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**The Praise is Pouring In**

We have never enjoyed such an overwhelming response to a new product. Letters of praise for Tempo's S-1 are coming in daily. Words such as great, fabulous, and fantastic are common. In a few short months the S-1 has taken the Amateur world by storm. In addition to its unique features and its versatility, it has now proven itself to be an extremely rugged and dependable unit...qualities unmatched at any price, but unheard of at the S-1's low price.

This amazing pocket sized radio represents a major breakthrough in 2-meter communications. Other units that are larger, heavier and are similarly priced can offer only 6 channels. The S-1's price includes the battery pack, charger, and a telescoping antenna. But, far more important is its proven performance record as a fully synthesized 800 channel hand held transceiver.

The optional touch tone pad adds greatly to its convenience and the addition of a Tempo solid solid state amplifier adds tremendously to its power.

The Tempo line also features a fine line of extremely compact UHF and VHF pocket receivers. They're low priced, dependable, and available with CTCSS and 2-tone decoders. The Tempo FMT-2 & FMT-42 (UHF) provides excellent mobile communications and features a remote control head for hideaway mounting.

The Tempo FMH-42 (UHF) and the NEW FMH-12 and FMH-15 (VHF) micro hand held transceivers provide 6 channel capability, dependability plus many worthwhile features at a low price. FCC type accepted models also available. Please call or write for complete information. Also available from Tempo dealers throughout the U.S. and abroad.

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Channel Coverage</th>
<th>Power Output</th>
<th>Sensitivity</th>
<th>Current Drained</th>
</tr>
</thead>
<tbody>
<tr>
<td>144 to 148 MHz, 130A02</td>
<td>Better than 1.5 watts</td>
<td>Better than 5 microvolts</td>
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</tr>
<tr>
<td>17 ma-standby</td>
<td>1.5 watts</td>
<td></td>
<td></td>
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<tr>
<td>500 ma-transmit</td>
<td>500 ma-standby</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 cell ni-cad pack included</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>165 mm x 62 mm x</td>
<td>165 mm (1.6&quot; x 2.5&quot;)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.5&quot;)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>RF Output</td>
<td>Power Required</td>
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<tr>
<td>9.6 VDC</td>
<td></td>
<td></td>
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<tr>
<td>Transmit Simplex or</td>
<td>80 W 130W 130A10 $189</td>
<td></td>
<td></td>
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<tr>
<td>1600 kHz</td>
<td></td>
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<tr>
<td>17 ma-standby</td>
<td>160 W 130W 130B02 $199</td>
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<tr>
<td>500 ma-transmit</td>
<td>160 W 130W 130A30 $199</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 cell ni-cad pack included</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SUPPLIED ACCESSORIES**

- Telescoping whip antenna, ni-cad battery pack, charger.

**OPTIONAL ACCESSORIES**

- Touch tone pad: $55 • Tone burst generator: $29.95 • CTCSS sub-audible tone control: $29.95 • Rubber flex antenna: $5 • Leather holster: $16 • Cigarette lighter plug mobile charging unit: $6 • Matching 30 watt output 13.8 VDC power amplifier (S30): $89 • Matching 80 watt output power amplifier (S80): $169

**TEMPRO VHF & UHF SOLID STATE POWER AMPLIFIERS**

Boost your signal... give it the range and clarity of a high powered base station. VHF (135 to 175 MHz)

<table>
<thead>
<tr>
<th>Drive Power</th>
<th>Output</th>
<th>Model No.</th>
<th>Price</th>
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<tr>
<td>2w</td>
<td>130w</td>
<td>130A02</td>
<td>$209</td>
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<tr>
<td>10w</td>
<td>130w</td>
<td>130A10</td>
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<td>30w</td>
<td>130w</td>
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<td>$199</td>
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<td>10w</td>
<td>80w</td>
<td>80A02</td>
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<tr>
<td>10w</td>
<td>30w</td>
<td>30A02</td>
<td>$89</td>
</tr>
</tbody>
</table>

UHF (400 to 512 MHz) models, lower power and FCC type accepted models also available.

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The Model M-520A offers the discriminating DXer an unexcelled beam antenna that really punches through the QRM . . . ask anyone who owns one! Features 5 full-sized elements on a 2” O.D. x 34 ft. boom. Low SWR across the entire 20 meter band. The M-520A is shipped UPS in two cartons.

**M-520A**

5 ELEMENT MONOBANDER

The magic 20 meter beam: M-420A . . . 4 elements on a 26 ft. boom. Super front-to-back and side rejection. The M-420A ships UPS in two cartons.

**M-420A**

4 ELEMENT MONOBANDER

The M-155A is the top of the line 15 meter monobander. This is the one for the serious DXer. Top performance that will make you heard on 15! 5 elements wide spaced on a 25' 7” boom.

**M-155A**

5 ELEMENT MONOBANDER

The M-105A — our latest 10 meter design uses W·I·D·E spacing. Well researched design provides the ultimate in a 10 meter antenna. 5 elements on a 23' 5” boom.

With the 10 meter band making a strong comeback, choose our model to fulfill your needs. Five wide spaced elements will provide a top performing antenna.

**M-105A**

5 ELEMENT MONOBANDER

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**Consumer Products Division**

Wilson Electronics Incorporated

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>MODEL M-520A</th>
<th>MODEL M-420A</th>
<th>MODEL M-155A</th>
<th>MODEL M-105A</th>
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<tr>
<td>Band Width</td>
<td>14 GHz</td>
<td>14 GHz</td>
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<td>Maximum Power Input</td>
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<td>1.5 kW</td>
<td>1.5 kW</td>
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<td>VSWR (at Resonance)</td>
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<td>1.1:1</td>
<td>1.1:1</td>
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<tr>
<td>Impedance</td>
<td>50 ohms</td>
<td>50 ohms</td>
<td>50 ohms</td>
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<tr>
<td>Beam O.D. x Length</td>
<td>2' x 36’”</td>
<td>2' x 40’”</td>
<td>2' x 45’”</td>
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<tr>
<td>No. Elements</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Longest Element</td>
<td>36’”</td>
<td>36’”</td>
<td>36’”</td>
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<tr>
<td>Turning Radius</td>
<td>25’</td>
<td>25’</td>
<td>25’</td>
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<tr>
<td>Max Diameter</td>
<td>2” O.D.</td>
<td>2” O.D.</td>
<td>2” O.D.</td>
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<tr>
<td>Boom Diameter</td>
<td>2” O.D.</td>
<td>2” O.D.</td>
<td>2” O.D.</td>
</tr>
<tr>
<td>Surfaced Area (ft.2)</td>
<td>9.9</td>
<td>7.8</td>
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<tr>
<td>Wind Load</td>
<td>227 lbs.</td>
<td>186 lbs.</td>
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<td>Assembled Weight (Approx.)</td>
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<td>66 lbs.</td>
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<tr>
<td>Shipping Weight (Approx.)</td>
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<td>66 lbs.</td>
<td>66 lbs.</td>
</tr>
<tr>
<td>Matching Method</td>
<td>Beta</td>
<td>Beta</td>
<td>Beta</td>
</tr>
</tbody>
</table>

Prices and specifications subject to change without notice.

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Reader Service—see page 211
NEVER SAY DIE

editorial by Wayne Green

DAYTON

Despite the rapid growth of the Atlanta HamFestival, Dayton pulls 'em in in greater numbers every time. It's gotten so big that it is difficult to see everyone there. No, it's impossible. Whether they have 15,000 or 20,000 in attendance is irrelevant—it's too much to handle. I had not really intended to get to Dayton this time, feeling that I would do better to spend the four days involved working on Instant Software and a new publishing project. But I began to wonder just a bit when they called up and wanted to know where they could reach Jean Shepherd K2ORS in order to get him to entertain at the banquet. Then they asked if I would be available to speak on the microcomputer forum ... and I gave in.

Shep was outstanding, as usual. I think they had well over 1,500 at the banquet, and he held them in stitches. The banquet was nice ... grilled hockey pucks, I think. I wasn't sure. The potato was good, which is more than I can say for a lot of restaurants ... and the company was fine. Most of the entertainment was a bore ... some local group singing and dancing ... unfortunately none of them were singers or dancers. That went on incredibly long. The MC was excellent ... he introduced the two hundred or so people at the head table in a minute and a half, making some very entertaining comments as he went along.

The Dayton crew has been at it for years and they are certainly professional about it. There are few glitches in the Hamvention.

The crowds seemed to be down a bit this year—no one knows why, I heard rumors that they clocked in 14,000, compared to 19,000 last year. The aisles were easier to traverse. Other later reports put attendance at 17,000. Big deal ... that's numbers. I talked with exhibitors, and sales were the best ever, no matter how many were there. Some dealers went home with over $50,000 in sales for the three days.

Despite long-term delivery delays promised by Drake, I understand that dealers were really loaded up with Drake gear for the show ... which brought prices down to perhaps $5 or $10 over cost on the big gear. While this is hard on the dealers, it is a bonanza for the rest of us. All HTs were selling well, too. I don't think a single dealer went home with an HT in his truck. The showing of the first prototype of the new Yaesu programmable HT helped convince dealers that long-term stocks of the more traditional HTs would not be prudent. It's getting time to liquidate HT crystal stocks.

Swan showed their new line of transceivers and wowed everyone. Their microprocessor-controlled units will be in short supply for a long time. The Japanese are going to have to work a little harder to keep their larger share of the US market.

But long after the new ham gear and the acres upon acres of flea market fade into fuzzy memory, the Jean Shepherd entertainment at the banquet will live on in memory. Long after the old rig we bought off a flea market truck that chilly Saturday has been auctioned off at a local hamfest, we'll remember Shep and his problems with the Texas kilowatt on 7182 kHz back in the '30s. "Doesn't that sonofagun ever sleep?"

ARMAC

The most recent meeting of the Amateur Radio Manufacturer's Association came the night before the Dayton Hamvention and was sparsely attended, considering that almost 250 firms run adds in any one month in the ham magazines. A representative from the Electronic Industries Association was there to try to convince the ham industry that they might do better to join the EIA rather than fritter around with ARMA. It was noted that only one ham manufacturer is presently a member of EIA, and that one admitted discovering the membership with some surprise, a sort of bonus for their CB affiliation.

I don't think I helped that project as much as I might have when I reminded everyone that we had heard this same story ten years ago when Bob Walters lured the ham industry away from a ham manufacturer's association and into the EIA. The ham industry was in the same division as the CB industry, and thus when it came to any conflicts between the two (and there were beaus, like 220 MHz), money talked and the ham industry seemed to get a deal each time.

The costs of joining the EIA are not insignificant. It would cost $73 about $2,000 per year to belong, with few (if any) benefits which I could pin down. And then, if any special projects for lobbying came up, the cost of them would be on top of the two thou. Someday, I'd like to have a general idea of how much Hy-Gain and Johnson put into the pot to get more CB channels on eleven meters and the 220 MHz band for CB. Both of those projects were bummers, incidentally. The eleven meter expansion project resulted in the serious wounding of CB and cost the industry billions. It sank Hy-Gain.

It was noted that ARMA had not been able to decide on anything and follow it through with success. The effort to stave off FCC actions on linear amplifiers was an abject failure. I feel that this total defeat was primarily due to the lack of support of ARMA by some of the larger firms in the ham industry, the back-stabbing (to put it politely) by the ARRL, and the lack of strong leadership in ARMA to put together a program with which to fight the
TS-120S... A big little rig.

It's a compact, up to 200 watts PEP input, all solid-state HF transceiver with such standard features as built-in digital readout, IF shift, new PLL technology... and requires no tuning!

Exciting and perfect for car or ham shack use! But, there's more to say about the TS-120S: This unique all solid-state HF, SSB/CW transceiver produces a hefty signal and also offers a lot of other great features in a very attractive, compact package.

FEATURES:
- All solid-state with wideband RF amplifier stages. No final dipping or loading, no transmit drive peaking, and no receive preselector tuning! Just dial your frequency and operate!
- Five bands, plus WWV. Transmits and receives on 80/75, 40, 20, 15, and all of 10 meters... and receives WWV on 15 MHz.
- 200 watts PEP (160 watts DC) input on 80/15 meters, 160 watts PEP (140 watts DC) input on 10 meters LSB, USB, and CW.
- Digital frequency display (standard). 100 Hz resolution. Six digits. Special green fluorescent tubes eliminate viewing fatigue. Analog subdial, too, for backup display.
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- Advanced PLL circuit, which eliminates need for heterodyne crystal element for each band. PLL lock frequency, CAL marker signal, and counter clock circuit use single reference frequency crystal. Simplifies circuitry, improves overall stability. Also improves transmit and receive spurious characteristics.
- Attractive, compact design. Measures only 3½” high X 9½” wide X 13½” long, and weighs only 4.9 kg (11.7 lbs). A perfect size for convenient mobile operation and rugged enough for either mobile or portable use. Also has all the desired features for optimum ham shack operation at home.
- Noise blanker. You’ll wonder where the ignition noise went. See the big little TS-120S rig and matching accessories (VFO-120 remote VFO, SP-120 external speaker, PS-30 AC power supply, MB-100 mobile mounting bracket, AT-120 antenna tuner and YK-88C CW Filter) at your nearest Authorized Kenwood Dealer!

STILL AVAILABLE... KENWOOD TS-520S
One of the more serious problems facing any industry association is the seemingly permanent reference to the death of amateur radio over accommodation between the US manufacturers and importers of Japanese (called "foreign") equipment. I understand the whole thing is involved, particularly when you consider that somewhere around 70% of the ham gear being sold is being imported from Japan. I've heard repeated claims that the Japanese are not selling this ham gear at a loss here in order to destroy the US manufacturers. I'd like to see some proof of this contention.

On the surface of it, the high sales of Japanese equipment seems to be the result of a lot of advertising, excellent design, good marketing, and factors such as this. The Japanese have some unfair advantages. I'll admit, in that they have about 400,000 hams in Japan as a market that is virtually closed to our manufacturers. With about double the manpower, they can afford to spend more on design and run larger production runs . . . which means lower costs.

Then there is the matter of Japanese productivity vs. that of the US. A recent article in Fortune pointed out that the US has been down toward the bottom of the list in worker productivity improvements. The Japanese have been building new and more automated plants, while our unions and government have been making it almost impossible for us to do the same, thus forcing dealers to sell imported equipment which has more features and costs less.

There have been some strong moves to turn this around. Swan has stopped importing their equipment and is now making everything here in the US. Their new line of transceivers is going to have a strong effect on the market, for they are taking advantage of microcomputer technology. But other US manufacturers have been complicit, telling dealers that they are so busy with other things that ham gear will be six months or more back-ordered. And one major firm has been making a big deal out of hams buying American has some very clearly identifiable Japanese parts in its new rig.

Some of the US problems undoubtedly could be cured if we could get the government out of the act. I talked with one manufacturer recently who had had his plant closed down by OSHA because they found a fire escape support column which was galvanized. It seems that they could not inspect the column for any possible cracks . . . so everyone had to be sent home until the paint could be removed from the fire escape column.

OSHA seems to be the cause of the recent semiconductor plant shutdown which caused incredible consternation in the entire electronics industry. The early estimates are that more than $10 billion was lost as a result of this unnecessary action. Some 20c chips were being bid up to $5.00 and more by contractors frantic to finish contracts on time or by manufacturers being pressured by customers for delivery.

I doubt if they are having nearly as much government harassment in Japan . . . and this means that they can be more competitive. When you read much about Japan, you know that workers take their jobs very seriously and are dedicated to their employers. The excesses of many industrials a few years ago have spawned a strong union movement in the US, and some of the ramifications of that have not been helpful in making us competitive with other countries. The strong union positions in England have been a powerful factor in keeping that country from being seriously competitive with much of the world.

In the microcomputer field, no one is any closer to being able to provide any serious competition for the US. You can bet that the Japanese microcomputer makers have been over here, sizing up the market, but they have been so much more secretive about it. Between our technological advances and the dollar/syen relationship, US firms are getting into better positions to give the Japanese a run for their money. After all, we are not being held back by union restrictions on modernization and excessive government regulation, we can raise hell with imports.

Well, getting back to ARMA, the suggestion was made that instead of trying to represent the industry, getting involved with battles with the FCC, or trying to help our WARC position, it be made more of a social club . . . perhaps with an industry friendship dinner during the more important hamfests and conventions. If the group is afraid of anything more meaningful than that, then let's have dinner meetings and eat. That's better than protracted meetings hassling over bylaws, dues, and elections, which are just an enormous waste of time and of little interest.

There is one point of history that I would like to clarify since it seems to already be in the process of being rewritten. It was mentioned at the ARMA meeting that the opinion about trying to do something to help the amateur radio position at WARC was about evenly split. I might remind the ARMA that the motivation to tackle this project was made by Tom Gentry of IC--it was carried with one and only one negative vote.

I recognize that the eventual outcome is not for the project which is an attribute to Ham Radio magazine, calls for a distribution of
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- Precision TCXO time base ±0.1PPM Stability 17-40°C
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- Auto Decimal Point
- Aluminum Case
- Socketed IC's
- Three position attenuator:
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  - X10
  - X100 (avoids false counting)
- **# OPT0-9000-1A Factory Assembled - 2 Year Guarantee** $329.95
- **# OPTO-8000.1AK Kit Form - 1 Year Parts Guarantee** $279.95
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- **# OPTO-7000K Kit Form** $199.95
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**CM-1000 Digital Capacitance Meter**
- Measures from 1pf to 9999 ufd
- 6" Digits
- Aluminum Case
- Accuracy of 1% less one digit
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- For Use with Digital Voltmeter
- Output: 10 mV per Degree
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- Resolution to .01" with 4½ Digit Meter
- Requires two 9V Batteries - not included
- **# T-100 Factory Assembled & Calibrated** $59.95
- **# T-100K Kit Form** $39.95
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- **# D-146 Antenna, Rubber Duck, 146 MHz** $12.50
- **# RA-BNC Right Angle BNC Adapter for Above Antennas** $2.95

**PROBES**
- **# P-100 50 Ohm, 1X Direct Connection RF Probe** $13.95
- **# P-101 Low Pass, Attenuates RF at audio frequencies** $16.95
- **# P-102 HI-Z, 2X High Impedance, general purpose** $16.95

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- **POWER** — 235 watts PEP and CW on all bands for that DX punch
- Advanced microcomputer technology developed and manufactured in the U.S.A.
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Reads PEP output in watts and receive "S" units.

**Mike Tuning**
For accurate 100 Hz steps or fixed rate scan.

**Wide Frequency Coverage**
- 10M — 28.0-30.0 MHz
- 15M — 20.8-23.0 MHz
- 20M — 13.8-16.0 MHz
- 40M — 6.0-8.3 MHz
- 80M — 3.0-4.5 MHz
- 160M — 1.8-2.4 MHz*

*in lieu of 10M band on Model Astro 151
I was reading my March issue of 73 and noticed your story of the trip we took to Europe in October, 1963. I always felt that the idea of the Institute of Amateur Radio was a very good one and that hams getting to know hams through group tours to other countries was an excellent way of promoting amateur radio.

I am a holder of a lifetime subscription to 73 (yes, I was one of the lucky ones who subscribed in Miami back in '61 or '62), and I have followed you through your editorials. Many times I started to write and tell you how much Anna and I enjoyed the trip, but somehow I never got around to it.

Do you remember your miniature greyhound jumping off the bed and breaking its leg? Or Anna Todd yelling that she wanted to get off at "Arts and Medicine" underground station in Paris? Wasn't the cannelloni good at the restaurant in Rome where we went with you one evening and ate in the open-air section? Do you remember when one of the single guys had to double up in the room with the gal in the red coat and her husband? I can't remember her name, but in a crowd we would all say, "Follow the gal in the red coat."

Well, I've finally gotten around to telling you (after all these years) how good I think your idea was and how great the trip was. I have gone many places since then, but never had one-tenth the fun we all did on that momentous trip to Europe by 73 hams. If that trip could ever be duplicated and it looked as much fun as it was and how interesting it was to meet hams from other countries, you would have to form a full-time travel agency.

I have recently retired from practicing dentistry, and Anna and I moved here to the mountains of western North Carolina from Miami, Florida. Good luck, Wayne, and keep up the good work.

Lamon L. Whiddon K4MHy
Boone NC

I was January, 1961, and you were Lite Subscriber #1. I remember it well! The Italian greyhound was named Petite Chienne because that's what everyone called her when we got to Paris. The Rome restaurant was the Tres Scalini and it is still there and superb. I often look at the slides and relive that fantastic trip.—Wayne.

Somehow I was propelled to open the March copy of 73 and I read Never Say Die.

My husband has been dead a year and I had not opened any of his ham magazines until today. As one of the XYLs on that 1963 trip to Europe, I want to thank you for renewing all those wonderful memories.

It would be wonderful to be in contact with the travel group again.

Anna Todd
222 W. Hawthorne St.
Aurora MO 65605

High-school graduates who plan to enter college this fall and who are licensed amateurs may be eligible for one of the $250 scholarships offered by the Atlanta Radio Club. If you qualify, write to the ARC Scholarship Fund, PO Box 77171, Atlanta GA 30350.

Philip J. Latta WAGTS
Marietta GA

I feel that the idea of each ITU country having one vote each at WARC is absurd. Although some people have expressed discontent at the very idea of one country having more say than another, citing it undemocratic, I see it as just the opposite. I see it undemocratic when a handful of radio users have the same vote as millions. This is totally unreasonable for the millions of radio users, since the more operators there are, the more air space is required.

The only truly fair way on which to base votes is on radio population. Because it is not going to change, I feel the US should drop out of the ITU. Many countries play the ITU game during conferences and then disregard the decisions made afterwards, anyway.

William D. Matteo WB2IVI
Toms River NJ

From time to time, you mention your television career. With this in mind, I thought you might be interested in the accompanying picture which shows a young (1948) Wayne Green, hair and all, behind a WPIX RCA-TK 10 camera.

I believe the man at the piano is Sigmund Spaeth, who had a program called "The Tune Detective."

I am sure your loss to TV was a gain for amateurs.

Otis Freeman
WPX, Inc.
New York City NY

Thanks, Otis! Sure, I remember Dr. Spaeth and his program... and little things like the night I did the Woody Woodpecker call for him on camera. I remember the Gloria Swanson show, too, with Zasu Pitts and a lot of other old-time stars. Those were fantastic times. The hair? Heck, my father has more hair than I do... so did his father, right up until he died... but then they didn't have the aggravation of my first wife.—Wayne.

I just read an article in one of the back issues of 73. The issue, Feb., '78, had an article by James C. Chapel WH6DA, entitled "Surplus Adventures—bound foolish!" He didn't feel he could trust a company to ship a signal generator to him from a government surplus outlet. Well, this definitely points out a need of hams.

