUCTS GmbH
Baeumlesweg 21 • D-7031 Weil 1 • W. Germany

Free Project-of-the-Month to Hobby-Blox purchasers!

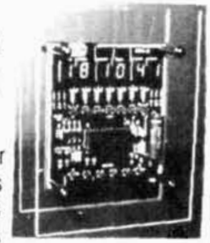
DE DEBCO ELECTRONICS

RAPID MOBILE CHARGER

The DEB-TED Rapid Mobile Charger is a constant voltage charger that will charge your batteries off a 12 Volt source in 4-6 hours. You may use the charger at all times, this includes transmit and receive periods. It is equipped with a cigarette lighter plug on the input side and the appropriate charging plug on the output side. Models available now for the Kenwood TR2400, Yaesu 207R, Tempo S1, S2, S5, the Wilson Mark II and IV, and the Santec HT-1200. Other models available also please call or write for info $34.95

COMING SOON
THE NEW AC VERSION

"SEE THE WORKS" CLOCK



OUR EASIEST CLOCK TO ASSEMBLE!

6 Digits 12 or 24 Hour Format Clock rests between two pieces of clear plexiglas A GREAT CONVERSATION PIECE! Kit is complete including top quality PC board, all components, pre-cut and drilled plexiglas and all hardware $29.95
Wired and Tested $39.95

VEHICLE INTRUSION ALARM

An easy to assemble and install kit that offers options not normally found in other alarm systems. Hidden switch mounts under the dash. Kit has provisions for sensors and remote control switch. Programmable time delays for exit, entry and alarm periods. Basic hook-up utilizes dome light circuit activating when doors are opened. The alarm will drive a siren or pulse horn at a 1HZ rate. Not prone to false alarm do to reliable CMOS circuitry. No external switch required! Complete kit with easy to follow instructions and diagrams $12.95
Wired and Tested $19.95

P.O. BOX 9169
CINCINNATI, OHIO 45209
Phone:(513)531-4499

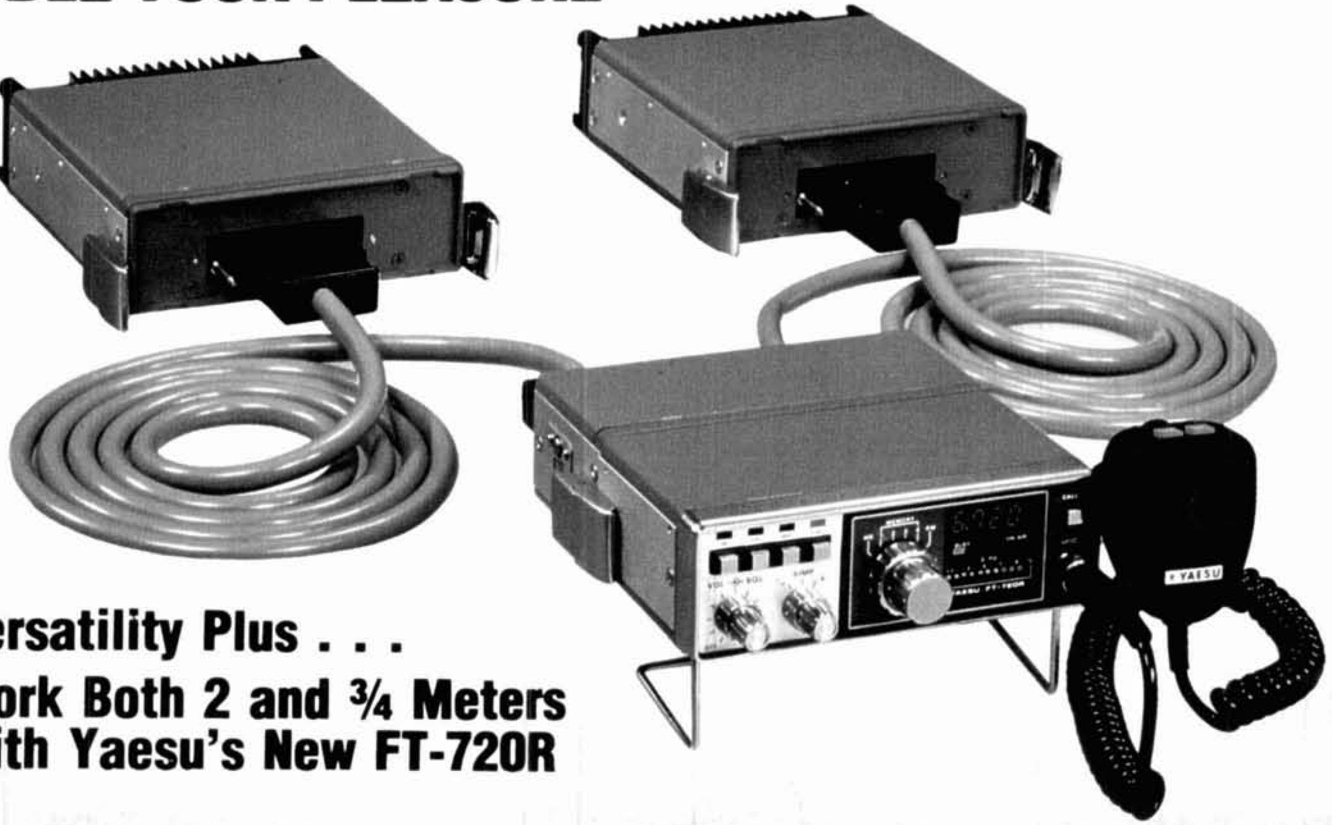
- Add 5% Shipping for U.S. & Canada
- All foreign orders add 10%
- COD orders add $1.25
- Master Charge and Visa Welcome
- Orders under $20.00 add $1.00 handling
- Ohio residents add 4½% Tax

Dealer Inquiries Invited

CALL OR WRITE FOR CATALOG

Tell 'em you saw it in HAM RADIO!

DOUBLE YOUR PLEASURE



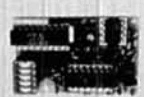
Versatility Plus . . .
Work Both 2 and ¾ Meters With Yaesu's New FT-720R

The FT-720R series is a compact VHF/UHF mobile transceiver that harnesses the incredible power of the microprocessor to bring you top-operating flexibility. Start with the FT-720R Control Head, then add either the 10 watt FT-720RU 440 MHz or 25 watt FT-720RVH 2 meter RF Deck. You can clamp the Control and RF Deck together or use an optional remote cable to hide the RF Deck.

And for Top Performance while portable . . . Choose the new FT-404R 70cm Hand-held.

FT-404R
Channel, 3 Watt
UHF Hand-held

FTT-1
16 Key
DTMF Encoder



FTS-32ED
CTCSS Encode/Decode
32 Tone Selection

FTS-32E
CTCSS Encode Only
32 Tone Selection

LCC-4
Shorty Case

LCC-2/LCC-3
Heavy Duty Case

281

Also available:
- **NC-3A** Quick Charger
- **YM-24A** Speaker/Mic
- **PA-2** Mobile Adapter
- **MMB-10** Mobile Bracket

YAESU
The radio.

YAESU ELECTRONICS CORP., 6851 Walthall Way, Paramount, CA 90723 ● (213) 633-4007
YAESU ELECTRONICS Eastern Service Ctr., 9812 Princeton-Glendale Rd., Cincinnati, OH 45246