I want to become a ham but suffer from a pecuniary deficiency. Since I work at the Ogden depot, which is a major electronics surplus outlet in Utah, I think I can benefit all those out there who wish to purchase this equipment and who do not wish to suffer expense-wise in the process! In short, I offer, for a reasonable fee, to ship what they wish from Ogden to wherever they may desire.

My background consists of thirteen years in electronics, the last 6 months of which have been as a quality control inspector in the same field. I could, most likely, even inspect the item they wish to bid on, given enough lead time. Not only will all the hams out there benefit, but maybe I'll finally be able to join the fraternity.

If I should thrive at this, I shall definitely make it a business and we'll all benefit because then I'll be able to afford to advertise in your superb magazine. Until then, I shall have to rely on your largess to print this in your next Letters column. If anyone out there is interested, please have them include an SASE.

Thomas W. Newbery
610 North Liberty St.
Ogden UT 84404

I am returning to the frontiers of Texas again, this time back-packing in the arid wilderness mountains of the Chihuahuan Desert. Please publish the particulars of the expedition so that more experimental NBVM stations may participate. One of the following mountain ranges will be selected for a base camp above the desert floor where temperatures will be more tolerable while operating: Chisos, Davis, Glass, Guadalupe, Christmas, Solitario, or Caballo Muerta.

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Reader Service — see page 211
Looking West

Bill Pasternak WA61TF
24854-C Newhall Ave.
Newhall CA 91321

Mike Davis WD6FFV of Torrance, California, is a real live 13-year-old hero. On the evening of April 24th, Mike’s parents gave him permission to stay up late in order to indulge in a bit of his favorite pastime—operating his station and hunting DX. Everyone else in the house was asleep as Mike searched the band looking for the western Caroline Islands. At about 1:00 am on the morning of April 25th, Mike happened across a QSO between someone on a fishing boat off the coast of Jamaica and someone in New Zealand. Conditions between the craft (later identified as the fishing vessel Carmen) and ZL-land were poor at best, and the information exchanged showed that an emergency existed. When those aboard the Carmen, identified as the boat’s owner Leonard Hutchinson and crew members David Dalquist and Sergio Perez, again sent out a “Mayday” call, Mike responded, obtained their latitude and longitude, and phoned this information to the Long Beach Coast Guard station, which in turn relayed the same to Miami. The situation was this: The Carmen was some 60 miles off the coast of Jamaica. It had been severely battered by high winds and rough seas and was taking on water. Those aboard knew that the craft would sink; they needed immediate rescue. Mike spent the next 45 minutes relaying information between the Coast Guard and the stricken Carmen until the signal from the vessel disappeared due to changes in propagation. It was at that time that a W5 in New Mexico acquired the Carmen’s signal and continued the relay between the Miami Coast Guard and the Carmen.

As a result of Mike’s quick thinking, the Coast Guard dispatched a rescue plane which dropped a pump, rescue raft, and marine Coast Guard radio. Later, the cutter Sherman took the stricken Carmen in tow and brought it back to Montego Bay, Jamaica. A spokesman for the Coast Guard credited the success of the rescue to Mike’s quick thinking and positive action. Because he maintained his cool, three men who might have drowned are alive today. They have a 13-year-old amateur radio operator in Torrance, California, to thank for this.

THE “HAIT-TO-THE-QUEEN” DEPARTMENT

Nate Brightman K6OSC is another amateur we can all take pride in. He is a ham who had a dream and persevered for twelve years to see it come true. Thanks to Nate, amateur radio is now operational in full view of the general public on a day-to-day basis aboard one of southern California’s most renowned tourist attractions: the Queen Mary ocean liner now permanently docked in Long Beach harbor.

Nate is a member of the Associated Radio Amateurs of Long Beach, California. Twelve years ago, when the Queen Mary made her last sea voyage from England to her final home in Long Beach, Nate and his club thought that it would be fitting to have an operational amateur station on the trip. Nate spearheaded the drive and succeeded. It was at that time that the idea of a permanent station came to him. Having an idea and making it come true are not always one and the same. In this case it took years. During its transition from an ocean liner to a tourist attraction and hotel, the original wireless room had been dismantled. Nate’s idea was to restore this room to as close to its original state as possible and then add a permanent amateur station.

On April 22, 1979, Nate’s dream came true. On that evening, Sharon and I attended a special invitational press preview of what had been accomplished by Nate and the Associated Radio Amateurs of Long Beach. On the top deck of the Illustrous Queen, the wireless room had indeed been restored. Amid the relics of times gone by was nestled neatly, in a special panel arrangement, some of today’s most sophisticated amateur equipment on indefinite loan from such well-known firms as Yaesu, Trio-Kenwood, Swan, DenTron, and others. What about antennas? Neatly built into one of the Queen’s stacks and rising above it stands a triband beam and a two-meter Ringo from Cushcraft. The array is rotated by an Alliance rotor. Shortly, two dipoles (one for 75/80 and another for 40 meters) will give the ship’s station 80- through 2-meter capability (six meters excluded).

Something very apropos happened the evening that the station opened. After the initial ceremony was concluded, it was time place the station on the air. One of those present was famed DXer Don Wallace W6AM. When his turn came, Don contacted a station in New Zealand. As the QSO progressed, it was learned that the ZL had been one of the wireless operators who served on the Queen Mary during World War II. I remember the ZL saying, “Don, if you are where I think you are, then I preceded you some 30 years ago and had my feet in the same spot that yours are now.” All of us gathered around the TS-820’s speaker beam with delight. If the QSO had been planned—and it was not—nothing could have been

Continued on page 170

A very happy Nate Brightman K6OSC (center) chats with Roy Neal K6DUE (left) and WA61TF during a break in the filming of “The World of Amateur Radio” aboard the Queen Mary. (Photo by KH6IAF)
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The listed data tells you the time and place that OSCAR 7 and OSCAR 8 cross the equator in an ascending orbit for the first time each day. To calculate successive OSCAR 7 orbits, make a list of the first orbit number and the next twelve orbits for that day. List the time of the first orbit. Each successive orbit is 115 minutes later (two hours less five minutes). The chart gives the longitude of the day's first ascending (northbound) equatorial crossing. Add 26° for each succeeding orbit. When OSCAR is ascending on the other side of the world from you, it will descend over you. To find the equatorial descending longitude, subtract 166° from the ascending longitude. To find the time OSCAR 7 passes the North Pole, add 29 minutes to the time it passes the equator. You should be able to hear OSCAR 7 when it is within 45 degrees of you. The easiest way to determine if OSCAR is above the horizon (and thus within range) at your location is to take a globe and draw a circle with a radius of 2450 miles (4000 kilometers) from your QTH. If OSCAR passes above that circle, you should be able to hear it. If it passes right overhead, you should hear it for about 24 minutes total. OSCAR 7 will pass an imaginary line drawn from San Francisco to Norfolk about 12 minutes after passing the equator. Add about a minute for each 200 miles that you live north of this line. If OSCAR passes 15° east or west of you, add another minute; at 30°, three minutes; at 45°, ten minutes. Mode A: 145.85-95 MHz uplink, 29.4295 MHz downlink, beacon at 29.502 MHz. Mode B: 432.15-175 MHz uplink, 435.975-925 MHz downlink, beacon at 435.972 MHz.

OSCAR calculations are similar to those for OSCAR 7, with some important exceptions. Instead of making 13 orbits each day, OSCAR 8 makes 14 orbits during each 24-hour period. The orbital period of OSCAR 8 is therefore somewhat shorter: 103 minutes.

## RTTY Loop

### Program 1

| 0014 | 001B | 001D | 0020 | 0024 | 0026 | 002D | 002F | 0030 | 0032 | 0034 | 0037 | 0038 | 003A | 003B | 003D | 003E | 0040 | 0042 | 0043 | 0047 | 0048 | 004E | 004F |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| UTC | JPT | JG3 | FCB | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S |

### External References

- RTTY TRANSMIT PROGRAM
- VER 0.0 - 06 MAY 79
- MISC I - LEAVE A - D

### ASCII

| 001 | 002 | 003 | 004 | 005 | 006 | 007 | 008 | 009 | 010 | 011 | 012 | 013 | 014 | 015 | 016 | 017 | 018 | 019 | 020 | 021 | 022 | 023 | 024 | 025 | 026 | 027 | 028 | 029 | 030 | 031 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 00 | 03 | 02 | 01 | 00 | 03 | 02 | 01 | 00 | 03 | 02 | 01 | 00 | 03 | 02 | 01 | 00 | 03 | 02 | 01 | 00 | 03 | 02 | 01 | 00 | 03 | 02 | 01 | 00 | 03 | 02 | 01 | 00 |
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Sunday, July 15

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- Use all amateur bands to commemorate the Colombian 169th independence anniversary. Stations on county line give and receive only one number per QSO, but each county is valid for a multiplier. Suggested frequencies are 3575, 7055, 21070, and 28070. It is requested that only portable or mobile category stations call CQ or QRZ on 40 meters below 7055 and on 20 meters below 14070 with all stations spreading out above those frequencies.

**SCORING:**

- QSO number, category (portable = P, mobile = M), RST, country of the contestant or the rules of the contest, taking credit for incorrect QSO multipliers, or duplicate contacts in excess of 2% of the total made will be deemed sufficient cause for disqualification.
- The LCRA Contest Awards Committee will determine if incertainties shall be final. All logs must be mailed to: LCRA—Concurso Independencia, c/o Contest Committee Manager, Apartado Postal 584, Bogota, Colombia, SA. All entries must be postmarked no later than September 30.

**CW COUNTY HUNTERS CONTEST**

Starts: 0000 GMT July 28

The CW County Hunters Net invites all amateurs to participate in the 1979 contest. All mobile and portable operation in less active counties is welcome and encouraged. General call is “CQ CH.” Stations may be worked once on each band and again if the station has changed counties. Portable or mobile stations changing counties during the contest may repeat contacts for QSO points. Stations on county line give and receive only one number per QSO, but each county is valid for a multiplier. Suggested frequencies are 3575, 7055, 21070, and 28070. It is requested that only portable or mobile category stations call CQ or QRZ on 40 meters below 7055 and on 20 meters below 14070 with all stations spreading out above those frequencies.

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SAMPLE-AND-HOLD DEVICES

Sample-and-hold (S/H) devices or sample-and-hold amplifiers (SHA) are analog circuit elements that are the analog equivalent of the digital latch. They are used when we wish to sample an analog signal and then hold it steady at a particular point so that a voltage of interest may be measured or used elsewhere in a system. The operation of an ideal sample-and-hold device is shown in Fig. 1. In this example, the S/H output follows, or tracks, the input during the sample period and then holds the latest analog voltage when it switches to the hold mode. In the figure, the input and output voltage lines are offset slightly for clarity.

Sample-and-hold devices are widely used in conjunction with digit-to-analog and analog-to-digital converters. For example, they may be used to:

- Hold an analog signal steady so that an A/D conversion may be performed.
- Simultaneously sample many analog inputs for later measurement (requires one S/H device per analog input);
- Deglitch a D/A converter's output to eliminate output voltage spikes or settling transients;
- Distribute one D/A converter's output to several points, where analog voltages must be constantly maintained.

The second and fourth uses listed above are becoming less important than they were two or three years ago. It is probably less expensive now to dedicate an A/D converter to each input to be measured and to have one D/A converter per output, depending upon the specific application.

The most common use of sample-and-hold devices is to sample and hold an analog signal at a particular point while it is being analyzed. For example, in Fig. 2 we provide a block diagram for a typical sample-and-hold computer interface that permits you to measure the peak voltage from an instrument. We have assumed here that the instrument provides a positive clock pulse, called PEAK, when the peak maximum is reached. The SAMPLE pulse from the computer allows the S/H module to sample the unknown signal from the instrument. When the peak is reached, the PEAK signal clocks a logic 0 into the output of the flip-flop, forcing the S/H device into the hold mode. Fig. 3 shows the timing diagram that would be required by the interface circuit shown in Fig. 2. Again, the S/H output and the instrument output have been offset for clarity. Now, either a slow ramp A/D converter or a fast successive approximation A/D converter can be used to provide the correct value for the peak voltage since the S/H device will maintain the voltage until it can be digitized.

Sample-and-hold devices are not ideal, and there are some terms that will help you better understand their limitations and uses. These are listed in Table 1, which is keyed to Figs. 4, 5, and 6. As can be observed, there are important limitations to the capabilities of S/H devices. Those devices that have a slow acquisition time, that use small capacitors and thus the output droop rate will be slow. When high acquisition speeds and long hold times are required in an application, two S/H modules may be used. The first quickly acquires the analog signal at the point of interest and the second acquires and holds the output from the first device. The second S/H device takes longer to acquire the voltage presented by the first device but since a larger capacitor is used, its droop rate will be much lower. For further details, the reader is referred to reference 2.

There are a number of commercially available sample-and-hold devices which eliminate the need for you to construct your own. The following modules are representative of those available:

- Analog Devices, Inc., Norwood, Massachusetts 02062—SHA-5, general purpose, $47; SHA-1A, general purpose, $150.
- Burr-Brown, Tucson, Arizona 85734—SHC800, $16.4 cost; $34; SHM60, high speed, $104.
- Datel, Inc., Canton, Massachusetts 02021—SHM-LM2,
# Frequency Counter Consumer Data Comparison Chart

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Model</th>
<th>Suggested List Price</th>
<th>Frequency Range</th>
<th>Type of Time Base</th>
<th>Accuracy Over Temperature</th>
<th>Sensitivity</th>
<th>Digits</th>
<th>Pre-Scale Input Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSI Instruments</td>
<td>100 HH</td>
<td>$99.95</td>
<td>50Hz-100MHz</td>
<td>TCXO</td>
<td>1 PPM</td>
<td>100 Hz</td>
<td>2</td>
<td>25 MHz</td>
</tr>
<tr>
<td></td>
<td>500 HH</td>
<td>$149.95</td>
<td>50Hz-550MHz</td>
<td>TCXO</td>
<td>1 PPM</td>
<td>50 Hz</td>
<td>2</td>
<td>250 MHz</td>
</tr>
<tr>
<td></td>
<td>MAX-550</td>
<td>$149.95</td>
<td>1kHz-550MHz</td>
<td>Non-Compensated</td>
<td>3 PPM @ 25°C</td>
<td>500 Hz</td>
<td>6</td>
<td>400 MHz</td>
</tr>
<tr>
<td>Optoelectronics</td>
<td>OPT-7000</td>
<td>$138.95</td>
<td>10Hz-800MHz</td>
<td>TCXO</td>
<td>1.8 PPMi4</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

The specifications and prices included in the above chart are as published in manufacturer's literature and advertisements appearing in early 1979. DSI INSTRUMENTS only assumes responsibility for their own specifications.

## Frequency Counter

- **Model 500 HH**
  - Frequency Range: 50 Hz — 500 MHz
  - Pre-Scale Input: 1 Hz to 1.3 GHz
  - **Price:** $149.95

- **Model 100 HH**
  - Frequency Range: 50 Hz — 100 MHz
  - Pre-Scale Input: 1 Hz to 1.3 GHz
  - **Price:** $99.95

The 100 HH and 500 HH hand held frequency counters represent a significant new advancement, utilizing the latest LSI design and because it's a DSI innovation, you know it obsoletes any competitive makes, both in price and performance. No longer do you have to sacrifice accuracy, ultra small readouts and poor resolution to get a calculator size instrument. Both the 100 HH and 500 HH have eight .4 inch LED digits — 1 Hz resolution — direct in only 1 sec. or 10 Hz in .1 sec. — 1 PPM TCXO time base. These counters are perfect for all applications be it mobile, hilltop, marine or bench work. **CALL TODAY TOLL FREE** (800-854-2049) (800-542-6253) TO ORDER OR RECEIVE MORE INFORMATION ON DSI'S FULL PRODUCT LINE OF FREQUENCY COUNTERS RANGING FROM 10 Hz TO 1.3 GHz.
New Products

KANTRONICS’ AMATEUR UPGRADE™

Kantronics' "Amateur Upgrade" is an educational board game that familiarizes players with FCC rules governing amateur radio and elementary radio concepts. The game comes complete with playing surface, playing pieces (coin, grommet, etc.), a die, a deck of exam cards, and corresponding answer sheets.

"Amateur Upgrade" is packaged in a colorful light blue box; it measures 1.5" high by 8.25" wide by 15.5" long. Game pieces and exam cards fit in a pocket adjacent to the support tray. The game surface is 15.4 inches square and is printed in five colors corresponding to beginner, Novice, General, Advanced, and Extra class.

Players roll the die to determine the number of spaces to move. Some spaces players land on have a consequence, such as "taught a Novice class"—move one square, or "exceeded 1000 Watts—answer question; if wrong, go to start," or "illegal third party traffic—lose one turn."

When a player lands on an exam space, he must take an exam card from the card pile corresponding to the license level he is trying to upgrade to. After three cards have been collected by one player, he must "take the exam." All three questions must be answered correctly to pass the exam. Answers can be checked against the answer sheets. If the exam is passed, the player moves up (upgrades) to the adjacent exam space on the next license level. If the exam is failed, the player remains on the same level and must collect another three exam cards.

The first person to progress through all levels to obtain the Extra-class license wins!

Novice, General, Advanced, and Extra-class questions are included. For a less advanced game, the Novice cards can be used exclusively for all license levels.


NEW COMMUNICATIONS RECEIVER FROM NATIONAL RADIO

National Radio now offers the latest version of its Model HRO-600 high precision/performance solid-state general coverage communications receiver, conceived for applications requiring wide frequency coverage, high stability, sensitivity, and selectivity. The frequency stability of this professional receiver, over the temperature range of 0° to 50° C, will drift less than one part in one million, and, under normal operating conditions, it can be expected to drift less than one part in one hundred million. The receiver's fine-tune mode, using the Model 602 plug-in module, permits tuning to a fraction of 1 Hz without any loss of stability.

The HRO-600 was originally designed and built to the exacting requirements of the International Maritime Standards. With its versatile plug-in modules and accessories, the Model HRO-600 becomes a custom receiver designed to meet users' specific needs at the lowest cost. The manufacturer states, "The HRO-600 is unmatched in performance and versatility in its price range."

The receiver's excellent selectivity from 16 kHz to 30 MHz is achieved by a built-in tunable preselector. Depending upon the plug-in module selected, the receiver will operate at any frequency between 10 kHz and 30 MHz in any of the following reception modes: AM, CW, SSB, FSK, and FAX.

The basic applications of the HRO-600 include: commercial communication, ship-to-ship, ship-to-shore, ground-to-air, frequency/time measuring, process control, laboratory instrumentation, military, paramilitary, international monitoring, limnology, etc.

The HRO-600 meets applicable military standards as to shock and vibration, has an operating temperature range from 20° to +55° C, measures 5 1/4" high x 17" wide x 15 1/2" deep, and is provisioned for self-supporting rack mounting. The approximate weight is 40 lbs., available from stock, FOB factory.

For additional information, write or call Robert Reeves, Sales Manager, National Radio Company, Inc., 89 Washington St., Melrose MA 02176; phone (617)-662-7700. Reader Service number N23.

The Astro 150 from Swan.

SWAN'S ASTRO 150 TRANSCEIVER

Swan Electronics Corporation has announced its newest entry into the amateur radio market with the introduction of the Astro 150 transceiver, featuring microprocessor control and memory.

The new solid-state transceiver, with its microprocessor control, provides more than 100,000 digital-controlled frequencies and variable rate scanning (VRS). VRS is a dramatic new method of tuning which provides ease and accuracy and works in conjunction with hand-held microphone scanning. With microphone "up" and "down" push-buttons, the Astro 150 can be tuned in accurate 100-Hz steps or at a fixed rate scan. VRS is a supplement to the Astro 150's conventional tuning knobs.

The compact new radio also has additional features which include 235 Watts input power, full and semi break-in CW, narrowband CW filter, expanded frequency coverage, and microprocessor-controlled frequency memory.

"Amateur Upgrade" game from Kantronics.

National Radio's latest version of the HRO-600.
The Astro 150 will be sold through Swan's worldwide network of dealers. For further information, contact Gary Pierce at Swan Electronics Corporation, 305 Airport Road, Ocean-side CA 92054; phone (714)-757-7525. Reader Service number S44.

**METZ COMMUNICATION'S AMATEUR ANTENNAS**

Metz Communication Corporation has broad experience in producing mobile-type antennas. However, until recently, the company has concentrated its sales efforts in the commercial land mobile and marine radio markets. Now Metz has entered the amateur marketplace with mobile antennas for the 10-meter, 2-meter, and 70-cm bands. I bought and operated the 2-meter version, the Mobile 2, in preparation for this review.

The commercial heritage of the Metz amateur antennas is readily apparent. Instead of the usual plastic tube to protect the base loading coil from the weather, the Metz coil is housed inside a machined stainless steel cylinder. This cylinder, in turn, is filled with epoxy to completely encapsulate the coil...no more worries about a leaky base coil.

The tapered stainless steel whip is held in place by a metal ferrule that is (would you believe?) gold-plated to prevent corrosion. Overall, the construction of the Metz Mobile 2 is so rugged that it will probably still be going strong when you and I are long gone.

The Mobile 2 is designed to operate as a half-wavelength antenna on the 2-meter band. This design makes the antenna a bit shorter than the more familiar 5/8-wavelength 2-meter antennas. I consider the reduced length a plus; in my case, it made the difference between being able to mount the antenna on the car roof (the best location) and being relegated to the trunk lip (for fear of bashing the whip against the garage door).

In operation, the Mobile 2 is a breeze. When cut for lowest swr in the center of the 2-meter band, it's possible to operate from 144-148 MHz with an swr of 2.5:1 or better. Of course, if you work primarily in one end of the band or another, you can optimize the performance for that portion of the spectrum.

I found the Metz to be equal to or better than my 5/8-wave antenna in every respect. Additionally, the completely weatherproof design of the Mobile 2 means that leaking and condensation around the coil are never going to be a problem; you get full performance even in the worst weather. The Mobile 2 is rated at 200 Watts for those who need the extra punch of a linear amplifier. Several mounting styles are available in addition to the excellent magnetic mount I used.

For those who demand quality construction in everything they own, the Metz antennas are going to be tough to beat. Metz Communication Corporation, Corner Routes 11 and T1C, Laconia NH 03246. Reader Service number M100.

Jeff DeTray WB8BTH/1
Assistant Publisher

A NEW CONSUMMATE DIGITAL VOLTMETER

Non-Linear Systems' new Model LM-353 3½-digit digital Voltsmeter was designed to include numerous advanced state-of-the-art features. The LM-353 is packaged in a small 1.9-inch-high by 2.7-inch-wide by 4-inch-deep attractive plastic case. It weighs only 9.2 ounces.

Basic functions include ac and dc volts, Ohms, amperes and dc milliamperes. Full-scale ranges are 1, 10, 100, and 1000 volts, 1, 10, 100, 1000, and 10,000 kilohms, and 1, 10, 100, and 1000 milliamperes.

In addition, a low-Ohms capability is present which provides for in-circuit test of resistive components. It is particularly useful for in-circuit test of resistors shunted by semiconductor devices because the low compliance voltage provided does not turn on the semiconductor.

The low-Ohms function adds other capabilities to the meter. It can be used to increase the sensitivity of the voltage ranges by a factor of 10. It provides a 0.1-kilohm resistance range having 100 milliohm resolution. In addition, the milliamperes function is enhanced in two ways. First, a .1-milliampere range is available. Second, the voltage drop across the internal current shunt is reduced by a factor of 10. Measurements from 100 nanoamperes to 100 milliamperes can be made in this mode.

The LM-353 utilizes an LCD display. Replaceable AAA-size batteries allow up to 100 hours of operation. Standard features include auto polarity, decimal location, input overload protection, and automatic zeroing.

Options include a tilt-stand case for bench use and a panel-mount flange case for installation into equipment. A 45-kV high-voltage probe and leather carrying case are also available.

The complete NLS digital Voltsmeter line is sold through a worldwide network of leading electronic distributors. The Model LM-353 will be available from distributors in July. Non-Linear Systems, Inc., PO Box N, Del Mar CA 92014; phone (714) 755-1134. Reader Service number N22.

NEW 300-WATT DRY RF LOAD RESISTOR

The new Bird model 8173 TERMALINE® dry high-power coaxial load is designed for 50-Ohm rf-line and system termination during design, test, and alignment. At 300 Watts continuous duty, it complements the present Bird Dry Loads group ranging from 2 Watts through 600 Watts. The group, with its rugged construction and air dielectric (no liquid coolants), now includes 2-, 5-, and 10-Watt loads with fixed input connectors, and 25-, 50-, 100-, 150-, 300-, and 500/600-Watt loads with Quick-Change connectors.

The use of Bird QC Quick-Change connectors offers unsurpassed flexibility; a choice of any common rf connector either at the time of order or in the field eliminates adapters and degradation of performance.

Available from Bird Electronic Corporation, 3030 Au...
CDE INTRODUCES TWO NEW ANTENNA ROTOR SYSTEMS

Two new models of high-performance antenna rotor systems, the Ham IV and the CD-45, have been introduced by Cornell-Dubilier Electric Corporation, Newark NJ.

The new Ham IV is designed for large communication antenna arrays up to 15.0 sq. ft. wind load area when tower-mounted. Highlights of the Ham IV include power braking, machined steel drive gears, dual transformer circuitry, and other design features that make it "the engineered choice" for serious communicators.

The new CD-45 accommodates antenna arrays up to 8.5 sq. ft. wind load area when mounted in a tower and features a professionally-styled control unit, illuminated metered readout, all-steel drive components, automatic disk braking, and more.

Both the Ham IV and the CD-45 operate at safe low-voltage control levels with reliable snap-action rotational controls for accurate, trouble-free operation.

For more information, write Leonard Sabal, Cornell-Dubilier Electric Corporation, subsidiary of Federal Pacific Electric Corporation, 150 Avenue L, Newark NJ 07101; telephone (201) 589-7500. Reader Service number C143.

ANTECK MT-1 MOBILE ANTENNA

Improved conditions on the HF DX bands has stirred increased interest in mobile operation on those frequencies by many amateurs. In mobile operation, the antenna is even more important than it is in fixed installations. For one thing, if you've got an inefficient antenna at home, you can always help to make up for its shortcomings by running more power. However, while there are a handful of mobile kilowatts around, most amateurs have to be satisfied with the output from their transceivers, usually in the 100-Watt range.

So, for effective mobile operation, an efficient antenna is of prime importance. It should also be easy to install and tune, weatherproof, and allow band changes without having to change coils. The new Anteck MT-1 certainly meets those requirements and, when properly installed and tuned, should provide a high degree of performance on the HF bands.

The frequency coverage of the MT-1 is 3.5 to 30 MHz, making it perfect for use on MARS and other non-amateur frequencies (in addition to the 10 through 80 meter amateur bands). Its power handling capability is 750 Watts PEP. The MT-1 consists of three main assemblies: mast or base section, loading coil, and whip. The overall length of the mast section and the loading coil is 80 inches and the diameter is approximately 1 inch. The total antenna length is 116 inches at 3.5 MHz and 92 1/2 inches at 30 MHz. The antenna is center-loaded on all frequencies except 29 to 30 MHz, where it works as a quarter-wave vertical.

Properly mounted and tuned, the MT-1 will display the Vswr/bandwidth shown in Table 1.

The loading coil is tuned from the base of the antenna, using a non-inductive plastic rod which is attached to the base of the whip assembly and extends down into the bottom mast section. The antenna comes with a handy chart that correlates the numbers on the antenna's tuning scale to frequency. To set the antenna for a particular frequency, loosen the knurled nut in the slot in the base section four turns and push the tuning rod to the middle of the base tube so that the tuning rod will move freely without binding. Then set the top of the nylon collar to the position called for on the tuning chart for the frequency in use and retighten the knurled nut. That's all there is to tuning the Anteck MT-1.

The MT-1 mobile antenna is manufactured entirely in the United States using only the best-quality military-standard materials and components. Its three-piece modular construction (base section, loading coil, whip assembly) makes for ease of repair or replacement if damaged. There is a 90-day warranty. Factory service is available.

The net price for the MT-1 mobile antenna is $119.95. Anteck, Inc., 239 Cedar Street, Box 543, Jerome ID 83338; (208) 324-3400. Reader Service number A80.

Morgan W. Godwin W4WFL Brattleboro VT

MICRONTA 12-VDC 8-AMP POWER SUPPLY

Now available from Radio Shack is a new power supply that converts an ordinary 120 V ac house current to 12 V dc at up to 8 Amps output for powering high-power auto sound equipment, mobile CB transceivers, and amateur radio equipment at home.

The Micronta 12-volt 8-Amp power supply includes a heavy-duty transformer and 35-Amp bridge rectifier for handling high-current demand devices. Filtered output is free of "hum," and ripple is less than 2 volts peak-to-peak with a full 8-Amp load, according to Radio Shack.

A built-in manually resettable circuit breaker protects the supply and your equipment from damage. An LED indicates power on.

Manufactured in Radio Shack's own USA factory, the power supply is housed in a metal cabinet with rubber feet. Size—3 3/4" x 6" x 5 1/8".

The Micronta 12-volt 8-Amp power supply is available exclusively from participating dealers.

Continued on page 174
Enter the exciting world of HF DX with ICOM’s outstanding, fully synthesized IC-701. Globe-spanning QSO’s are as easy as hook-up and tune-in. Complete installation requires only a good 50 Ohm antenna and an AC power plug-in. Your IC-701 comes with everything else you need for beginning DX transmissions, including the matching IC-701PS external speaker and power supply, the fine SM-2 base microphone, and even two built-in VFO’s.

Turn on the power, and the world’s at your single fingertip. The IC-701 lets you scan all the Amateur HF bands from 160M to 10M (plus some MARS coverage above and below some of the Ham bands) with one finger. No more fooling around with two or more tuning knobs, and no complicated retuning when you QSY.

When talking on your IC-701, you get a 200 watt PEP input signal whose punch is significantly increased by the high quality built-in RF speech processor. This makes your 200 watts sound like so much more that we recommend you leave the speech processor on all the time.

For adding on frequency memory and remote frequency control, the IC-701’s synthesizer is completely compatible with ICOM’s RM2 remote computer controller; and with ICOM’s optional EX1 extension, you can operate with the RM2 and a linear amplifier at the same time.

Nothing else matches the value and ease of the IC-701. Plunge into the excitement of HF DX now, and get the whole HF world with ICOM’s IC-701 LSI system.

IC-701: DXterity
ALONG A LITTLE QSL ADVICE THAT IS SEVERAL LOG BOOKS INVOLVED AND SASE MANAGER AND INCLUDE ONLY ONE BETTER CHANCE OF GETTING A FAST BEAR, THEN YOU REALLY DON'T NEED DRESSED, STAMPED ENVELOPE ALWAYS INCLUDE A SELF-AD- INCORPORATING THE DATE, BE SURE THAT MANAGER. WHEN SENDING A CARD WITH A DOLLAR BILL, FOREIGN MINT STAMPS, OR SUFFICIENT IRCs TO WHO FEEL THEY MEET THE OTHER FACTOR OF AMATEUR EQUIPMENT HAS ENDED THEIR INTENTIONS TO HOLD A CURRENT AMATEUR RADIO RESTRICTION THAT COULD BE A Few of them have been Silm himself: 6B1B, J1A, 701AA, 9N1AB, BY1USA, CR9CB, XZ2BC, KL8AA, AND, OF COURSE, VR60M FROM MALDEN ISLAND. BEING THE BASHFUL SORT, SLIM GENERALLY PRONOUNCES CV, BUT ON CALLSIGN YOU CAN BE FOUND ON THE PHONE BANDS. IF YOU HEAR THE GENERATOR WHU, YOU KNOW IT'S SLIM.

SV9JL ON CRETE HAS A WEEKLY SCHEDULE WITH W2TDQ ON TUESDAYS AT 2100Z ON 14280 KHz. LIND AND IRIS COLVIN, OF Y5AME DX FAME, REPORT THAT WITH THE END OF THEIR RECENT WEST INDIES SWING, THEY HAVE HELD 104 DIFFERENT CALLSIGNS, VISITED 135 COUNTRIES, AND HAVE MADE OVER 500,000 QSOs. THEIR QSL FILE OVER 250,000 ALPHABETIZED CARDS, PROBABLY THE LARGEST COLLECTION IN THE WORLD. GUINNESS BOOK OF WORLD RECORDS IS MISSING OUT.

A STATION HAS BEEN WORKED ON THE POSSIBILITY OF RAY AND GIVING HIS NAME AS BRAD EDMUND. SAID TO QSL VIA 10GPO. THIS COULD BE THE VATICAN OBSERVATORY STATION WE MENTIONED A FEW MONTHS AGO. A PREFIXED HEARD OVER THE MAY 18/20 WEEKEND WERE SPECIAL CALLS ISSUED FOR OPERATION BY SEVERAL GI STATIONS FROM INISHMURRAY ISLAND. QSL TO G3RC.

VR6HI WAS NUMBER 100 ON 160 METERS FOR PY1RO. VP8SU FROM SOUTH GEORGIA CAN USUALLY BE FOUND WITH WA2UJO IN A LIST-TYPE SCHEDULE. THEY PREFER CW, BUT ON OCCASION HE DX NETS SUCH AS THE FAMILY HOUR ON 14225 KHz AT 1500Z OR THE AFRIKANER NET, 21358 KHz FROM 1830Z. OVERSEAS COMMERCIAL INTERFERENCE HAS FORCED THE AFRIKANER NET TO MOVE FROM ITS NORMAL 21355-5KHz SPOT.

4U1UN HAS MOVED ITS LOCATION TO THE 48TH FLOOR OF THE SECRETARIAT AT UN HEADQUARTERS IN NYC. THEY STILL HAVE A LARGEST DX NEEDED TO PERMIT INSTALLING A BEAM.

3BBDA HAS BEEN ACTIVE MOST OF THIS YEAR TRYING TO CLEAN UP THE BACKLOG OF SOME 20,000 CARDS RECEIVED AS THE RESULT OF SOME OF HIS RECENT OPERATIONS.

THE VR6HI OPERATION FROM PITCAIRN ISLAND BY ZL1AMO AND ZL1ADI PRODUCED AN ALMOST UNBELIEVABLE QSO TOTAL OF BETTER THAN 4000 IN TWO DAYS SPREAD OUT OVER SIX BANDS. THE FEWEST CONTACTS CAME ON 160 METERS WITH 170, AND THE MOST, 10,885, WERE MADE ON 10 METERS. DURING THIS TWO-MONTH PERIOD, VR6BL AND VR8DX FROM THE YANKER TRADER MADE 753 AND 1100 QSOs RESPECTIVELY. 193 OF VR6BL'S CONTACTS WERE ON RTTY. THESE THREE OPERATIONS SHOULD HAVE DROPPED 100KP 1050 SPOT ON THE NEED list.

NEW OFFICERS FOR THE MIL-HI DX CLUB ARE ROGER PREECE W8BRTZ—PRESIDENT, BOB PIERCE WB8GGJ—VP, AND JIM HART WB8DAD—SECRETARY/TREASURER.

SV1JG EXPECTS TO BE ON RHODES IN THE DODECANESE GROUP THIS SUMMER SIGNING SV1JG/5VS. UNDER THE NEW CALL ALLOCATION SCHEME THERE IN GREECE, THE DODECANESE AND SV9 IS CRET. THIS WAS DONE WITHOUT DABD THE DESIRING DXER IN HIS NEVER-ENDING SEARCH FOR A NEW ONE.

SEVERAL VE TYPES ARE WORKING ON THE NECESSITY TO PERMIT ACTIVATION OF SABLE ISLAND DURING JULY OR AUGUST. THEY HAVE AUTHORIZATION FROM THE DOC BUT WERE AWAITING OTHER REQUIRED DOCUMENTS BEFORE FIRMING UP THE DETAILS.

AS THIS COLUMN IS BEING WRITTEN, THE YV9AA DXPEDITION IS GOING HOT AND HEAVY OUT AND GIVING OUT A NEW ONE TO DESIRING DXERS ALL OVER THE WORLD. WHILE WE REALIZE THE DX BANDS ARE CROWDED THESE DAYS, IT SEEMS A LITTLE RIDICULOUS TO SPREAD THE CALLING STATIONS OUT OVER A FORTY KHZ SECTION IN THE DX BAND. MAKING 14200 KHz TO 14240 KHz MAKES THAT SECTION OF THE BAND USELESS FOR ANY NORMAL DX ACTIVITY AND CERTAINLY DOES LITTLE TO OF A SEVEN-MAN SKIING TEAM HEADED FOR THE NORTH POLE. U8CR COUNTS FOR THE RAEM AND SASE.

THAT LINEAR SHIPPED TO FATHER DAVE CE5AE SHOULD BE IN USE NOW AND THE SIGNAL SHOULD BE MUCH IMPROVED. CE5AE CAN OFTEN BE FOUND ON THE LESS BUSY DX NETS SUCH AS THE FAMILY HOUR ON 14225 KHz AT 1500Z OR THE AFRIKANER NET, 21358 KHz FROM 1830Z. OVERSEAS COMMERCIAL INTERFERENCE HAS FORCED THE AFRIKANER NET TO MOVE FROM ITS NORMAL 21355-5KHz SPOT.

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enhance our image among the sizable segment of our fellow amateurs who somehow fail to see the need for keeping the normal day-to-day activities of amateur radio such as skeds, ents, SSTV, etc., to a screeching halt while we deserving ones strive to exchange signal reports. Replacing a temporary DX station located on an uninhabited island covered solid with birds and their natural residue. How anyone could fail to understand the social and stereo complaints about those DXers is certainly beyond us. Transmitting below the American phone band and listening up is the only way for many DX stations to be able to make any contacts with USA stations, but it seems that listening over, at most, a fifteen or twenty kHz portion of the band should be sufficient. How do you feel about this practice?

Still nothing heard from China but a few phonies. A usually reliable source from Europe reports that one of the eastern European countries will be sending a temporary radio technician to help the Chinese develop knowledge in that area. Some among this team will be amateurs ready to demonstrate the finer points of amateur radio should the opportunity arise. The source seems rather definite that something will be heard this fall.

There are serious discussions going on between some of the biggest of the big-gun-type DXers concerning a concentrated effort this summer to wipe Mt. Athos (SY) from the face of the earth once and for all. More information will come as plans gel.

If you think some exciting times can't be experienced in amateur radio, then you obviously were not in on the recent DX operation from Spratly. The initial landing was planned for Ambony Cay. When the Spratly crew got close, they could see that there were people on the island and they cautiously came inside the reef to a point some 300 yards offshore. Through binoculars it was easy to detect military personnel in black uniforms grouped around what appeared to be weapons. One of the military types began signaling with semaphore signals, but unfortunately no one in the crew understood the signals. As the crew moved in closer, the message became somewhat clearer as four warning shots were fired across their bow. Feeling at this point they were not wanted and seeing that they could be blown out of the water with little effort, the little group again headed out to sea.

After this initial problem, the group returned to Brunei, regrouped, and decided to make another run, but this time to Pearson Reef, located some eighty miles northeast of Ambony Cay and hopefully less inhabited since it had an elevation of only three feet above high tide. The approach to Pearson Reef showed how when it rains, it pours. Not only was the small reef occupied, but there were buildings and small craft around. Fortunately the group had selected a third alternate, which they now headed for. It was from this spot, Barque Canada Reef, a sand bar some 150 feet in length, that the much-delayed, constantly-in-danger DX operation finally took place.

Most of the sixty hours stay on Barque Canada Reef was spent operating, often with only one station on the air. Ten, fifteen, and twenty netted some 13,300 contacts with about half coming on fifteen. Phone seemed to result in a higher QSO/hour rate, so the concentration on this mode resulted in a 77%123% phone/CW split. Forty percent of the contacts were with Japan, thirty-five percent were with stateside, fifteen percent were with Europe, and the remainder were scattered around the world.

QSL to Harry Mead, Box 85, Round Corners, 2158 Australia. Expenses were excessive due to travel costs and any financial aid can go to K2TJ or via the Northern California DX Foundation.

The recent volcanic activity on St. Vincent Island in the West Indies found VP2SQ providing emergency communications for the local authorities. He is reported as having phone-patched Prime Minister Catto to other islands when there was a need for quick communications. It is this type use of amateur radio that we have been trying to demonstrate to the Third-World nations preceding WARC 79.

Rubin WASAHF and his XYL Ferne have had to curtail their YASME QSLing efforts on the recommendation of their doctor. Although giving up the YASME effort, they will continue to handle cards for those stations they are QSL managers for.

Some EP stations are again being heard on a somet ime basis, although the situation is far from being settled in. That 9N1yu being worked a few months back is reported by HS1ABD to be a true-blue type used by a Yugoslav mountain- climbing group in the Mt. Everest area.

S2BTF continues to show from Bangladesh on the week-ends working a list-type operation. Look for him on 14226 kHz Saturdays from 1300Z and Sundays from 1200Z. QSL Peter via Box 108 in Dacca.

9N1MM has been keeping a fairly regular schedule around 14243 kHz after 0100Z. QSL to Ed Blaszczyn N7EB, 12802 Sun Valley Drive, Sun City AZ 85351. Ed has been handling Father Moran's QSL duties since 9N1MM first came on the air in 1981. Ed, who has also held the calls W3KQ, W2K, and KX6EB, asks that we remind those needing a 9N1MM QSL to please enclose an SASE. It makes the job much easier.

As we have often mentioned, it's usually easier and cheaper to just enclose a dollar bill (green stamp) with your QSL when a direct airmail reply is required than to go through the hassle of buying IRCs or foreign mint stamps. We also mentioned that there were situations when it was best not to enclose money with a QSL going overseas. A letter from Mansur AP2MQ brings up a case in point. Incoming mail is often checked by the Pakistani postal authorities, and since the importation of foreign currency is illegal in Pakistan, this often leads to embarrassing circumstances for the amateur to whom such mail is addressed. It is always best to follow the QSL instructions given by the DX station. In the future, do not send green stamps to Pakistan.

There is a report that the number of complaints to the FCC concerning the Russian "woodpecker" have risen sharply. It is sometimes a bit frustrating to report such interference and realize that the person on the other end has never heard of the "woodpecker." Check last month's column for the telephone number of your closest FCC monitoring station. Keep them advised of the "woodpecker's" activity and someday the "woodpecker" will vanish.

Some claim that if we had reacted immediately two years ago, he would now be only a bad memory.

A couple of months back we mentioned the possibility of a Swedish group operating from the Northern Marianas. The expected callsign was mentioned as being ZAGT. Late word on this operation has been zilch, but if anything new develops, we will certainly pass it along.

Those new Pacific area prefixes still seem to cause much trouble. It was sure easier to remember when KM6 was Midway, KW6 was Wake, etc. To help you learn the new designations, we will list them again:

KH1 Baker, Canton, and Howland
KH2 Guam
KH3 Johnstown
KH4 Midway
KH5 Kingman if K suffix, Palmyra if not
KH6 Hawaii
KH7 Kure
KH8 American Samoa
KH9 Wake
KH0 Northern Marianas

UK8YAH is being worked around 14050 kHz after 1800Z. We mention this as a reminder that Soviet Siberian stations whose suffix begins with a Y are located in Tana Tuva in rare Zone 23.

The Brussels Millennium Award is available to anyone working ten of the OS prefixes on at least two bands. Send log data and three IRCs to Brussels Millennium Award, PB 1000, B-1040, Brussels, Belgium.

Continued on page 172
Introducing —
the new
SCR 4000

FEATURES:
* High-Watt Efficiency
* 2 Low Noise JFET Rcvr, RF Amp Stages w/ Poles of front end filtering for excellent sensitivity & "out of band" rejection
* Double-Balanced Rcvr, Mixer for super dynamic range, i.e., very low IMs, spurious responses, etc.

Shown in optional cabinet!

180 Day Warranty!

the Super Deluxe
450 MHz
FM Repeater!

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*Front Panel Receiver Discriminator & Deviation Meter functions
*Thursten Ultra High Stability Transmitter Crystal Oscillator/Oven Unit for the ultimate in frequency stability over wide temp ranges
*Plus—all of the many other well-known features found in the SCR1000 VHF Repeater.
Spec Comm is proud to announce the brand new SCR4000 UHF FM Repeater! There has been great customer demand for a repeater such as this for many months, and our engineers have put in hundreds of man-hours to develop a unit which incorporates all of the features requested by our customers over the last 2½ years.

The SCR4000 includes completely new transmitter and receiver boards, which were designed from the ground up specifically for this new repeater. The rest of the unit is basically the same as our tried and proven SCR1000 VHF Repeater which has an excellent reputation for performance and reliability throughout the world!

Of course, as with other Spec Comm products, only the latest state-of-the-art designs and the very finest quality components and workmanship are used throughout. Also, you’ll be happy to hear one of the most amazing things about the SCR4000—its price! About ½ that of repeaters sold by “the big two names” in 2-way radio. And their older design units don’t even offer many of the excellent convenient features which are standard on the SCR4000!

The SCR4000 is sold factory direct only, or through authorized Foreign Sales Reps. Since there has been a tremendous demand for the SCR4000, we suggest that you get your order in as soon as possible!

**ID1000 Automatic Base Station CW Identifier**

For Commercial & Amateur Applications

- Automatically IDs your Station (Base or Repeater) per FCC requirements every 5-30 min. (adjustable)
- Meets all FCC requirements for Parts 85, 91, 93, 95, 97 & other applications
- Convenient Front Panel Controls for AC Power, Trigger Mode. (Automatic or Manual)
- COR, Continuous or Disable) Local Monitor Volt.
- Front Panel Status Indicator Lights for AC Power, ID, Local Monitor, Volume
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**New COMMERCIAL MOBILE & BASE TRANSCEIVERS**

Spec Comm “Professional Communications” line

- 136-174 MHz & 220-240 MHz (470 soon)
- 6 channels
- 0.35 uf Rcv
- 8 or 9 Band Crystal Filter
- Beautiful Audio — RX & TX
- Very Reasonable Price

**SCR 4000 Specifications**

- RF Output: 30 Watts typ. VSWR 1.15
- Sensitivity: 0.35 uW/12 dB SINAD typ.
- Selectivity: 6 dB @ ±6.5 kHz
- 100 dB @ ±30 kHz

**Features**

- Full Metering of critical levels (Volts, currents, RF out, RX sig strength, etc.)
- Front Panel Controls for timers & AF levels
- Lighted push-buttons for control
- Set functions & status indicators
- State-of-the-art CMOS—control logic & times—no relay problems
- Built-in AC Supply w/automatic by switchover for emergency power
- Supplied with 0.0005 International Precision Xtal & local mic.
- Built-in CW (10 kHz—up to 100 MHz)
- Built-in CW (10 kHz—Low current draw, 250 bit PROM memory! Adjustable speed, pitch, tone, etc.
- Jams Provided for Remote Control: Auto Patch, DC out, AF input, COR Switch, etc.
- True FM—no RFI. Audio so good, "It sounds like direct!"

**Options**

- Full Autopatch, with or without reverse patch, and “Landline” or Radio Remote Control of the Repeater, (01 Inhibit Available)
- Radio and/or Landline Touch Tone

**New Spectrum Communications**

- Very attractive woodgrain housing

SC 250 25 wt. Mobile unit
- Super Rugged Housing

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The science of measuring antenna performance as part of the design process has come a long way in the last twenty years. A recent visit to the Antenna Specialists test site in northeastern Ohio brought back memories of my past visits to other such sites... and the enormous changes in test equipment and procedures which have come about.

Let me tell you about my visit to Antenna Specialists' test site.

Sherry and I were met at the Cleveland airport by Al Dolgosch K8EUR, who led us out to the test site, over an hour's drive away. There we met Dick Leach WA3HSE/WB8ZAA, Tom Baker KB8MM, and Rick Davis K8DOC, the test site team. The lab was set up in a trailer with a reference dipole nearby. The test antennas were set up on a platform a couple hundred feet away.

This is the trailer with the laboratory equipment for running the antenna field strength tests. The tower to the left is for a ham station in the house to the rear of the trailer. It's nice to have a ham living right there to watch out for the test lab equipment.

Was it only a little over twenty years ago that I visited a top manufacturer of ham antennas and watched them run tests on a long two-meter beam, measuring the signal strength every few degrees and writing down the figures? Today, this is all automatic. Today, they can run tests in a few minutes that used to take days, thus making it possible to design much more effective antennas. When you can make a small change in the antenna design and measure the results of that change quickly, it is relatively simple to explore many more variables for optimum performance.

With modern equipment at a test site, it is possible to measure the vertical and horizontal radiation characteristics of an antenna as well as the frequency response—all in a few minutes.

You're looking at an enormous investment in test equipment. This gear is made just for labs of this nature and allows the automatic testing of the antennas, complete with the graphing system on the right.

This is a small tower right beside the mobile lab. It is designed for mounting the transmitting antenna for the tests. Notice that this antenna can be raised and lowered to get the optimum vertical pattern of radiation.

Here Tom is showing the reference antenna which he set up by the receiving platform. This is a simple reference dipole.
The tests this day were going to be run on the Antenna Specialists 44-element beam.

This is the mechanism which is used to hold up the antenna to be tested and to turn it in time with the graph in the lab. The tilting gears allow the antenna to be brought down for mounting or changes. The whole mechanism is on the track and can be moved toward or away from the lab.

That’s Tom on the left in back, Al on the right in back, Rick on the left in front, and Dick on the right in front.

The test platform is being rotated so that the other two 11-element yagi antennas can be mounted on the boom. The rotating is all done remotely from the trailer.

Al Dolgosh K8EUR, who organized everything for us.

Dick, Al, and Tom get the beam onto the boom and tightened in place for the tests.

Here’s the beam all set up and raring to go, about 300 feet from the source site.

Dick runs the antenna array through a complete rotation, watching the pen on the chart as it traces the pattern of the beam.

Here you see the finished pattern of the array. How about all that gain! And you surely can null out the interference with that incredible front-to-back ratio.

Over to the right of the test platform I found these tracks. They are for rotating cars to measure the radiation patterns of mobile antennas mounted on different parts of different cars. They drive the

This is the pattern drawn by the chart recorder for the 44-element array on 146 MHz with the comparison from a reference dipole (dotted line).
This is the same array, but measured at 148 MHz. Not a lot of difference—certainly none that you would ever notice in use.

After the test, Al had the 44-element array boxed up and shipped to the 73 lab. It took longer than we figured to get it airborne.

One more run was made with the array on 144 MHz to make sure that it was capable of working over the entire 2m band. It takes a lot of careful design to make a high-gain array such as this work over a four-megahertz bandwidth with as little loss as this one shows.

due to some serious delays in getting a promised tower. The antenna puts out one whale of a signal, as you can see from the pattern on the graph.

---

ROBOT'S MODEL 400 CONVERTER MAKES SSTV OPERATING EASY!

Contacts are established by voice communications.

SSTV is voice alternated with video operation.

Your SSTV system applies the SSTV audio signal to the transmitter microphone jack in place of the voice signal from your microphone.

Operation requires no more than the ability to focus a camera and adjust a TV set.

Any home TV set can be used for a display monitor without modification. The Model 400 connects to your TV set's antenna terminals by means of the RF adaptor kit.

In fact, SSTV is so easy, it's the first ham radio activity that permits the whole family to be involved.

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SSTV EQUIPMENT

<table>
<thead>
<tr>
<th>Product</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 400 Scan Converter</td>
<td>$795</td>
</tr>
<tr>
<td>RCA TC100D CCTV Camera</td>
<td>$280</td>
</tr>
<tr>
<td>500 line resolution; 10,000: 1 ALC, ext. adj; Beam, Target, Focus, vidicon position;</td>
<td></td>
</tr>
<tr>
<td>Weight: 3 lbs., 10 oz. Comes with 18mm lens. 2½&quot; H x 4½&quot; W x 9½&quot; D.</td>
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<tr>
<td>Shipping weight: 7 lbs.</td>
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<tr>
<td>RF Modulator Kit</td>
<td>$25</td>
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<tr>
<td>P.C. board, assembled and tested, for converting video to RF for input to TV receiver antenna terminals (Channel 2 or 3), with tuning tool. Requires +5V d.c., power supply.</td>
<td></td>
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<tr>
<td>20 ft. coax video cable with BNC connectors</td>
<td>$15</td>
</tr>
<tr>
<td>UHF Plus to BNC jack adaptor</td>
<td>$2.08</td>
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</tbody>
</table>
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LUNAR'S 28-432 LOW NOISE FIGURE RECEIVING PREAMPLIFIERS

These ultra-performance "ANGLELINEAR" receiving preamplifiers are suitable to the most demanding needs where low noise figure is important. Amateur Radio, Commercial, NASA & Military users have lauded their superior performance. Uses include all types of weak signal work such as EME, Tropo & Ionospheric Scatter, Satellite Communications, Radio Astronomy, Meteor Scatter, etc.

Construction of highest quality: small physical size, gold nickelated conductive chafing film encases for maximum shielding, RFI filtering of DC line yields -50 dB at 30 MHz and >=70 dB. 1-10 GHz attenuation, PC Boards are double sided plated holes to ensure maximum performance. All amplifiers are aligned on automatic noise figure measuring equipment, with traceability to standard Hot-Cold noise test system.

**MODEL**
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- PAI 28
- PA 50
- PAI 50
- PA 144
- PAI 144
- PA 220
- PAI 220
- PA 432-2
- PAI 432-2
- PAE 432-5

**NOISE FIGURE**
- 1.1 dB
- 1.5 dB
- 1.3 dB
- 1.6 dB
- 1.5 dB
- 1.9 dB
- 2.0 dB
- 2.5 dB
- 1.6 dB
- 3.0 dB
- 1.0 dB

**GAIN**
- 15 dB
- 14 dB
- 12 dB
- 11 dB
- 11 dB
- 10 dB
- 11 dB
- 10 dB
- 14 dB
- 13 dB
- 16 dB

**3 dB BW**
- 1.3 MHz
- 1.3 MHz
- 2.5 MHz
- 2.5 MHz
- 2.5 MHz
- 2.5 MHz
- 6 MHz
- 6 MHz
- 150 MHz
- 50 MHz
- 180 MHz

**1 dB COMP.**
- +1 dBm
- +1 dBm
- +1 dBm
- +1 dBm
- +1 dBm
- +1 dBm
- +1 dBm
- +1 dBm
- -20 dBm
- -20 dBm
- -20 dBm

**1c @ 12VDC**
- 10 mA
- 10 mA
- 10 mA
- 10 mA
- 10 mA
- 10 mA
- 10 mA
- 10 mA
- 10 mA
- 10 mA
- 10 mA

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Brake holds up to 2000 kg/cm (175C lbs./inch) torque.

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Handles up to 10 sq. ft. antennas and to 500 lbs., balanced weight.
8 conductor cable.

**ART 8000**
Handles extra heavy duty azimuth rotator for the most demanding installations. 10 conductor cable. The King Kong of rotors. Loads in excess of 1 ton.

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Secrets of Guyed Towers
— put 'em up and keep 'em there

Trade real estate for security.

Who among us can truthfully say that on those long winter days we haven't spent a moment or two thinking how great it would be to have a five-element, 40-meter beam in the backyard, fed with 2 kW, and a hundred feet above ground? Dreams? Well, maybe. But it's sure that whatever your idea of the "ultimate" antenna array, it's got to be held up by something.

Since the best antenna farm starts with the support equipment, let's look at the best antenna support: the guyed tower. A tower is like a chain, in that it is only as strong as the weakest link. Self-supporting towers are linked to Mother Earth at one point—the base. Guyed towers, on the other hand, have four support points over which to spread the load—three anchors and the tower base. The penalty for this added strength is the larger chunk of real estate required to accommodate the guy-anchor supports.

In planning to erect a tower, there are some decisions and compromises to be made. One must be realistic about what will adorn the top of the tower and the worst case of wind loading that can be anticipated. The antenna load must be added to the wind loading to determine the total load environment in which the tower will be operating. Most antenna manufacturers publish load figures as part of their advertising, or will furnish data on request. The same goes for tower makers, and they also have data about

This is a commercial CATV tower. The dish at the left is a microwave receiving antenna. Mounted below it is a "star mount" anti-torque guy wire/frame system. The tower height is 500 feet.
wind and ice conditions throughout the country to help in figuring the operating load.

As a rule of thumb, anchors should be placed out from the tower base a distance of between one-half and two-thirds the tower height. For a hundred-foot tower, this means the distance from base to each anchor will be from fifty to seventy-five feet. Since this distance determines the angle of the guys at the tower, it represents a compromise between the ideal one-foot-up for one-foot-out, or guy angle of forty five degrees, and some even sharper guy angle which conserves real estate. These considerations outline the practical limits of tower height.

Other factors which limit tower height are: surrounding objects like houses and trees, sloping terrain, local building codes, and neighbors. Each should be taken into careful consideration since towers are no less expensive to take down than to put up.

Since the load of a tower is in two parts, it is best to look at each in choosing a brand and model of tower. The side load is the force which is supported by the anchors and guy lines. The vertical load is supported by the tower and base alone. Most towers are triangually shaped, and the wider the spread between the vertical legs and the larger in diameter they are, the greater the vertical load they will hold. Knowing the antenna loading figures and the weather conditions for your area, it is possible to have a tower manufacturer recommend the proper size tower for your needs.

Two last considerations should be figured into the choice of heights. How far will the rig be from the antenna, and what will the cable loss be, compared to the benefit of added height? In addition, who will service the array? It seems that the number of volunteer climbers varies inversely with the height of the work!

Planning the actual construction is the next step in the process. Survey the land for the locations of the base and anchors. Let's say you come up with a layout similar to the one in Fig. 1.

In this “helicopter” view of the project, we see that the anchors are laid out 120 degrees apart and that two of them are upwind of the tower base. This spreads the worst of the wind loading between two anchors.

The type of soil will determine what type of anchor should be used. There are screw-type units which don't need a hole but are screwed into the undisturbed earth. These are okay for smaller systems with light loading and with firm to slightly-rocky soil. The other type is the bell anchor which requires that a hole be dug. The bell-shaped bottom of this type of anchor is attached to a long rod which sticks out of the ground after the anchor is placed in the hole. When the bell is struck with a heavy bar, the anchor will spread out and dig into the sides of the hole. The hole is then backfilled using small rocks and well-tamped dirt. These bell anchors hold a larger load since they are bigger at the bottom and deeper in the ground than the screw type.

The tower base also is chosen after considering the type of soil at the construction site. Since the base has to support only the vertical load, it doesn't have to be very deep. It should be down far enough, however, so that frost will not cause it to shift position. Manufacturers' recommendations should be followed here so that a firm footing is assured.

Finally, make a list of the required tools and gear for the actual job. Try to obtain the services of someone who has done similar work before, and rely on his experience. If no hams are around to fill the bill, try the local power or telephone company. Their construction crews routinely handle projects similar to this, and probably will know where you can obtain the ropes, guy/jacks, strain dynamometers, and climbing equip-
Guy wires and preformed wrap-on grips are shown at the tower end. Note that the bolt acts as an axle for the grip. The height is 375 feet.

The Dill tower base rests on a large flat rock two feet down and buried in small rocks and well-tamped dirt.

A Dill tower in CATV service is pictured here. The tower is 100 feet tall, in 10 foot sections weighing about 60 pounds each. The sections are 11 inches on a side.

Line up enough people to do the job, and don't forget that at least one should be experienced. All climbing tools and small hand tools should be in first-class shape. Hardhats are a must for the ground crew, and no one should be closer than twenty feet to the tower base for any reason other than to attach gear to the ropes going up the tower. The auxiliary leg, which sometimes is used to hold the weight of a tower section as it is placed on already erected sections, should be inspected carefully. The combined weight of the leg and section can do considerable damage and injury if they fall.

When everything needed is on hand, the anchors are dug in, and the necessary personnel have been lined up, it is time to pick a day to complete the job. Weather is the main consideration here since to be safe the entire job should be completed in one day. The Flight Service Center at the local airport is an excellent source of weather information, and their forecasts of wind conditions are especially good.

On the morning of the big day, begin by bolting the first three sections of tower together on the ground. Attach to the top of the assembly three guy wires which have been cut to roughly the correct length. Set the bottom of the assembly next to the tower base (which is in the ground) and lay out the guy wires down the length of the three-section assembly, over the base, and straight out beyond. With one man holding down on the bottom to make it dig into the ground, and three more pulling at the guy wires, have the remaining people lift the top of the tower and raise it over their heads. As they walk toward the base raising the tower above them, the guy wire attendants will steady the tower side-to-side while at the same time helping to pull the tower vertical.

When this move is completed, the tower should be standing on the ground next to the base, stabilized by the guy wires. Next, lift the tower onto the base and install the three bottom bolts. Attach the guy wires to their respective anchors, and, using a spirit level, a plumb bob, or other sighting line, snug up the guys until the tower is exactly vertical. This operation is important since when later sections are installed, the tower will be put into a bind if it is not...
The anchor rod holds three guys using preformed grips. The rod is six feet long and is buried nearly five feet down.

This is a partly installed preformed grip. No tools are needed, and it may be removed for re-tensioning of the guys and easily reapplied.

Guy wires and grip are attached to a tower leg.

The climbing people are now sent aloft, and the auxiliary leg (or stiff-leg), pulleys, and hand ropes are made ready to raise the next tower section. Since it is very hard for a person to get good lifting leverage while leaning back in a line belt, the ground crew should raise each section while the climbing crew steadies it and guides its placement atop the last section erected.

Remember that during this operation those on the ground should not stand near the tower base, or in an area where dropped tools or parts might fall.

Continue adding tower sections and guy wire sets until the tower is complete. Since the last section normally is built to accept an antenna rotator and mast, these items are more easily installed before that section is raised.

Having aligned the tower each time that a set of wires was installed, the complete unit should be pretty close to vertical. By sighting upward along each leg of the tower, any bends will be seen easily and can be removed by adjusting tension on the appropriate guy wire.

Now that the tower is straight, the next step is to equalize the tension on each set of guy wires. A device called a strain dynamometer is used to read tension on a cable. If this is not available, the only recourse is to pull each guy wire slightly out of line and feel the tension by hand. Sighting up each guy wire from anchor toward the tower and judging the sag is another method, but it is not as reliable due to the varying lengths of the lines. The aim is that each guy wire should carry the same strain as every other.

The tower is now complete and ready to accept antennas and downleads. Even though it is ground-mounted and is attached to guy wires and anchors which also are at earth ground potential, it still is wise to electrically ground the tower. Most commercial installations use a six-foot ground rod at each tower leg, driven as close to the base as possible.

This is sufficient to protect the tower, although lightning protection at the shack end of the downleads still should be used. In the event that lights are required, or any source of commercial power is used at the tower, the ground system should be tied into the neutral of the electric line.

When very large arrays are rotated on a tower, the torque will cause twisting of the structure. While this does not affect the life of the tower, it does affect the aiming accuracy of VHF directional arrays during windy conditions. The cure is to install another guy system by bolting to the tower a length of pipe or angle iron about six feet long, as per Fig. 2.
Since this guy system carries only the twisting load applied to the tower, it need not be as heavily constructed as the main system. Screw-type anchors and number ten steel fence wire are more than adequate, along with TV-type U-bolts connecting the pipe to the tower legs. With this arrangement mounted about three-fourths of the way up the tower, it should remove most of the twisting action and considerably reduce the whiplash effect on the antenna elements.

There you have it. Guyed towers offer the most stable platform for large arrays and greater heights under the most extreme weather conditions. They also offer confidence in the knowledge that those expensive antennas are mounted up where they operate best and are supported by a system which will offer safe and reliable operating for years to come.

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Author's Note: Since this article was written, KDK has improved their “fix” by adding additional RC filters between the NOR gate and the base of the output transistor.

This article is not for the timid soul. It takes considerable courage to take a brand new rig and cut the circuit foil and drill holes in the PC boards. This statement is not intended to scare you off, but to forewarn you. The results, however, are well worth the effort.

A prerequisite for outlining any solution is to first define the problem. The basic complaint with the original KDK PL is that it may or may not activate a given repeater, and when it does, there are complaints of the PL being audible and clipping with modulation.

Investigation of the existing PL circuit reveals a CMOS 2-input NOR gate chip (MC14001) connected as a square-wave oscillator as shown in Fig. 1. They couldn’t have planned it worse. The fast rise and fall time of the square wave produces many harmonics of the 100-Hz fundamental at 200, 300, etc., accounting for the audible complaint.

To make matters worse, the square wave is differentiated by the .01-uF coupling capacitor to the speech amplifier, producing narrow pulses from each edge of the square wave (pulse modulation, yet). This has to be a terrible shock to the preamp and is probably the reason why the repeater does not recognize the PL. Attempts to activate the repeater by increasing the PL level further aggravate the audible problem.

The official “fix” available as a modification kit from the US distributor of the KDK units leaves much to be desired, since it simply adds a 0.1-uF shunt capacitor from the base of Q3 to ground to drastically slow up the rise and fall times, making it a triangular wave.

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The ultimate solution, of course, is to change the PL signal to a sine wave. This is where the timid souls can leave to purchase their ME-3. The hardy and courageous individuals, however, should stay while we discuss how to linearize the existing CMOS digital gate for analog operation to generate a sine wave.

Any digital logic-inverting element (NAND or NOR gate or inverter) produces a high-level output with a low-level input and vice versa. The input switching threshold for a CMOS logic element is approximately 45% of the supply voltage (9 volts in the KDK). When the input signal passes through the threshold (4 volts), the output switches. It is at this switching level that the gate is operating in the linear region. A feedback resistor connected from output back to input, as shown in Fig. 2, linearizes the gate since a high output fed back to the input would tend to drive the output low, which when fed back to the input tends to drive the output high, which ... etc. The gate finally compromises itself with both input and output floating at the 4-volt switching threshold level. This circuit configuration lends itself very well for a Wein bridge sine-wave oscillator (sometimes it's...
called a twin-T) by simply dividing the feedback resistor into two parts and adding the other necessary RC constants as shown in Fig. 3. The basic frequency of oscillation is given as $F = 1/(2\pi R C)$, but this is not exact and may vary considerably. A word of caution here: The capacitors must be a good quality ceramic or mica with good temperature stability, and the resistors must be 100 part-per-million temperature-coefficient units. One such circuit constructed with miniature plastic capacitors changed frequency by 50% when sprayed with Quick Freeze circuit cooler.

The final circuit design and KDK modifications are shown in Fig. 4. Note that the second gate is no longer used. The IC pad of pin 11 on the circuit board is still utilized, however, so the legs of the chip (pins 11, 12, and 13) were cut and a jumper added to connect circuit board pad 10 to 11 to complete the path to the output transistor. The legend for the various circuit modifications appears below the schematic. The 0.15-uf capacitor across the 287-Ohm resistor and 1k pot was required to eliminate a secondary high-frequency oscillation. The value of this capacitor, although not critical, will have some effect on frequency.

The major problem encountered was getting the PS board out far enough to work on it. There are a few wires from the PS board which are routed under the PLL board. This problem is solved by removing the four PLL mounting screws and tilting the board forward towards the front panel. A piece of masking tape will hold this board in the upright position.

The second problem is caused by the choke mounted on the rear plate and the ground wire from the power input connector. These leads are very short and make it impossible to move the PS board. It may be possible to unsolder the choke leads; however, I chose to unmount the choke, leaving it attached to the board. This is accomplished by gently removing the rear identification plate by lifting with a small screwdriver (sticky back) to expose the choke-mounting screws. The ground wire can easily be unsoldered at the power input connector.

The transceiver is then positioned on its side and the PS board separated as far as possible from the chassis with all other wires still connected. Not an ideal work situation, but tolerable.

The following is a complete step-by-step procedure for making the modification. Refer to the PS board layout diagram on page 12 of the KDK manual to locate the various points referenced.

1. Unsolder the two shielded audio cables from the PS board, cut them to a length sufficient for splicing, and cover the splices with shrink tubing. This disconnects the PL output and completes the microphone cable routing to the SEL-CAL connector and speech amplifier.

2. Cut the legs of pins 11, 12, and 13 on IC2.

3. Solder a jumper across pads 10 and 11 on rear of board.


5. Cut circuit foil between P2 and R18 potentiometer.

6. Replace R16 470k resistor with a 16.9k resistor.

7. Replace R17 33k resistor with a 14.3k resistor.

8. Replace R18 50k pot with a 5k pot.


11. Replace C11 .01-uf capacitor with a .22-uf capacitor.

12. Replace the combination of R20 4.7k and R21 470-Ohm resistors with a single 5k miniature potentiometer (about the size of a transistor). Mount this pot with one end in the R21 ground pad, the other end in the R20 pad which connects to the emitter of Q3, and the rotor in either of the two pads at the junction of R20, R21, and C11.

13. Drill a hole through the ground plane at the edge of the PC board in line with R16 and next to the nicad battery. Mount the .33-uf capacitor from the junction of R18 pot and R16 resistor to the ground-plane hole.

14. Position the 1k pot next to the nicad battery such that the rotor and one end are over the ground plane and the other end is over the open area (no ground plane). Mark the points, drill the holes, and mount the pot. Make sure the speaker clears the pot when the bottom cover is mounted.

15. Drill two more holes in the open area for mounting the 287-Ohm resistor next to the 1k pot. Mount the resistor in the holes and bend one lead over and solder it to the open pot lead.

16. Drill another hole in the open area next to the 287-Ohm resistor hole and also another hole through the ground plane for mounting the .15-uf bypass capacitor across the 187-Ohm 1k pot combination.

17. Connect a wire from...
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...and the junction of the .15-uF bypass and the 287-Ohm resistor to P2.

18. Connect a jumper wire from P1 to the pin 9 end of R16.

19. Connect a wire from "PL OUT" (open end of C11) to P2 "MOD IN" on the PLL board (terminal with green wire).

Adjustment is best accomplished with a scope and counter; however, it may be possible to "ballpark" the frequency adjustment by comparing it to a strong signal with PL on the repeater input with an auxiliary receiver. The 1k oscillation control should be adjusted for the maximum resistance possible that will sustain oscillation without distortion of the sine wave. A rough setting of the level control can be made by measuring the audio voltage level with a voltmeter at the "MOD IN" terminal under normal modulation and adjusting the PL "LEVEL" for 10% of this value. Final tweaking may require on-the-air tests with assistance from another operator.

This modification has been in use for several months with excellent results. Temperature stability is very good (±0.2 Hz) when sprayed with Quick Freeze circuit cooler (~50° F.) and heated with a heat gun. Both temperatures were well beyond my operating thresholds. Final results — no more clipping or complaints of audible PL with 100% solid QSOs.

Next project — slowing down the scanning rate so more than two words can be heard when continuously scanning the memory channels for familiar voices or calls. Maybe we can start a KDK "mod squad."
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Until you know a little bit about the subject, the antenna portion of a microwave project seems quite simple. The most difficult aspect is building or finding a dish—or so it seems! No matter how you acquire the dish, however, you will discover that your problems have just begun.

Next you must find a suitable feed, and if this search leads you into the literature, you will discover that that subject can be quite complex indeed.

In the final analysis, one of the simplest and most effective feeds in the low-frequency end of the microwave region is the horn feed. Rectangular horn feeds are superior, in the sense that the illumination pattern can be controlled with some precision. Their main drawback is that they are mechanically unwieldy.

Despite their reduced illumination efficiency, cylindrical feed horns are quite popular in that they can be constructed of metal pipe, tubing, or cans. A number of articles have appeared in the amateur literature describing the construction of horn-feed systems. They are quite non-critical in use—particularly in receiving applications.

Horn Mounting

Once you have obtained a dish and constructed a horn, you inevitably encounter the real problem—how to get the darn thing mounted! I have been working on antennas in the low microwave region (S-band) for the past two years now, in conjunction with a series of projects involving the GOES weather satellites. These satellites transmit pictures on a frequency of 1691 MHz, and thus I was forced to deal with the feed-horn mounting problem. The answer to it has proved to be quite simple and effective and should be applicable to similar situations involving operations on 1296, 2304, and 3300 MHz.

The key point in any mounting scheme is to avoid obscuring the open end of the horn with metal in any form. Any metal will serve to shield out a certain portion of the received rf, all of which will be focused into the mouth of the horn in a well-designed system. The two most common mounting schemes are shown in Fig. 1. One of

Photo A. This is a feed-horn assembly for use at the 1.7-GHz satellite frequency.
these is excellent but largely impractical, while the second is very inelegant and somewhat inefficient.

The first involves the use of either three or four spider-arm assemblies running from the horn to the periphery of the dish. The arms do not impede the rf front reflected from the dish surface into the horn, and they can be made of metal for, although they do intercept the wave front as it arrives at the dish, their area is quite small compared to the area of a typical dish; the gain reduction is not measurable.

This does, however, highlight why obstructions to the horn are so critical. All the rf energy reflected by the dish surface must pass into the relatively small opening represented by the mouth of the horn. Any metal obstruction here can cancel out a good percentage of the gain.

The primary disadvantage of the spider-arm system is the difficulty in fabricating it. One must have considerable mechanical ingenuity to devise fastenings to secure the arms to the horn and to the edge of the dish. The arms must be of equal length, provide rigid support, and must hold the horn at the proper focal length for the dish in use while also permitting rotation of the horn to match polarization with the transmitted signal. Since the precise position of a particular feed horn relative to a particular dish at a given frequency can be determined only approximately at first, one is in for a considerable period of tinkering to get everything right.

The second approach is to use a support rod at the center of the dish—usually fabricated of plumbing tubing and fittings—with an offset to accommodate the horn radius, as shown in Fig. 1(b). The horn is clamped to the tubing using large hose clamps or some other system. It is an easy system to adjust, since the horn can be moved up or down the tube for focusing prior to being clamped in place. The major disadvantage is that the tube does absorb rf coming in from the dish surface. Also, the system looks terrible!

Figs. 2 and 3 show a much better system. The horn is mounted to a square of unclad G-10 board material (no copper) using four small metal brackets outside of the horn. The G-10 square is just slightly larger than the outside diameter of the horn, and the horn brackets attach within the corner areas that extend beyond the edge of the horn.

Other materials may be used for the mounting square if they pass a simple test. Simply hold a sheet of the material across the mouth of the horn and observe the indicated signal strength on the receiver. If there is no noticeable drop in the signal level, you are getting minimal attenuation and the material may be used. Most plastics appear to work fine, but be sure to check them out anyway, as the composition of a few plastics or their additives can sometimes show unexpected rf absorption at some frequencies in the microwave region.

The mounting square is attached to a mast of PVC plumbing tubing (don't use metal!) that holds the horn at the proper focal point. The mast is mounted to the center of the dish by sliding it over a stub of metal pipe secured to the center of the dish with a pair of pipe-mounting flanges. The PVC mast is slit where it slides over the pipe, and the entire mast assembly can be moved both up and down the pipe to optimize focus and rotated to match polarization. Once the proper orientation is achieved, the mast is locked into place with one or more hose clamps.

If the mast is quite long or the feed horn is heavy, the assembly can be guyed with dacron lines run from the corners of the G-10 mounting plate to screw-eye and turnbuckle assemblies attached to the rim of the dish.

**Construction**

The diagrams in Figs. 2 and 3 provide most of the information required, but a few points are worth discussing. First, the mounting plate must be attached to the PVC mast using nylon mounting brackets and hardware. If you use metal here, you will eliminate most of the advantages of this particular mounting scheme. The brackets and hardware can be obtained from hobby shops that carry supplies for radio-controlled airplanes.

The PVC tubing is cut about four inches shorter than the focal length of the dish. This permits the focal point to fall about 2 inches (5 cm) into the horn while...
still permitting about the same distance for downward movement of the assembly if required for focusing. The following assembly sequence should be followed:

1. Mount the nylon mounting brackets to the end of the PVC mast. Doing this first lets you get pliers or fingers down inside the mast to tighten the hardware!

2. The mounted brackets then can be used as a guide for marking the G-10 plate which can be drilled then and mounted to the end of the mast—again, use nylon hardware!

3. The brackets (aluminum, brass, or other metal is OK) then may be mounted to the horn and the horn attached to the plate. In mounting the horn brackets, be sure to use pan-head screws with the heads inside the horn and the nuts outside. This minimizes metal protrusions into the horn which could distort the wavefronts in the waveguide horn assembly.

4. The entire assembly is placed over the pipe stub, its position optimized, and then everything is tightened up with hose clamps.

If guying is required, it can be installed now. In the case of an antenna used for support of a satellite ground station, the guying system can perform a fine-tuning function in the alignment department. Large dishes (8-10 feet or larger) are quite critical in orientation, and it often is possible first to horse the dish into the best possible orientation, and then to use the guy adjustments to shift the horn position laterally as required to peak the signal level. If large displacements of the horn are required (more than an inch or so), it means that the dish was not aligned properly. The horn should be centered (guy lines of precisely equal length) and the alignment of the dish altered to bring up the signal. You then can fine-tune the alignment with the guy cables.

Since the pipe attached to the dish can provide some rigidity to the PVC mast, it is useful to know how long the pipe can be without absorbing significant rf. This is dependent upon dish focal length. Generally, if the pipe is about one-third of the focal length, it will not affect the signal level. This is because the horn obscures the center of the dish and the converging wavefront from other areas of the dish will not intersect the pipe as it would if the pipe were much longer.

If desired, you can run a bead of silicone seal around the edge of the dish where it attaches to the G-10 plate, to provide some weather-sealing. This is usually most important with antennas used for point-to-point ground service, as the horn is not likely to pick up water or snow when pointed up in the air at a satellite! In the latter case, it is not even necessary that the plate cover the entire opening to the horn. I have built several feed assemblies where the plate was simply a wide strip across the opening of the horn. In making an inspection of one GOES satellite installation, however, I discovered a nice wasps' nest in the feed horn! I suppose that if a bird decided to use the horn for its spring nesting ritual, it might result in some puzzling signal-level anomalies! It probably is best to seal up the horn—if only to exclude the local wildlife!

This mounting scheme has been used in a number of GOES satellite ground station installations, with antennas ranging from 3 to 10 feet in diameter, with excellent results in all cases. Cylindrical feed horns are certainly simple to construct, and they provide fine results. I think you will find that this mounting system will make them just as easy to use!
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Antenna Tuning Joy Revisited
— remember the Tektronix 190B?

Amplifying K5QY.

In the May, 1978, issue of 73 Magazine there was an excellent article by Dick Sander K5QY entitled "Make Antenna Tuning A Joy." The article described the modification of a Tektronix 190B constant-amplitude sine wave generator. It is my intention in this follow-up article to add to Dick's comments and ideas and give a few basic details that he left out on the generator itself.

I can testify to the long-term worth of his unit, because I did the same modification 2 years ago. It has proven to be worth at least a hundred times the time spent on it. When I say I did the same modification, like any ham, I have to add an important word—almost. It is additional information and some of the ways I did things as a VHF ham that I believe will be of additional value to readers.

To keep this as short and to the point as possible, I'll first cover the additional specifications you may find of interest. We both started off with the 190B. This unit will run on 105 to 125, or 210 to 250 V ac, with a very slight wiring change similar to Heath-kit equipment (change jumpers, etc.). Further, it runs fine on 50 to 400 Hz. The latter part may not seem important, but I have found that I can use part of an old 6 meter AM mobile power pack unit that was designed to put out around 250 V dc. If you take out or disconnect the dc portion (mine was shot and burned up, anyway), you get, from the ac portion, about 230 V ac and 360 Hz, in my case. The 190B requires about 100 W on 120 V ac, 60 Hz, but the power pack only warms to the touch after about 30 minutes of use. Just a thought for those of you who really must be portable and dc only.

The gear is quite compact and portable compared to some of the older tube-type bench or rack-mounted equipment. It measures only 9-3/4" wide, 13½" high, and 11" deep. Its all-aluminum alloy construction gives it a total weight of only 24 pounds, so it is no surplus boat anchor.

The frequency indication specification for the dial readout is quite good at 2%. This is nice, even if you use the generator only as a generator, but invaluable if you modify it, as Dick and I did, into an antenna bridge.

The output amplitude is continuously variable over a 40-mV to 10-V peak-to-peak range. Looking into a 50-Ohm load, you have 5 volts peak (times .707 for rms volts). Square that result over a 50-Ohm load, and indeed you have an output of about 250 mW.

This brings out the only point I question in Dick's article. I am a QRP power nut and a VHF/UHF ham. I often have worked another ham 63 miles away with only 16.5 mW on 6 meter CW. That's no great feat, but it all started by accident and has continued using the same setup: my transmitter coupled to a light bulb dummy load in the basement! All I am driving at is, while this may be the handiest device you have ever built for antenna work, remember: You are radiating! Use the minimum on-air time you need for antenna pruning and try to pick non-peak hours in your locale—especially on VHF.

The original output meter read the output peak-to-peak volts at that funny-looking connector your unit will come with and is accurate only to ± 10% of full scale. This is really no problem in the modified version, as the absolute value of forward power (voltage) is not important as long as it will drive the swr meter to full scale in the forward mode. Dick mentions changing to a plain voltmeter with a different scale from the original and using a chart supplied by him in the article to calculate vswr. I went one better, I think, and it is by total accident that we were working toward the same general ends at nearly the same time. I found the meter for the Heath VHF wattmeter (HW-2102) to be a great replacement in the $15 range, as it has a direct reading scale for swr. You can ignore the power out-
...put scales! I used the bridge basically out of the Heath wattmeter, but have constructed Dick’s, too, and either seems to be fine for my VHF work. If you are HF inclined, stay with Dick’s resistive version. The Heath meter has a white-on-black scale that is both very attractive and easy to read out in the bright sunlight.

If you contemplate operating at the stock upper limit of 50 MHz, for 6 meter work, by all means use an N-type (50-Ohm) panel-mount female connector to replace the weird little output connector on the front panel of the 190B. Dick used a UHF-type connector here, which is fine at HF frequencies. Unfortunately, due to the huge demand created by the CB market, some UHF connectors are showing up that are UHF in style and name only. Some are OK at CB frequencies and useless at 50 MHz and up. Some would be junk at dc! Why have your worst swr “lump” built right into your test equipment? The extra cost for the N connector is worth it.

If you are unfortunate enough to get the attenuator that plugs into that same weird little connector on the panel, do not get any ideas about using it for any kind of accurate readings on antennas or any other load with reactance. As you do the band-wandering trick to prune an antenna, as Dick describes, the output impedance of the attenuator wanders all over, and right on the specification sheet it states the following information: Output amplitude is constant ±5% from 30 to 50 MHz, if the load capacitance does not exceed 10 pF on the 10-V range. This can be a fixed C, or the antenna reactance! In the 1-V-to-5-V range, it improves by allowing 50 pF for the same ±5%. Further, it is stated that all changes will be related to, and dependent on, the load capacitance, the length of cables (more on that later), the voltage range in use, and the frequency.

These facts are primarily for those of you who may want to use the generator as a attenuator. Dick comes right off the generator at the strange little plug you replace with the N fitting, and so did I. Speaking of the attenuator, and to further induce you to buy a 190B, consider the following:

It’s an old flea-market sales trick, but the truth is that you don’t want the attenuator unless you intend to outboard the bridge in a box, and swap back and forth between it and the attenuator as the attenuator replacement accessory. So, why let someone run the price up on you by saying he is offering more, or something the unit won’t work without? On the other hand, if he doesn’t have an attenuator to sell with it, you may succeed in driving down the price by screaming that you must have one!

Fair? It all depends which side of the fleamarket table you are standing on at the time, and I have spent 18 years on one side or the other. “Caveat emptor,” no doubt, has a seller’s corollary, too, and rightly so. The only good deal is where both parties feel they have a bargain—so bargain away!

Before we get away from the specifications on the stock 190B, there is one more thing you should know. If you are working with wideband or multiband antennas (log periodics, discones, trap dipoles or verticals, etc.), you should know that there is no specification made for the harmonic content of the 190B! I heard of a case where it was typically less than 5%, but that was a new unit in perfect shape.

If you are going to use your unit seriously, then it would pay to at least spot check it at your points of interest. Even a simple check on a shortwave/allband-type receiver will give you a good idea of where the unit is at. For instance, set the generator up on 7 MHz into a 50-Ohm resistor, with enough leads to radiate a little, and drive the generator up to where the 5-meter reads 56 to 59 depending on the linearity of your particular receiver’s agc system. Tuning the receiver to 14, 21, 28 MHz, etc., should produce readings in the range of 51 or at least as low as the meter reads, with the receiver input terminals shorted by a 50-Ohm resistor (or proper load to match receiver input impedance).

As for the unit you are looking for, I assume you are not rich enough to see Tektronix for a new one (and I doubt if they still even build it), and the used gear catalog prices are still quite high and are aimed at the small business user. This leaves the hamfests/flea markets. I mention this because the unit is easy to open up so you can look at the condition inside. You can plan on cleaning up a little dirt, but beware of anything that resembles saltwater corrosion (white, chalky, lumpy), extreme rust, or missing, bent, or battered shields or covers. You want a piece of test equipment, not junk.

I got a real bargain on mine—fully working and intact, for $20, from a man who knew not what he had! I sprayed over the slightly-scratched case with a forest green by Rust-o-leum, which is great for equipment you want never to rust or corrode. Besides, this is a nice match for the Heath meter, which has a black face and green plastic bezel, and it contrasted nicely with the brushed-aluminum panel.

My next modification will obviously be to get higher frequency operation out of this wonder of wonders. Even if I get a sudden interest in the low bands and get my Advanced license, I don’t really need the .35- to .75- and .75- to 1.7-MHz bands. The 21- to 50-MHz band on my unit does make it usable on 6 meters, but a bit of coil adjustment may be required on some you might purchase. If you have to juggle, my suggestion is to move the whole band up by 1 MHz and recheck the tracking. Use the allband receiver again to align the tracking by adjusting C on the high end and L on the low end until the dial tracking is as close as possible.

That wraps up my way of attacking the 190B and achieving the joy Dick mentioned in his title. I got my first exposure to this instrument at work and know it is a good one. I kick myself for not seeing the full LC impedance bridge Dick goes on to mention, but you can bet I am working on trying it soon. If anyone has any ideas on putting the higher bands into this gear (at least 2 meters), please write it up or contact me.

I promised to cover more on the capacitance effects, cables, etc., and I left it for last because it really does not pertain only to the 190B. Dick touched briefly on using the modified generator to check old coaxial cable. A lot of bridge, swr, and loading problems can be eliminated or minimized by using the same general techniques. By using a new piece of RG-8 foam, commercial grade and quality (not the CB-grade junk), and cutting it to ½ wave-length or even 1 wave-
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<table>
<thead>
<tr>
<th>MODEL</th>
<th>NOISE FIGURE</th>
<th>GAIN</th>
<th>3 dB BW</th>
<th>1 dB COMP.</th>
<th>1c (@ 12VDC)</th>
<th>PRICE</th>
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<tr>
<td>PA 28</td>
<td>1.1 dB</td>
<td>15 dB</td>
<td>1.3 MHz</td>
<td>+1 dBm</td>
<td>10 mA</td>
<td>$35.95</td>
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<tr>
<td>PAI 28</td>
<td>1.5 dB</td>
<td>14 dB</td>
<td>1.3 MHz</td>
<td>+1 dBm</td>
<td>10 mA</td>
<td>$49.95</td>
</tr>
<tr>
<td>PA 50</td>
<td>1.3 dB</td>
<td>12 dB</td>
<td>2.5 MHz</td>
<td>+1 dBm</td>
<td>10 mA</td>
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<td>1.6 dB</td>
<td>11 dB</td>
<td>2.5 MHz</td>
<td>+1 dBm</td>
<td>10 mA</td>
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<tr>
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<td>+1 dBm</td>
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<td>$35.95</td>
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<tr>
<td>PAI 144</td>
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<td>10 dB</td>
<td>6 MHz</td>
<td>+1 dBm</td>
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<td>$49.95</td>
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<tr>
<td>PA 220</td>
<td>2.0 dB</td>
<td>14 dB</td>
<td>6 MHz</td>
<td>+1 dBm</td>
<td>10 mA</td>
<td>$41.95</td>
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<tr>
<td>PAI 220</td>
<td>2.5 dB</td>
<td>13 dB</td>
<td>150 MHz</td>
<td>~20 dBm</td>
<td>6 mA</td>
<td>$49.95</td>
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<td>PA 432-2</td>
<td>1.6 dB</td>
<td>16 dB</td>
<td>50 MHz</td>
<td>~20 dBm</td>
<td>6 mA</td>
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<td>PAF 432-2</td>
<td>3.0 dB</td>
<td></td>
<td>180 MHz</td>
<td>~20 dBm</td>
<td>4 mA</td>
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Modern Solid-State Equipment Design: A Better Way
— sorry, tube fans

Most books and articles on solid-state design for rf stress the parallels between transistor/FET circuitry and tube circuitry. These parallels are accurate enough as far as they go, but they also are misleading. To the average reader, they imply that equipment design using transistors or FETs should parallel tube equipment. In many ways, especially for the amateur, this inference is wrong and accounts often for why we never get some piece of equipment to work.

In this article, I want to compare old-style tube techniques with some tried and proven principles for transistors. These principles are not for the engineer or the commercial manufacturer; they are for the home builder. They call for some changes in the way we think about building up a fairly complex piece of rf equipment. In this review of the similarities and differences between vacuum tubes and transistors, all of the ideas I give will be commonplace. But when set next to each other, they suggest new ways of doing things for the ham constructor.

Changing an old way of thinking is probably the hardest thing for any of us to do, but if you think through these ideas, and then take a look at some of the projects that have appealed to you (transmitters, vfos, receivers, and the like), you will be in a position to make the change. No longer need you believe that you can never get a bunch of transistors to do what the original author got them to do. By some simple redesign work, you can have confidence that you can do it, too—and maybe do it better.

Designing with Vacuum Tubes

The design of rf equipment using vacuum tubes has changed little in the past forty years. Perhaps the major change—outside of improved tube construction and improved individual circuits—has been the introduction into amateur gear of the heterodyne vfo system of frequency control. The 5- to 5.5-MHz vfo heterodyned to the ham band of choice has eliminated most of the prob-
lems inherent in the bandswitching vfo or the vfo multiplied to frequency. The instability of vfos required to cover a ten-to-one frequency spread, as well as instabilities introduced by switching tuned circuits, held back single sideband and serious communication on VHF frequencies for many years. Likewise, when we used frequency multipliers, we also multiplied any flaws in the vfo.

Other than this, equipment design has changed little. To illustrate this fact, let us look at Fig. 1, a simplified diagram of a straightforward receiver. In the diagram, I have shown most of the switching circuits, but omitted other circuit details. In both amateur gear and commercially-made gear, this basic system design has been standard. With vacuum tubes, there are good reasons for this standardization.

Notice that most of the switching involves the replacement of one frequency-determining circuit for another. To switch bands requires the exchange of several tuned circuits, as well as a change of crystals. Here are some of the basic reasons for working out the system design in this way:

1. The system permits the least number of tubes, which is desirable because, (a) tubes are large—they take up space; and (b) tubes are heat generators, and this system minimizes heat.
2. Tubes, being high-impedance devices (high especially when compared to the frequency-determining circuits associated with them), usually require little attention to perfect matching, and are, therefore, reliable for a given biasing arrangement over a large frequency spread.
3. Tubes are large compared with tuned circuits and switches (especially at low power levels), thus making it more economical of space and cost to switch tuned circuits.
4. Tubes are inherently expensive; for receivers, five tubes can cost five times as much as one five-position switch section.
5. Tubes, as they come into the hands of either the commercial manufacturer or the building amateur, are reliably similar, varying well within a 20 percent range in characteristics within types.
6. Most modern tubes have input and output capacitances which are small enough to present no design problems in the 3- to 30-MHz range (unlike the old '24 and '27, so popular around 1930).

Fig. 2 shows a simplified block diagram of a relatively recent piece of ham gear. The diagram has been drawn to bring out the similarities between tube and transistorized gear commercially available. Note that the switching arrangement is not materially different from that of Fig. 1. Single solid-state devices are used at each stage, and the frequency-determining circuits are switched with the traditional bandswitching arrangement.

Fig. 3 shows a simplified diagram of a piece of equipment taken from a recent ham publication. Notice that it, too, uses the very same system of switching and design.

Unless one is an engineer or has access to select components, circuit design of this order is difficult to replicate. Among the reasons for the difficulties we face in making a complex circuit work just as some article claims are these:
1. Transistors may vary greatly in characteristics from a design center. This problem is aggravated by the fact that hams generally have access to culls, hobbyist-grade devices, or surplus, any of which may vary by an even greater extent. For this reason, the amateur designer must do his own selection from among the batches of 20-cent transistors he has on hand, and he must be willing to rework bias and drive circuits to make the device work as it did in the original. To expect a complex group of transistors to perform reliably over a wide frequency range under these conditions often strains the imagination and the experiementer's patience.

2. Other materials of the system of circuits may not be available, and the amateur designer substitutes what he has on hand. He may use surplus or junk box coil forms or toroids of dubious ferrite or iron content. What this may do to circuit Q is anyone's guess. Capacitor quality is another overlooked problem, one aggravated by the uncertain history of the short lead parts in the junk box.

3. Those who attempt to reproduce equipment shown in articles and books often lack the test equipment necessary to perform the right measurements so as to find out what in a circuit may not be working correctly. Among our common building practices are these: tapping coils just as specified in the article, rather than determining the actual impedance to be matched; assuming that the bias circuitry of a transistor provides the correct parameters, rather than measuring actual currents drawn; and assuming that proper
Fig. 3. Amateur receiver (simplified block diagram), adapted from the 1974 Handbook. This particular unit was originally built in two pieces: a basic receiver from the CA3028A amp through the af board, and a converter section for all the HF bands. Note the attempt to use high-impedance devices—MOSFETs and JFETs—to minimize problems with switching-tuned circuits. Even so, a long five-section ceramic switch is required. Among the positive design features of this receiver are the provision of avc voltage to the first rf stage, upward conversion to minimize birdies, and switched bfos. Front end compromises would have been further minimized through the use of separate converters for each band.

drive levels are present from stage to stage, rather than measuring rf voltage.

Add up all these conditions and practices, plus perhaps a dozen others peculiar to certain kinds of builders, and it is little wonder that the amateur who tries to build a receiver designed like one in Figs. 2 and 3 has little luck making it work.

Now, it is not reasonable to believe that every ham builder will spend the money it takes to obtain select components or to set up complete test facilities. Nor should we expect that in the near future, circuit reliability will increase to make every wide-range rf system easily repeated. Does this doom the amateur builder to failure? No, not if we change some parts of our design philosophy.

Some Useful Things to Remember about Transistors

Transistors and FETs resemble tubes in these two main ways: First, they may be operated Class A, AB, B, or C (plus some other ways to which experimenters have given new class names); second, any element may serve as the common element, so that we have corresponding common cathode/emitter/source amplifiers, common grid/base/gate amplifiers, and common plate/collector/drain (cathode/emitter/source follower) amplifiers. Knowing this much is important in determining the details of individual circuits. However, transistors also have significant differences from tubes, differences which are very important in the development of a design philosophy for complex pieces of equipment. As we did with vacuum tubes, let us set them out together:

1. Transistors and FETs are very small and take up little space on a chassis or circuit board. About fifty of them might fill the space taken up by one miniature tube and its socket. Principle: Unless we are interested in the greatest degree of microminiaturization, it really does not matter how many transistors we use, so long as each is used well.

2. Transistors and FETs create little heat at low powers, i.e., under a Watt. Principle: No matter how many low power stages we use, heat will probably not be a factor in either the stable operation of a circuit or in the lifetime of the circuit.

3. While MOSFETs are very high input impedance devices, transistors especially, and to some extent JFETs, will have lower impedances which require attention to matching. There are, of course, many more wide-range circuits for FETs than for transistors, which require little attention to matching. Principle: For transistors, at least, matching to the individual device is still best.

4. Transistors, especially in the hobbyist class available to most ham building, will vary in characteristics and require attention to operating levels. Principle: Bias levels for transistors may need to be fiddled with, and may not work consistently across wide frequency excursions.

5. Transistors and most FETs are cheap; to buy them five for a dollar is not uncommon, and even specified types like the popular 40673 or MPF 102 cost under a dollar. Principle: The number of transistors and FETs in low power stages is not likely to make a ham project too costly to build.

6. Compared to other components, such as switches, coils, and capacitors, transistors and FETs are small and inexpensive, and their associated biasing resistors may cost a nickel or less apiece. Principle: It is better to substitute small, inexpensive components for big expensive ones wherever circuit reliability can be maintained or improved.

From these points of comparison and their associated principles, you can see a design philosophy beginning to emerge. Since it is often (though not always) necessary to tweak a circuit up for an individual frequency band, and since the necessary components are cheap (and for other reasons which will become obvious in a few more paragraphs), it is better for the ham to build rf systems of circuits for one band at a time, and then to switch them in and out as needed, rather than to use the tried and true (for tubes but not necessarily for transistors) method of switching frequency-determining components. Not only can this method assure better circuit reliability, but it can also simplify the process of building, provide operational equipment before the entire unit is functional, and save money for the builder.

Some Examples

Let us look at a couple of examples of this design philosophy and see how they work out in practice. First, go back to the receivers of Figs. 1, 2, and 3. Fig. 4 shows how the receiver can be designed using the principles above.

The revised receiver employs converters for each band except 80 meters. This is a scheme used extensively and, with the exception of separate converters, goes as far back as the Drake 2 series of tube-type receivers. The i-f frequency is a matter of choice in accord with the design objectives, and can be a function of up or down conversion. The
main design features to note are these:

1. No device operates at more than one frequency or band, thus allowing for optimization of all parameters. Among these are gain, bandwidth, oscillator output level, stability, and avc action. For each converter, bias values, coupling capacitors, LC values, and the avc voltage divider network can be juggled either to provide equal gain for all bands or to emphasize or deemphasize some bands. (Maximum gain for 80 and 40 meters usually means more noise talsign.) The remainder of the circuit is standard, in the sense that almost all receivers operate i-f and detector stages at one frequency.

2. Note the switching system. Converters which are not in use are not powered, thus eliminating some potential birdies. Switching, however, requires only a three-pole switch, one each for antenna input, converter output, and Vcc. Moreover, by using shielded signal leads (and shielding the power lead is not a bad idea) and minimal inter-section shielding of the switch, the entire switching network can be made very compact. In some receivers using similar schemes, I have seen retained the classic long switch, running from front to rear on the chassis. It is quite unnecessary.

3. The avc system employs resistor-divider sections to limit or expand voltage excursions so that the avc action is controlled for each band. Many receivers of this design omit avc to the converters, relying upon the basic receiver sections to do the job. Given the gain of the converter sections, overloading can become a problem. Tailoring the avc action to each converter solves the problem. Avc voltage can be switched or not, depending on circuit design; it should be switched out unless the converter, when not in use, shows an open circuit to the avc voltage. Otherwise, it will load the avc system. A compact fourth pole on the band-switch solves this potential problem.

4. Unlike many handbook designs, there is no need to make each converter identical. Single-ended rf stages operate well on all HF frequencies with MOSFET devices, but experimentation with a pair of grounded grid amplifiers in cascade, or with cascode circuits, is worthwhile. Moreover, one can try push-pull circuits, since the usual mechanical problems of band changing with balanced LC circuits are not present. I am often amazed at the lack of experimental ingenuity which appears in rf designs in the ham journals, despite the large number of possible circuits available for use, and the variety of devices which just might make one or more of them a good performer.

5. The main limitation on this design philosophy is that it does not produce the most compact equipment possible. For subminiature gear, perhaps another method of design should be used, but for home station use, miniaturization is not the ideal situation. The two main physical considerations should be experimental flexibility and accessi-
Fig. 6. Block diagram of mixing vfo for tube-type transmitters. Individual circuits are similar to those of Fig. 5. Buffers are FETs with about —4 volts grid/gate block. Note especially the simplification of switching, which allows a single wafer to be used rather than the 8” switch used in the original of Fig. 5. Notice also that either mixer-amplifier section may be removed for adjustment or experimentation without disabling the vfo completely. Total cost of the “extra” mixer-oscillator-buffer-amplifier devices was under $2.00.

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During 1975 and 1976, I tested various 75 meter antennas with several ZLs and VKs. This band is generally open from there to the United States during the early mornings (local US time) around 1000 to 1200Z. I have been trying to determine if there is any particular 75m antenna best suited for this 7- to 8-multipath 8000-mile-plus path. There are usually a number of US hams working the ZLs and VKs on SSB between 3775 and 3850 kHz. The ZLs are permitted to work this portion of the band. As the VKs' highest frequency end is 3700, they generally transmit SSB between 3680 to 3695; therefore, split operation must be used with them.

75m antennas tested here during 1975-76 were: several dipoles at various heights (40 to 70 feet); three delta loops; a two-λ horizontal quad at 70 feet; two ½-λs in phase, collinear at 70 ft. (broadside to NZ); several ¼- and ½-λ verticals; a 3-element yagi at 60 feet; and three horizontal monoband dipole log periodics (DLP), one 3-element, one 4-element, and one 5-element, all at 60 feet.

At times, I have had as many as 3 or 4 75m antennas up at the same time for making direct comparisons between the various types. During the tests, the best reports from the ZLs and VKs have been with the log periodics and the yagi. As all of my antennas are supported by pine trees, the maximum height above ground for the horizontal antennas is limited to 60 to 70 ft., or approximately only ½ λ above ground at 3.8 MHz. These are, of course, fixed-wire beams.

At times, the yagi or the log periodic would be reported as much as 10 dB better than some of the other types being tested. The yagi and the LPs were all beamed west or SW.

The log periodics and
the yagi, although producing the best reports from "Down Under," are quite large, requiring a width of approximately 150 feet and a boom length of at least 100 feet. The general design of the 5-element monoband log periodic is given in reference 1, Fig. 6, reference 2, Fig. 2, and reference 3, Fig. 4. The dimensions for the frequency range 3.8-4.0 MHz are given by reference 2, Table 1. This LP was supported at about 60 feet by 8 pines.

As an antenna of this size is generally impractical for the average ham on a city lot, during 1977 I tested 75m antennas requiring less space but still giving some gain and more directivity than the usual 75 or 80m dipole or inverted vee when limited to a height of only sixty to seventy feet. These are described in the following.

**Shortened Dipole Slopers**

During the tests with the ZLs and VVs, it was noted that W2GO, one of the more consistent early morning DXers, uses a single shortened (66-foot) dipole as a sloper to the west with very good reports.

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Shorned dipoles using off-center loading coils were well covered by Jerry Hall K1PLP (QST, Sept., 1975, page 28). By use of two 40-µh loading coils, the 75m dipole was shortened to 66 feet. This is the type used by W2GO for his shortened 75m centered ½-λ sloper, which requires only a single 60- to 70-foot pole, tower, or tree support. It is sufficiently compact to be used on a small lot. This was the type which I selected as being the most simple and compact antenna requiring minimum space.

As I did not have a pair of loading coils as specified in the QST article and did not wish to take time to wind them, I used instead two lengths of 300-Ω TV line as loading stubs for the shortened dipole. See Fig. 1(b). As a start, I used 30-foot stubs which resonated the shortened 68-foot dipole at approximately 3.5 MHz. Resonance can be determined by a GDO or by running an SWR.

Next, the stubs were each pruned about 6 inches and the resonance was again checked, and then another 6 inches were removed and the frequency checked. This procedure was continued until the dipole resonated at 3.8 MHz. A total of 3.5 feet had been removed from each stub, making them each 26.5 feet in length. These loaded the dipole to the desired center frequency, 3.8 MHz.

An SWR was then run to determine the usable bandwidth of the shortened stub-loaded dipole, illustrated in Table 1. It will be noted that the bandwidth is quite narrow but usable ±0.1 kHz covering the DX portion of the 80m phone band.

This shortened or loaded dipole was then suspended as a sloper (Fig. 2) from the top of a 70-foot tree and sloped SW for tests with the ZLs. Although the overall length of the sloper was only 68 feet, it worked surprisingly well, considering its simplicity and ease of construction. It was fed with 72-Ω twinlead connected via a 1:1 balun to a buried coax to the shack.

For a dipole-type sloper to be effective for DX, or rather to have a fairly low angle of radiation, it should form an angle of at least 60° to ground. 70° to 80° would probably be better. It, no doubt, acts as a ½-λ vertical or semivertical. Being centered, the necessity of an elaborate ground radial system as required with a ¼-, ⅔-, or basefed vertical is probably not as important. None was used during these tests. If the slope angle is less than 60°, say 45°, it will probably have more horizontal polarization and higher angle radiation and would become more like a low horizontal dipole with the major radiation lobe at 90° or straight up. In this configuration, it would no doubt show an improvement with nearby stations up to a few hundred miles, but DX operation would suffer.

A second sloper using an old Hy-Gain 40/75 trap dipole (overall length about 110 feet) also was tried, suspended from a 100-foot tree and aimed SW. This sloper seemed slightly better than the original 68-foot stub-loaded sloper. This was no doubt due to greater overall radiating length, more effective height, and an angle of about 70°. It had the advantage of also being usable on 40, though no extensive tests have been made with it on this band.

**Phased Slopers—Endfire Array**

As above slopers gave fair results considering their simplicity and ease of construction, it was decided to try a 3-element phased sloper (all elements driven) in a log periodic, endfire sloper array configuration. This was constructed by using a nylon line catenary stretched between two high pines separated by about 200 feet and oriented to give a beam at about 225°. The higher, rear tree was about 75 feet in height and the forward tree was about 60 feet high.

As the use of stub-loaders was not desirable due to complications in suspending the stubs so that they would come off at about 90° with respect to the sloper elements, it was decided to use end loading instead of stubs. This was accomplished by folding about 25% of each element end to the rear and securing them to the top and bottom catenaries, as illustrated in Fig. 3(a).

As it was desired to operate this beam centered on 3800 kHz, it was adjusted so that the longest rear element, #1, resonated at 3.7 MHz, #2 at 3.8 MHz, and the short forward element, #3, at 3.9 MHz. The easiest
way to adjust this is to cut each element slightly longer than its required frequency. Then put temporary jumpers across the center insulators (feedpoints). Secure the ends of each element (folded back portion) to the catenary and then raise the array to its normal suspended height. At this point, the 2-wire center feeder is not used.

Next, check resonance of each of the three elements separately by holding the GDO near the horizontal section at the bottom of the catenary, and pruning the ends as necessary to the three frequencies, 3.7, 3.8, and 3.9 MHz, as mentioned above. This must be done with the array suspended at its final location due to variations of resonance depending on the height of the three elements above ground. These three frequencies were selected so that the completed antenna would be centered on approximately 3800 kHz, and also to allow the array to operate as a log periodic.

Once the three elements are tuned, the array can be lowered, the jumpers across the three center insulators removed, and the 2-wire open feeder or phasing line connected as shown in Fig. 3(a). Note the transposition required for the array to perform as a log periodic or an endfire array. Each element must be out of phase with its neighbor, as required of any log periodic. The construction of the feedline is presented by the articles in references 1, 2, 3, 4, and 6, covering log periodic wire beam construction, and will not be repeated here.

A large array of this type for 75, even though using only 3 elements, must be assembled and tuned on site for its particular surroundings and height above ground. Table 2 is overall swr covering 3.5 to 4.0 MHz, after adding the center feeder to the array. It then centered on about 3.7. However, as the swr at 3.8 was only 1.25:1, no further changes were made since the beam was usable between 3.6 to 3.9 MHz.

Although this phased-slower log periodic was only tested for about one week, it appeared to have gain and directivity as hoped. During one of the tests on 3808 kHz, Bob Tanner ZL2BT advised that it was about the same as the 3-element horizontal yagi at 60 feet which I was using at the same time.

The main advantage of the above phased sloper is that only two trees or masts are required, as compared to 6 or 8 necessary to support the 3-element yagi or an equivalent 3-to-5-element DLP. Further, the phased array, being primarily vertically polarized, should have a lower angle of radiation. Since the radiating elements are semivertical dipoles (centerfed), a ground screen or counterpoise was not used during the tests. Although the length requires about 200 feet of mast spacing, its width is less than 1 foot, compared with the 150-foot width of a 75m dipole log periodic or yagi.

For those who prefer yagis, the same 3-element sloper could, no doubt, be arranged as a 3-element yagi by deleting the open wire center feeder, deleting the center insulators from elements #1 and #3, and feeding the center of #2 element directly with 72-Ω twinlead or, better still, with an open tuned line. See Fig. 3(b).

The array would then become a yagi with #2 the driven element, #1 a parasitic reflector, and #3 a parasitic director. The yagi sloper array would, no doubt, have a more narrow bandwidth (possibly no more than ±50 kHz) than the bandwidth of the log periodic configuration. I have not tested the sloper array as a yagi, but, on previous tests comparing a 3-element horizontal monoband DLP with an equivalent 3-element yagi, a greater bandwidth was given by the log periodic.

Test Results

Shortened loaded slopers — From the tests made with ZLs and VKs on these 75m antennas, and also from comparing notes with the previous tests with ZL1BKD during 1975-76, it appeared that the single shortened loaded-dipole sloper was equal to the larger delta loops, 2-λ horizontal quad, verticals, etc., which were tested then versus the large 75m yagi and/or log periodic (horizontal dipole-type) beams. The latter did average out about 10 dB better than the more simple antennas, including the slopers.

Considering the simplicity and ease of building the loaded sloper, and the fact that only one support is required as against 6 to 8 to support my large beams, it is believed the loaded sloper is the least expensive 75m DX antenna and about the only one suited for a city lot except, possibly, a single ¼- or ½-λ vertical, which can be quite expensive if a 60- or 120-foot tower or mast is used and the required 60 feet or more of ground radial system buried. The latter may also be a problem on a city lot.

During the tests, the large beams would show as much as a 15-dB increase over some of the more simple antennas, but these differences would vary from day to day. The 10-dB gain over the more simple antennas was more the average.

Comparing the simple sloper with the delta loops, the type with apex topside requires only one high support but needs about 120 feet of space for the lower horizontal section. The type with the horizontal section up and apex down requires two supports spaced at about 120 feet.

Comparing it with the
horizontal 2-λ quad, the latter requires four supports arranged in a square with about 130-foot separation, hardly suited for a city lot. The delta loops and quads also require more wire. 75m phased verticals are also impractical in a small space.

Therefore, the simple loaded-dipole sloper is recommended as a good all-around and inexpensive DX antenna if one does not have an open space of about 150 x 150 feet for a large beam to provide gain. Further, the latter, requiring 6 to 8 supports, also requires considerably more wire, insulators, etc., and a great deal more effort and labor!

For anyone not interested in 75m DX, a shortened or loaded sloper used as a high-angle radiator, either as a sloper at about 45° or as a dipole at about ¼ λ or at approximately 60 feet above ground, will be a good average short-haul antenna for several hundred miles.

One suggestion would be to have two anchor posts for the bottom end, one to provide a slope angle of at least 60° for low-angle DX, and the other to give about a 45° slope for general short-haul communication.

The 3-element phased sloper—

Although this is a more elaborate beam, having gain, it is not generally suited for a city lot, since two masts with a 200-foot separation are required. It does have an advantage in that very little width is required, but it does require considerably more wire, insulators, and labor to assemble. It did appear to be about neck and neck with the yagi (also being used at the same time) from the ZL and VK reports. It may have been just a bit noisier on reception due to being more nearly vertically polarized. However, I did not have time to determine this for sure. It did make a good showing "down under" when compared directly with the yagi being used then.

A 3-element wide-spaced horizontal log periodic beamed west was set up later, which Bob Tanner ZL2BT advised was the best antenna tested here over the past 3 years.

I might add that, when comparing the various 75m antennas during this period, if the ZL or VK reported a 1 or 2 S-unit or 5- to 10-DB increase or difference between two antennas, the same difference on reception of their signal would generally be noted, as would be expected.

On this multihop 75m path, there is generally less QSB than on the higher bands. When there is fading, it is usually slow, unlike rapid QSB on 20.

For the information of those who do not work 75m DX, the VK and ZL signals generally have a slow buildup about 15 minutes before sunup, when they peak. They remain peaked for 15 to 30 minutes, and then start a decline for 30 minutes to 1 hour after sunup, local time.

As yet, I have not determined if the sunrise peak is due to "gray line" propagation or possibly due to a change in ionization of the F-layer, causing less attenuation at this end or possibly in the last hop (received at this end), thus giving the 5- to 10-DB signal increase which is generally noted at sunup.

It is doubtful that "gray line" affects the US-NZ path since they are in total darkness approaching midnight (sunup here in the east). "Gray line" might affect the W-VK path since sunup here is about sunup in certain parts of Australia.

To get more firsthand information on this, I am now (as of this writing) in the process of putting up two beverage receiving antennas, one N-S and one E-W. These are 2-wire reversible-direction beverages, each 520 feet in length, for use on 160, 80, and 40. Some very excellent data, suggestions, and material have been made available to me by Paul W6PYK for this test, for which I am very grateful. I had previously tested several simple single-wire beverages, resistor-terminated, to improve S/N.

The beverage project was started here originally to try to improve reception which is extremely poor, especially on 75, at this QTH. This is due to very poor ground conduc-


\[
\text{Table 1. Shortened dipole sloper.}
\]

\[
\text{Table 2. Log periodic as in Fig. 3(a).}
\]
who is interested in antenna design.

**Multidirectional slopers**—
If there is sufficient open area around a single high mast or tree, 3 or 4 of the shortened 75m dipole slopers could be used for several directions as per K1THQ's 40m four-direction sloper described in the ARRL Antenna Book (Figs. 8-12, page 200, 13th edition). According to his measurements, the forward gain was about 4 dB and front-to-back up to 20 dB. Note that the coax to the relay box must be just over 3/8 λ. At 3.8 MHz, this length would be approximately 63.4 feet of RG-8/U or RG-58/U (VF = 66%), or 74.9 feet of RG-8/AU or RG-58/AU (VF = 78%).

I have not tried this 4-directional sloper, but it sounds interesting for anyone having the room and needing a lobe in more than one direction. If a mast at least 130 feet in height is available, full 1/2-λ sloping dipoles could be used without loading and would no doubt be more effective. The dimensions would then be about double those given for K1THQ's 40m switchable sloper.

### 1/4-λ slopers—
Not having a tower, I have been unable to test a 1/4-λ inverted sloper fed by coax at the top of the tower (with the coax sheath grounded to the tower near the feedpoint). I have worked several on 75 who have reported good results with this type of inverted sloper.

Theoretically, this should be a good antenna, since the current loop of the 1/4-λ sloper is topside and generally in the clear. The tower provides a ground plane or acts as a reflector, which should give some directivity. However, this type appears to be tricky (and they either work or they don't). No doubt the 1/4 wavelength and the angle between the sloper and the tower are critical, probably affecting the impedance at the top feedpoint, which is probably low. Possibly a matching network between the coax and the feedpoint would help, or possibly the top of the 1/4-λ element could be grounded directly to the towers and the lower end voltage fed at the bottom with a tuner or a 1/2-λ tuned line used to voltage or end feed, similar to the old Zepp. Using voltage feed at the bottom also saves the length of coax from bottom to top of tower.

I have one friend, YV5DLT, who put up two of these 1/4-λ inverter slopers (topfed), one for 75 and one for 40. He said the 75 worked with no problem, whereas the 40m refused to work. I have noted that about 25% of those using the 1/4-λ sloper have gotten them to work; the rest had problems or became discouraged if they did not work right away.

Possibly those using these successfully can give some suggestions. Also, the estimated angle of radiation, H-plane pattern, etc., would be interesting.

### Dual 1/4-λ phased slopers—
Possibly, using two of these side by side, in phase, spaced 1/2 λ broadband to the desired direction, might be of interest, as per Fig. 4(a). The two 1/4-λ elements spaced 1/2 λ would be grounded topside, as mentioned above. The two bottom ends (voltage loop) would be voltage-fed with a 1/2-λ open phasing line feeding the ends, so the two 1/4-λ radiators will be in phase. The 1/2-λ phasing line is current-fed, slightly off center directly with the coax or with a 1:1 balun. For 3.8-MHz operation, the two 1/4-λ slopers would be approximately 61.5 feet and the 2-wire open phasing feedline approximately 126.8 feet long. This beam requires two 70-foot towers spaced about 130 feet apart and oriented broadside to the desired direction. A few wire reflectors between the towers might improve the lobe in the desired direction.

This array would be similar to the broadside or side-by-side phased slopers described below, except 1/4-λ slopers would be used in place of the 1/2-λ shortened dipoles. See Fig. 4(b).

### 1/2-λ phased sloper or vertical-dipole arrays—
If a mast at least 130 feet high is available, it could be used to support a full 1/2-λ phased sloper or vertical dipole endfire array. The elements would then be a full 1/2 λ (no endloading required), thus being more efficient and having greater effective height.

Another advantage of greater height would be the possibility of having the three elements near or exactly vertical, so the array would then become a 3-element vertical (dipole) log periodic or 3-element vertical yagi (whichever configuration is preferred) as was described above under "Phased Slopers—Endfire Array."

With the shortened dipole sloper or multi-element sloper arrays, the loaded elements probably reduce efficiency about
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50%, as the shortened radiating portion is only approximately ½ λ. Their ¼-λ radiating portion should be about the same as the vertical radiating portion of a Bruce array.

The end-loaded sloper array might be considered as a 3-element endfire array, as opposed to a 3-element Bruce array which is a bidirectional, broadside one using ¼-λ radiating elements in phase spaced ½λ. The 3-element endfire array would be unidirectional and should give greater gain. The Bruce would, however, probably have a greater null to the sides (180°).

If a single high mast is available, it could also be used as the center support for 3 or 4 separate phased endfire arrays, thus providing 3 or 4 separate beam headings or separate selectable lobes at 120° for 3 arrays or 90° for 4, for beaming N, E, S, or W.

Granger, Trylon, and Hy-Gain manufacture commercial or military fixed-wire monopole and vertical dipole log periodic wire beam arrays of these types for frequency ranges 2.5-32, 3.0-32, 4.0-32, and 6.0-32 MHz. These are recommended for long-haul HF circuits. See the Hy-Gain commercial catalog E, 1969.

Incidentally, if any hams are interested, these commercial wire beams are generally in the $20,000 to $50,000 class. However, this does include an 100- to 240-foot steel tower. A 3- to 5-element vertical (monoband) dipole log periodic for 75m can generally be ham-built for $100.00 or less for wire, insulators, etc., less tower and coax.

Broadside or side-by-side shortened slopers — Another suggested phased sloper could be the use of two shortened 78-foot ½ λ (loaded) sloper dipoles suspended from two 70-foot masts spaced ½ λ (approximately 130 feet at 3.8 MHz). See Fig. 4(b). The two slopers would be operated in phase with 130 feet of separation. A ¼-λ tuned feeder/phasing line would be required for feeding and phasing the two slopers, similar to the dual ¼-λ phased slopers described above in Fig. 4(a).

Better still, if the two phased slopers could be a full ½ λ (requiring two 130-foot masts), they should give about maximum gain to broadside for an array of this type. I believe I have heard of some ham using this type of beam.

There are, no doubt, many phased-sloper-array combinations which can be designed. I again wish to point out that I have only built and tested the loaded sloper of Fig. 2 and the 3-element (end-loaded) phased sloper of Fig. 3(a).

I would appreciate hearing from anyone who is using or has tried any phased-sloper arrays or has any suggestions along this line.

References
2. 73 Magazine, Sept., 1973, op. cit., part II.

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F135 | Fan Kit, 115VAC | 381x140x89mm | 3 kg (6.7 lbs) | $39.00
F235 | Fan Kit, 230VAC | 381x140x89mm | 3 kg (6.7 lbs) | $39.00
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When the June, 1978, issue of 220 Notes (volume 1, number 4) arrived at my doorstep, I was new to 220 MHz; in fact, the ink on my Tech ticket was still moist! So the blurb titled "Your Own Little 220 Beam" on page one captured my immediate interest. Although 220 Notes included a marvelous sketch of the antenna (which they adapted from C. N. Zornes W9TAL), the newsletter contained no instructions for assembly. Fig. 1 is redrawn from 220 Notes and shows antenna dimensions.

To build W9TAL's beam, I purchased a GEC-52 conical TV antenna, made by RMS Electronics, 50 Austin Place, Bronx NY 10462, for five bucks from a local radio-electronics store. I chose this model because of the cheap price, but any television antenna will do. Another route is to buy a boom and 1/8" or 3/8" aluminum rods separately.

Step 1: After taking the TV antenna from the shipping carton, remove the elements (secured to plastic hubs with pop rivets) by drilling out the rivets with a bit slightly larger than the head. Now you have several aluminum elements of various lengths and a boom.

Step 2: Measure the length of your boom. It must be at least 30 inches. The mast-cum-boom supplied with the GEC-52 is 31½ inches long. If your boom exceeds three feet, I recommend shortening it...
to 30 inches. A hacksaw or saber saw will do the job. Now mark a ¼-inch point in from either end; mark another ¾-inch point on the other side, i.e., directly behind it. You will be drilling through these points, so make sure they line up! Make similar marks 19½ inches in front of the first two. Measure the diameter of your elements, add 1/16 of an inch, and drill holes in each of the four marks. The drill bit will not slip if you first punch holes in the boom with a large nail.

Step 3: Make marks midway between the holes you drilled for the reflector elements. These are perpendicular to and ¾ diameter away from the original holes. Stove bolts will drop through these points to secure the reflector. Repeat this procedure for the director. Once the spots are marked, drive a large nail through them and wiggle it around to ream out the aperture.

Step 4: Time to cut your elements. Measure and cut one element 27-1/8 inches long—this is the reflector. Measure and cut another 24-1/8 inches long—this is the director. Measure and cut two elements each 12 inches long—these are the driven elements.

Step 5: Crimp the open ends of the reflector and director and one open end of each driven element with pliers to prevent water from entering and rusting them. If the cramped ends are rough, a file or sandpaper will smooth them off. Locate the midpoint of each element (13-9/16 inches for the reflector; 12-1/16 inches for the director) and punch a hole, using the nail from Step 3, to allow a bolt to pass through it.

Step 6: Take a 4-inch piece of 2" x 4" and bore a hole in it as shown in Fig. 2, to accommodate the boom. Use a smaller bore (or large bit) to drill holes in the sides of the 2" x 4". These holes should be ¼ of an inch to 1 inch deep and under no circumstances should they intersect with the boom bore.

Set a driven element in each of the two side holes (make sure it is snug against the back) and screw a 1½-inch wood screw into the top of the 2" x 4" about ½" from the edge. The screw will secure the element and will later serve as a conductor between the coax and element. Slide the 2" x 4" on the boom so that the elements' centers are 10½ inches from the middle of the reflectors' holes.

Step 7: You're in the home stretch...final assembly begins here. Place the reflector (remember that's the longer element) in the large holes near the rear of the boom. Align the holes in the boom and reflector so they match. Set a flat washer over the topside hole and drop in a bolt. Tighten the bolt with a lock washer and nut on the underbelly. Repeat this for the director.

Strip 1½ inches of the coax's outer covering off the end. Twist the shielding braid into a "wire" and remove the plastic insulator from around the center conductor. The total distance between the split in the coax to the end of each driven element is 12½ inches. Measure the length from one screw in the 2" x 4" to the tip of the corresponding driven element. Subtract this size from 12½ inches and wrap all but the difference of the twisted coaxial braid around the head of the wood screw. Drive the screw as deeply as possible into the 2" x 4". Repeat this part of Step 7 for the remaining screw and the cable's center conductor.

I wrapped silver duct tape around the 2" x 4" to isolate it from the nasty Michigan winters and to increase the beam's life.

Bathtub caulking is another solution.

Results

In preliminary tests the yagi performed admirably. My first simplex contact was with Tom WB8GVC in Detroit (a distance of about fifteen miles), and the antenna was only ten feet above ground level. When I taped the beam on a twenty-foot makeshift mast (and had my father and Tom WD8OTN take turns playing rotor), I raised the WR8AOK repeater in Livonia, Michigan. WR8AOK sits forty-five miles from my home QTH—not bad for a ten-Watt Midland 13-509 rig and a twenty-five-foot run of RG-58/U. In the low power position (one Watt), I full-quieted the WR8AEF machine in Mt. Clemens, Michigan, a six-mile haul. All in all, I've been impressed with the results of W9TAL's design.

For maximum results, mount the beam as high up as possible—or, at least above surrounding trees away from other metallic objects, and use RG-8/U coaxial cable to minimize transmission line loss.

Parts List

1/2" pipe of 2" x 4" wood
saber saw or hacksaw with blade
2 wood screws (1" long)
2 stove bolts (1½" long) and lock and flat washers
wood bore and drill bits
electric drill
RG-8/U coax with 1 PL-259
rosin core solder and soldering iron

Fig. 1. Antenna and dimensions. Adapted from: 220 Notes, volume 1, number 4, June, 1978, page 1.

Fig. 2. Sketch of wood block holding driven elements.
Beware of the Dreaded Phantom Ground
—exorcise those antenna gremlins

Avoiding the non-radiant antenna.

The article by John Cranston WB2DYU/2 in the March, '78, issue of 73 ("I Need A Contact!") brought back many unpleasant memories of past station operation and more than too many of how it works now. I, too, have a long history of inventing the non-radiant antenna. However, a few of the rules of thumb (or burned fingers, if you will) arrived at may be of help to other hams starting out.

If you don’t read too much theory, it is harder to build an antenna that will not work than to build one that works.

From the description of what Cranston has, there seem to be a few old friends. One of my favorites is the phantom ground. All the books say that you should ground the equipment, particularly the transmitter, to avoid all sorts of troubles. Usually this leads to all sorts of troubles just like the ones you wanted to avoid, like TVI and RF burns when you touched the rig.

So what happened? Well, the ground was always shown in a picture-book station. There was all that beautiful gear, all hooked up together with a heavy copper braid ground bus to a conveniently located ground. It is the “conveniently located” that kills you. When they say ground, they mean ground, as in nice wet earth. To work, the direct earth connection must be quite close to your equipment and connected with a solid hunk of metal.

Many hams have some heavy copper water pipe that goes right through the basement shack and into the ground. Now that is a reasonable ground. If you don’t have that, you don’t have a ground. The further away from that you are, the less ground you have.

If your shack is on the first floor, or more probably the second floor or attic, you don’t have any ground at all. What you do have is a hunk of far too thin wire draped all through the house to a water pipe and maybe a long run of that to the ground. For rf purposes, you aren’t even connected to the ground. What your transmitter sees is what looks like another hunk of antenna. That, added to your nominal antenna, results in almost as good a radiator as your store-bought dummy load.

I have tried a number of different configurations of this basic circuit and can recommend it for tune-up purposes. It also is very impressive to show visitors how you can light a small neon bulb with your nose when you key the rig.

Let’s get back to practical for a bit. There is no such thing as a long ground unless you can run something the diameter of a sewer pipe from the rig to the ground. I don’t think that will work well, either.

So, forget the ground. Build an antenna that will work without the ground. This is not as hard as it sounds. Without the false ground to give trouble, many antennas will do the job without trouble.

Most rigs are coax-fed these days, so the basics will be for that type of output. The coax-fed antennas, dipole, beam, quad, etc., will work fine without the earth ground. Here you may want a balun or other matching device to go from unbalanced line to balanced, but it should not be critical.

If you can do it, the attic shack is the ideal location for the roof-mounted antenna. A simple mast with a small beam or quad will do nicely. From there it will be a short coax run to the rig.

So far, so good. What about that dipole you wanted to have? It doesn’t matter that the rig is in the attic, but it usually happens that when you have met the condition that your rig is nowhere near a good ground, it probably is situated where you can’t have a good antenna. Somehow the landscape has been carefully arranged so that there is no possibility of stringing a dipole, inverted V, or
anything resembling the antennas shown in the book.

Now what? This is where the all-time easy antenna comes into its own—the classic random-length antenna. What this is is a long piece of wire. You make it as long and as high as you can. Nominally, you want it more than ¼ wavelength long. It would be nice if it was in a straight line, but it is quite accommodating to being bent into odd shapes. It would like to be free and clear of other objects, particularly metal ones.

With a little thought, it is almost impossible to not be able to meet the requirements of this antenna, but there are a few little hitchs.

It runs from your transmitter to where it ends. That means there will be radiation in the shack; however, this should not be what is usually thought of as rf in the shack, i.e., burned fingers when you touch the rig. It just has to be hooked up right. Most rigs have a 50-Ohm output. The random is high impedance. You have to use an antenna tuner. This can be as simple as a coax jack, a variable capacitor (with insulated shaft), a coil and a few clip leads, or a fancy store-bought tuner. A short run of coax from the rig to the tuner and the antenna goes from there to the great outdoors. It works quite well.

It's hard to miss, but you're not home free yet. The books still say to ground everything together. This is how you get all that rf in the shack, plus assorted rf burns and minor jolts.

You still will have your phantom ground problem. It wasn't until I got rid of both the ground and connecting the various chassis together that my setup got tamed.

Don't connect anything to anything else that you don't have to. They fight with each other. This will leave you with only one problem.

There may be potential differences between the various chassis. If you are holding onto one and reach for another, you may get bitten. This is not pleasant, so learn not to do that any more. Don't grab two pieces of gear when both are live (or plugged in). This is a small price to pay for a reliable attic system. It may not happen that your particular gear does that. Some of mine does and some doesn't.

Of course, you are going to ground your antenna when not in use... or are you? You will have the same problem trying to ground your antenna to a phantom ground as your transmitter had working with it.

Antenna grounding is supposed to serve two purposes. It is fondly believed that it will protect your rig from a direct lightning hit. Lots of luck. Even with the usual textbook ham ground setup, that is asking a lot. A direct lightning hit will go to ground, but it is probably going to take everything along the path with it. I don't know if the usual antenna, lead-in, and grounding setup is going to stay put for that, not to mention any gear connected to it. The best you usually hope for, and the usual case, is protection against the static charge build up from a nearby electrical storm. While this is not usually big enough to turn your antenna into abstract artwork, it is often big enough to put a wallowing charge into the front end of any rig that's there.

Here the solution is simple. It is not so much a direct earth ground you need as a chassis ground connection. Any of the antenna switching arrangements can usually be hooked up to short the antenna lead directly to the ground of the coax connector (chassis ground).

I haven't seen it mentioned in years, but there was a time when many schematics made a distinction between chassis ground and earth ground. There are different schematic symbols for each. The familiar ground symbol, Fig. 1(a), is the one for chassis ground. Fig. 1(b) is the symbol for earth ground.

If your shack location is such that you can't get a good earth ground for antenna grounding, the chassis ground will still work a lot better than leaving your rig there to get hit.

It also doesn't cost much to run a ground wire to your shack and try it for rf purposes. Then if you have trouble with operating, remove it when you use your rig and reconnect it just for electrical safety when you are not operating.

The key is to go by the book as far as you can and only make such modifications as you have to for your particular circumstances. Then do as much as you can to restore non-operating safety.

I hope these two particular techniques, the use of a tuned random-length antenna and the avoidance of a phantom ground, will help solve a few problems for those who are just beginning or not able to use a more conventional configuration.

It drove me nuts for quite some time until I got the hang of it. It's not the best, but it will be reliable when properly applied.

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members gave up lunch
periods, many after-work
hours, and weekends dur-
ing the period from March
1-11, 1979, to operate their
club station W6VIO in cel-
bration of the close ap-
proach of the Voyager I
space probe to the planet
Jupiter and its four
Galilean satellites, Io,
Europa, Ganymede, and
Callisto.

Dick Piety K6SVP organ-
ized and managed the op-
eration. He was assisted by
Jim Lumsden WA6MYJ.
Jim mounted a Herculean
effort in getting the newly
refurbished trailer which
constitutes the W6VIO
shack ready for the event.
Equipment, stored in many
locations during the refur-
bishing, had to be returned
to the shack and rein-
stalled in the beautifully
arranged shelves and
decks.

The 1540 contacts made
in the various bands on
which the operation was
mounted include:

10m phone  281
(includes a number of
SSTV contacts)
10m  CW    21
15m phone  123
15m  CW    164
20m phone  362
(includes many SSTV con-
tacts)
20m  CW    157
40m  CW    10
75m phone  1

Dick Piety K6SVP at the SSTV position. The image on the screen is of Callisto, one of
Jupiter's moons.
One of the SSTV monitor views of the W6VIO ID during the Voyager I commemorative.

2m FM 348 (includes check-ins to various JPL/Goldstone* nets run during the commemorative).

220 MHz FM 72 OSCAR 1

There were 79 contacts outside the United States.

Interesting sidelights arose during the commemorative. Dick says he “doesn’t believe” the contact on 2 meters who gave a K7 call and said he was speaking from Seattle. (Seattle to Pasadena on 2m!) Merv MacMedan N6NO began a CW contact with a Spanish amateur who wouldn’t let him go on to others. Merv explained to him in Spanish about the Voyager commemorative. The Spanish amateur wanted to “rag-chew.” Jim made a contact on SSTV with a Wichita Falls, Texas, amateur who said he was recording the pictures for his high school class of fourteen-year-olds. Dave Ingram K4TWJ telegraphed that he was recording the Jupiter images and sending them to the local press as fast as he received them. A Denver amateur contacted the Denver Post. They called K6SVP on the phone to interview him about the operation. A contact with F6KCP by W6VIO led to five or six other French amateurs joining the activity.

The promised QSL card, including Jupiter pictures made by Voyager 1’s cameras, was a magnet to pull in the contacts. All who contacted W6VIO during the March 1-11, 1979, period will receive QSLs if they send an SASE to W6VIO or QSL through their bureaus. The card also identifies their major discoveries about Jupiter and its moons made by the Voyager spacecraft in its close encounter of the most spectacular kind. Those who remember the Viking commemorative card from N6V, operated by the JPL club during the landings on Mars, can appreciate the beauty of these very special QSLs.

From July 6-15, 1979, there will be a second Jupiter fly-by commemorative for the Voyager II Mission. It will have a somewhat different card. If you missed out on Voyager I, try for Voyager II.

The individual members of the JPL ARC (in addition to myself) who took part in the Voyager I commemorative are: Dick Piety K6SVP (chairman of the commemorative operation), John Repar WA6LWD, Stan Sander N6MP, Ron Zenone W6TUZ, Warren Apel K6GPK, Merv MacMedan N6NO, Jim Longthorne WA6KPW (off-lab member), Bob Gasline AE6S, Rich Soikkele WD6ERI (an Arcadia, California, high school student, 16 years old, who is communications associate on the Sunfire I project), George Morris W6ABW, Jim Lumsden WA6MY (facilities chairman for W6VIO), Mike Griffin N6WU (president of the JPL ARC), and Glenn Berry K6GHJ (who organized the reconstruction of the trailer).
Have you ever found yourself wanting an antenna that was easy to put up, had gain over a dipole, was simple to match, and could work on more than one band? Then read on. This article shows how to design and build wire antennas which are longer than a half wavelength. These antennas may be operated as dipoles or V-beams. By careful choice of leg length, it is possible to build an antenna which will work on several amateur bands, but requires only a single feedline. The input impedance is about 200 Ohms and may easily be matched to 50-Ohm coax with a 4:1 balun.

**Background**

One advantage of the half-wave dipole is its low feedpoint impedance. The reason for this is shown in the upper drawing of Fig. 1. This drawing shows the standing waves of voltage and current which are present on a resonant antenna. From Ohm's Law, the input impedance is equal to the voltage divided by the current at the feedpoint of the antenna. For a half-wave dipole, the voltage at the feedpoint is low and the current is high, which gives a low value of impedance—typically, 50 to 70 Ohms.

Many hams use half-wave antennas, but it is also possible to make a dipole in which each leg is much longer than a quarter wavelength. Fig. 1 also shows the voltage and current distributions for 1-wavelength and 3/2-wavelength dipoles. Notice that the current in the center of a full-wave antenna is low and the voltage is high, resulting in a very high input impedance on the order of several thousand Ohms. However, the 3/2-wavelength antenna has a voltage minimum at its center, similar to the half-wavelength dipole. The feedpoint impedance is again relatively low—around 100 Ohms or so.

At the ends of each dipole drawn in Fig. 1, the current is shown to be at a minimum value and the voltage is maximum. This makes good sense if you think about it. The current flowing at the end of a piece of wire must be zero because it has nowhere to go. On the other hand, the voltage at the end of a wire easily can be quite high. The important point to remember is that to get a low value of input impedance, there must be a voltage minimum at the center of the antenna. In other words, each leg of the antenna must be an odd number of quarter wavelengths. For the half-wave dipole, each leg is 1/4 of a wavelength, while for the 3/2-wavelength dipole, each leg is 3/4 of a wavelength. Each of these antennas has a voltage minimum at its center, and each also has a low value of input impedance.

**Determining the Correct Antenna Length**

Table 1 shows the formulas to use in order to calculate the right length for each leg of the antenna at the frequency of interest, once you have chosen how many quarter wavelengths you want each leg to be. Notice that a 3/4-wavelength leg is more than 3 times as long as a 3/4-wavelength leg. This is because the influence of "end effect" diminishes as the number of quarter wavelengths in each leg increases.

The antenna may also be oriented as a V-beam rather than a dipole, if directivity is desired. Table 2 shows the included angle (angle between the two legs of the V) for several different V-beam leg lengths, as well as the approximate gain of each configuration.

For those of you with lots of real estate, Table 3 gives the data required to design and build antennas which are truly giants. The feedpoint impedance of these monsters is in the neighborhood of the 200-Ohm value given for the antennas of Table 1.
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The formulas shown in these tables will give leg lengths which are approximately correct, but these values should be used only as starting points. All antennas should be cut a little bit long to allow for trimming to the exact length which is required. The actual resonant frequency of any antenna is affected by factors such as height above the earth and proximity to other objects.

Multiband Use

Certain leg lengths will resonate on more than one amateur band, which can be very convenient. I used to work in a small coal-mining town deep in the hills and hollows of southern West Virginia. I lived in a mobile home and had 340 feet of RG-8 coax which ran from my ham shack up the hollow to a hilltop behind my trailer. I badly needed an antenna which could cover several bands with a single feedline and which had some gain to make up for the cable losses.

While reading Ed Noll’s book, 73 Dipole and Long-Wire Antennas, I came across the information given here as Table 1. Ed explained that multiband operation was possible, so I got out my calculator and made a list of antenna lengths which would be resonant in the bands I wanted to operate (80 and 20 meters). Then I looked through my list to see if any of the numbers matched. It turned out that a ¼-wave length leg on 80 meters was the same size as a 1¼-wavelength leg on 20 meters—about 190 feet in length.

This antenna was built from #12 copper weld wire and fed through a W2AU balun with a 4:1 impedance ratio. The swr was below 2:1 across the whole 20 meter band. On 80 meters, the resonant frequency was lower than I had planned (3.7 MHz versus 3.9 MHz), but I still was able to operate my Triton II on 75 meter phone with the swr around 3:1.

Other suitable combinations can be found by plugging desired frequencies of operation into the various equations and making a list of the resulting leg lengths. For example, a leg length of about 440 feet should resonate on both 80 and 40 meters, while 428 feet looks good for 20 and 15 meters. It has been my experience that the actual leg lengths on 80 meters are somewhat shorter than the formula values, so a leg length of 428 feet may work well on all bands from 80 to 15 meters. A leg length of 362 feet should work on 40 and 20 meters, 330 feet on 10 and 15 meters, and 310 feet on 80 and 15 meters. For really big antennas, a leg length of 710 feet looks good on 40, 20, and 15 meters, 943 feet for 160 and 80 meters, and 673 feet for 160 and 20 meters.

Conclusion

This article has described large centered antennas where the length of each leg is an odd number of quarter wavelengths. Multiband use of a single antenna is possible by a judicious choice of leg length, and low-standing wave ratios are achieved by placing a 4:1 balun at the feedpoint. These large antennas show gain over a normal dipole and may be oriented in either straight-line or V-beam configuration.

### Table 1. Determining the correct leg length

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<th>Leg Length in Wavelengths</th>
<th>Leg Length in Feet (f in MHz)</th>
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</table>

### Table 2. Gain and included angle for V-beams

<table>
<thead>
<tr>
<th>Leg Length in Wavelengths</th>
<th>Included Angle in Degrees</th>
<th>Gain in dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/4</td>
<td>60</td>
<td>5.3</td>
</tr>
<tr>
<td>13/4</td>
<td>56</td>
<td>5.8</td>
</tr>
<tr>
<td>15/4</td>
<td>52</td>
<td>6.3</td>
</tr>
<tr>
<td>17/4</td>
<td>48</td>
<td>6.8</td>
</tr>
<tr>
<td>19/4</td>
<td>46</td>
<td>7.2</td>
</tr>
<tr>
<td>21/4</td>
<td>44</td>
<td>7.6</td>
</tr>
<tr>
<td>23/4</td>
<td>42</td>
<td>8.0</td>
</tr>
<tr>
<td>25/4</td>
<td>40</td>
<td>8.4</td>
</tr>
<tr>
<td>27/4</td>
<td>38</td>
<td>8.8</td>
</tr>
<tr>
<td>29/4</td>
<td>37</td>
<td>9.2</td>
</tr>
<tr>
<td>31/4</td>
<td>36</td>
<td>9.6</td>
</tr>
<tr>
<td>33/4</td>
<td>35</td>
<td>10.0</td>
</tr>
<tr>
<td>35/4</td>
<td>34</td>
<td>10.3</td>
</tr>
<tr>
<td>37/4</td>
<td>33</td>
<td>10.5</td>
</tr>
<tr>
<td>39/4</td>
<td>32</td>
<td>10.7</td>
</tr>
<tr>
<td>41/4</td>
<td>31</td>
<td>10.9</td>
</tr>
</tbody>
</table>

### Table 3. Leg lengths for very long antennas

<table>
<thead>
<tr>
<th>Leg Length in Wavelengths</th>
<th>Leg Length in Feet (f in MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>45/4</td>
<td>11070/f</td>
</tr>
<tr>
<td>47/4</td>
<td>11562/f</td>
</tr>
<tr>
<td>49/4</td>
<td>12054/f</td>
</tr>
<tr>
<td>51/4</td>
<td>12546/f</td>
</tr>
<tr>
<td>53/4</td>
<td>13038/f</td>
</tr>
<tr>
<td>55/4</td>
<td>13530/f</td>
</tr>
<tr>
<td>57/4</td>
<td>14022/f</td>
</tr>
<tr>
<td>59/4</td>
<td>14514/f</td>
</tr>
<tr>
<td>61/4</td>
<td>15006/f</td>
</tr>
<tr>
<td>63/4</td>
<td>15488/f</td>
</tr>
<tr>
<td>65/4</td>
<td>15990/f</td>
</tr>
<tr>
<td>67/4</td>
<td>16482/f</td>
</tr>
<tr>
<td>69/4</td>
<td>16974/f</td>
</tr>
<tr>
<td>71/4</td>
<td>17466/f</td>
</tr>
<tr>
<td>73/4</td>
<td>17958/f</td>
</tr>
<tr>
<td>75/4</td>
<td>18450/f</td>
</tr>
<tr>
<td>77/4</td>
<td>18942/f</td>
</tr>
<tr>
<td>79/4</td>
<td>19434/f</td>
</tr>
<tr>
<td>81/4</td>
<td>19926/f</td>
</tr>
<tr>
<td>83/4</td>
<td>20418/f</td>
</tr>
<tr>
<td>85/4</td>
<td>20910/f</td>
</tr>
<tr>
<td>87/4</td>
<td>21402/f</td>
</tr>
</tbody>
</table>
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It has been called to our attention that the breadboard shown on page 51 of our June, 1979, issue is indeed Continental Specialties Corporation's Model EXP-300 Experimentor Proto-Board®.

John C. Burnett Managing Editor

In my article "Build the $80 Wonder" (November, 1978), there was an error in the input amplifier shown in Fig. 6. The corrected portion is shown below.

Howard M. Berlin W3HB Newark DE

Fig. 6 (partial), "Build the $80 Wonder."

In my article "12 Volts, 5 Amps, 3 Terminals" (April, 1979), there was an error in the schematic—the electrolytic capacitor should be somewhere in the range of 2500-4000 µF at 30 volts or so, not 500 µF at 1000 volts. My power supply has two 10k µF, 35-volt caps in parallel, but it should be emphasized that this was a commercially-built supply (minus the regulator which is what the article was intended to introduce). The designer of the supply took a shortcut in the cap's value in order to retain the small size of the supply. I am recommending the 2500-4000 µF, 35-volt electrolytics to those who have been writing, if they can get along with the extra space that is required.

Again, the intended purpose of the article was to introduce a very effective way to obtain regulation of a power supply with a minimum of external parts (one!). If anyone was to duplicate the circuit shown, it does work, and will make an effective supply at a small cost as long as the cap's value is changed as noted here. Any "computer-grade" electrolytic with a rating of 30 volts or more—and many are advertised at bargain prices in 73—should work just fine.

Readers might also be interested in knowing that one supplier of the chip, Tri-Tek, has just dropped their price for the 78H12 to $8.50. Fairchild has also introduced several other new regulators that might prove of value.

Gary H. Toncre WA4FYZ
Miami FL

I am looking for a schematic of a device which would allow me to tune in a CW signal and have the received Morse characters translated into Baudot and ASCII. Once translated, the signal could produce a teletype™ copy of the CW being received.

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Thank you.

C. H. Wiedeman K4KOE
204 Anne Burras
Newport News VA 23606

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Wolf Point MT 59201

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Microprocessors are not just super calculators. They are general-purpose electronic circuits waiting only for programs to transform them into specialized devices. In this article I will describe how a computer can be used as a frequency counter, and I will show how the counting program can become the basis of a microprocessor-centered RTTY terminal unit. I am writing this also to show how easy it can be to replace hardware with software. Applications such as the one I will describe require only a fraction of the amount of memory that is needed to do calculations with a high-level language such as BASIC. And, for the experimenter, replacing gadgets with programs has another great advantage. No longer do you need to worry about the condition of your gear if a lengthy equipment modification doesn't work. Rewind your tape cassette and you can have the old version up and running in a few seconds.

Counting Frequencies With a Computer
The computer works with ones and zeros; counting is a very simple task for it. A little bit of external hardware help is needed, however, to get the signal from the outside world into the form the computer requires. Fig. 1 shows an adequate arrangement. An operational amplifier circuit boosts the input signal to a level adequate to drive a TTL inverter. The resulting square wave is applied to one bit of an input port of the computer. On most systems, the other seven bits can just be left floating, but, if you are picky, you can tie them to either ground or +5 volts. On my home-brew computer, I have a number of input and output ports that are implemented as single bits for applications like this. The transformer shown may not be necessary, but may help in keeping 60-cycle interference out of the system.

The easiest way to measure audio frequencies is to time the duration of a half cycle. Fig. 2 shows a flowchart, and Fig. 3 shows an 8080A program to do this. Two registers are used, one to hold the previous input, and one to count up the number of times the program loops between changes in the input. Suppose, at the starting time, the input signal from the inverter is in the 0 phase of the square wave. The unused seven bits will be read as ones, and 11111110 will be stored. Until the input changes to the 1 phase, the program will loop and the counter will count. Eventually, a time will come when the input is read as 11111111. When this happens, the count will be displayed and a new count started. If desired, a bit of programming could be done to calculate the frequency in decimal units from the binary representation of the duration of a half cycle, but, for many purposes, it is adequate to know what pattern on the LED display corresponds to a desired frequency.

For a typical 8080A system with a 500-ns clock, the instruction loop just
discussed will require 14.5 µsec. If you were trying to measure the tones from an AFSK generator, this counter would produce a count of 16 (00010000 in binary) for a 2125-Hz input or a count of 15 (00011111) for a 2295-Hz input. That might be good for some purposes, but it obviously is not very accurate. The way to make a timer more accurate is to time longer intervals. The counting time can be doubled by timing whole cycles of the input instead of half cycles. This also will eliminate inaccuracy due to asymmetry in the square wave input. For the 8080A program illustrated, this can be accomplished by changing the JZ (jump on zero) instruction to JNC (jump on no carry). Following a comparison operation, the zero flag is set when the numbers compared are equal, so in the original version of the program, the loop is broken whenever the input changes from 1 to 0 or from 0 to 1. The carry flag is set when the number in the accumulator register is less than the comparison number. Thus, by using the no-carry condition to stay in the loop, the timer ignores transitions from 0 to 1 and the count accumulates until a transition from 1 to 0 occurs.

A second way to increase accuracy is to put the basic program inside a larger loop that counts down a predetermined number of cycles of the input signal. Figs. 4 and 5 show the flowchart and program for this approach. The inner loop again takes 14.5 µsec, but now the JNC instruction is used to keep the timer going for the entire duration of an audio cycle. The outer loop causes the inner loop to be repeated as many times as the value initially loaded into register D calls for. With this approach, standard AFSK tones in the range of 2000 to 3000 Hz can be measured to the nearest 10 Hz or so. This will suffice for adjusting an AFSK generator or calibrating an oscillator to be used in adjusting a RTTY demodulator. More accuracy yet can be achieved by timing a larger number of cycles and accumulating the count in a 16-bit register pair. Still other software frills could turn the computer into a fancy frequency meter indeed, but that is not my present goal. Instead, I would like to show how the basic timing program can be used to build a radioteletype terminal unit with capabilities not usually found in the simpler analog TU circuits.

**The Software Terminal Unit**

My home-brew computer decodes audio signals from an audio cassette recorder by means of a simple cycle timer program which is stored in read-only memory. Compared to the problems of decoding over-the-air RTTY signals, it is trivial to decode a tape. A few preliminary experiments showed me that the simple frequency measuring routines could work on clear and strong signals, so I set out to define the additional requirements for RTTY.

Essential features for RTTY are some kind of filtering to minimize the effects of interferences and some kind of tuning indicator. Another feature, not necessary, but very desirable, is a squelch or mark-hold provision to keep the printer from running wild when a useful signal is not present. Finally, an easy way of throwing in a locally-generated line feed or carriage return can sometimes prevent loss of print. Doing all this in software is easy.

The flowchart of Fig. 6 shows how all these provisions are included. Entry and exit from the program are through a control section which allows a local ASCII keyboard to direct operations. Next, a cycle timer section determines the frequency of the incoming audio. Decision routines cause execution to branch, first to display the current state on a tuning indicator, and then to take appropriate action. A "noise counter" disables the printer whenever the signal-to-noise ratio becomes lower than the preprogrammed acceptable limit. A "signal counter" takes over the functions of a post-detection low-pass filter, and the processed data then drives the printer magnet through an output port and very simple interface circuitry.

The details can be seen in the program listing. In my system, a surplus 8-bit parallel-output ASCII keyboard has its data lines connected to one input port and its strobe line connected to another. The control section of the program first examines the strobe signal and skips to the frequency-measurement section if no key is depressed. If a key is pressed, a subroutine in my monitor program is called which converts the ASCII to Baudot and drives the printer. The subroutine checks for control characters and returns immediately when one is encountered. The TU program then checks for `F` (control B) or `f` characters, which cause exits to either a RTTY transmit routine or the control level of my monitor program. `T`, `TN`, or `fR` characters are stored for later reference; they signify Tune (no printing), Normal (low tone is mark), and Reverse (high tone is mark).

The frequency measurement portion of the pro-

![Fig. 2. Flowchart for frequency measurement by cycle timing. Note that this simple version times the duration of a half cycle of input.](image)

```
START
IN AUDIO
MOV B,A
INR C
IN AUDIO
CMP B
JZ LOOP
MOV A,C
OUT DISPLAY
JMP START
reset counter
get input
increment counter
get new input
compare with first input
otherwise display count
and do it all again
```

![Fig. 3. An 8080 program that times half cycles of audio according to the flowchart of Fig. 2. The DISPLAY output port can be a row of LEDs or 7-segment displays which show the count in octal or hexadecimal. The meaning of the count in real-time units will depend on the clock frequency of the processor.](image)
gram works like the routines described in the first part of this article, with two refinements. It doesn’t matter that a simple continuously-cycling routine gives a short count on its first cycle. For RTTY decoding, an accurate count is needed the first time. This problem is solved by an extra loop which causes the computer to wait for the cycle in progress to finish before the following five cycles of audio are timed. The other refinement is a more complicated nesting of the inner and outer loops which keeps the execution time constant regardless of which branch is followed. This is aided by inserting a “nonsense instruction” (MOV B,B) into one branch to compensate for the execution time of the DCR C instruction in the other branch.

All the information needed to accurately tune in a RTTY station and drive the printer is in the output of the frequency measurement section of the program. With analog circuitry, at this point one would use a comparator to decide whether a voltage was above or below a criterion level. Having a count, not a voltage, and having the power of the microprocessor makes possible a six-way decision. Try setting up comparators to do that at the output of a phase-locked loop! I use the various possible outcomes of this six-way decision to light up a row of LEDs on the front panel of my computer. As the receiver is tuned across a signal, the light appears to move from left to right as the audio tone goes from low to high. Fig. 7 illustrates the pattern encountered. Valid signals decrement the same counter. Limits are placed on the maximum and minimum values the noise counter can hold, and, after each frequency measurement, the noise-counter value is compared with an intermediate criterion.

When the criterion is exceeded, operation of the printer is suppressed. With the values given in the listing, printing will proceed when a good signal is decoded one-third of the time. When the signal drops out, the printer is silenced almost immediately, but a fraction of a second of steady mark tone at the beginning of a transmission immediately enables the printer.

The low-pass filter also uses a counter, which I call the signal counter. Mark signals increment this counter and space signals decrement it. The counter is limited to a minimum value of zero and a maximum value of seven. A mark signal is sent to the printer when the value is four or higher; otherwise, a space signal is generated. Thus, at any time, the printer is given a signal corresponding to the majority of the eight previous samples of audio from the receiver. Without some

---

**Fig. 4. Flowchart for an accurate frequency-measurement program that times the duration of n whole cycles of the input signal.**

START
- MVI D,n: set loop counter
- MVI C.O: reset timer counter
- IN AUDIO: get input

LOOP
- MOV B.A: store it
- INR C: increment timer
- IN AUDIO: get new input
- CMP B: compare with first input
- JNC LOOP: if equal to or greater than first repeat cycle
- DCR D: otherwise decrement cycle counter
- JNZ LOOP: and continue timing another cycle
- MOV A,C: when done, retrieve the total count and show it
- OUT DISPLAY: and do it all again

**Fig. 5. The 8080 program corresponding to the flowchart of Fig. 4. The count indicates the duration of n complete cycles of the audio input signal.**

**Table 1. The above locations will probably have to be changed to make the TU program run on a different machine. The values for CRIT1, CRIT2, CRIT3, CRIT4, and CRIT5 will depend on the clock frequency of the computer being used. The other values listed are port numbers or, in the case of PRINT and MONITOR, routines in the author's ROM monitor.**
Program listing for RTTY TU.

The listing is a part of the RTTY receiving routine. It includes a test to recognize a 1C character as a command to leave the transmit routine and return to the receive routine. This is not a misprint as the keyboard is called by a different port number than that used in the control section of the program. I decode two different port numbers for my keyboard; the one used here initiates a WAIT state in the 8080A which is terminated by the falling edge of the keyboard strobe signal. This allows me to simplify the coding used for getting keyboard input in cases like this.

It would be cruel to present a program listing of this sort without pointing out the parts of the program that might need to be changed to make it run on another system. Table 1 lists the instructions which are unique to my own computer. For the most part, patching the program will require changing only I/O port assignments and relocating addresses, but it should be noted that a major and crucial difference between my computer and most others is the clock frequency. My junk-box crystal gives me a clock period of 694 ns instead of the usual 500 ns. The various criteria constants will need to be reevaluated to suit the timing of another system. This can be done experimentally by using a calibrated audio oscillator (calibrate it with the timer program!) and trying different values for each criterion, using the tuning indicator to check results. For example, CRITERION 3 should be a value that causes the low space and high mark lights to blink as the audio input is rocked around 2210 Hz.

Interfacing and Operation

A few pieces of hardware external to the computer are needed, of course. At the input, a circuit such as the one already described in Fig. 1 is needed to convert the receiver audio to digital levels. It will help if a bit of audio filtering precedes this. Fig. 8 shows a simple filter which gives good results when followed by the recommended 10k-Ohm load. The 0.05-uf capacitor should be chosen to give a peak at around 2200 Hz. The last external item
needed is a driver for the teleprinter loop. Fig. 9 shows how I do it. A high-voltage transistor can be used for the switch if one is available. The piggyback circuit shown allows the use of relatively low-voltage "experimenter grab bag" power transistors to switch the high-voltage loop current.

For initial setup, an oscilloscope is convenient to allow determination of the proper audio level. I usually use a simple audio monitor connected right at the computer input port. With this arrangement, I can tell by ear when the audio level is adequate. Tuning is simply a matter of watching the LED display and making corrections when the low mark or high space lights begin to flash.

As I said at the start, one of the advantages of software is the ease of modification. Just sitting down to type this manuscript made me think of four or five changes, and I just had to try them before getting back to the typewriter. I'm sure anyone who tries this method of copying RTTY will come up with other changes. I intend to do some experimenting with different amounts of averaging in the signal counter and different criteria in the noise counter. It also would be possible to add more control signals to instantly modify the criteria and allow for different shifts. Enough information is extracted to allow the generation of control signals for AFC. I would enjoy hearing from readers who undertake some of these improvements.

Fig. 6. Flowchart for complete TU program. Note the 6-way partition of the data for driving the tuning display. The noise counter squelches the printer when there is too much noise present. The signal counter acts as a post-detection low-pass filter.

Fig. 7. Some of the possible combinations seen on the row of LEDs that serve as a tuning indicator. It is very easy to see which way the receiver dial should be tuned to maintain good copy. O = on; • = off.

Fig. 8. A simple 2200-Hz filter. A lower-value resistor will widen the passband. Selecting capacitors from the junk box is the easiest way to tune the filter.

Fig. 9. A TTL-to-60-mA loop interface circuit. Q3 and Q4 could be replaced by a single high-voltage transistor. This piggyback circuit is a useful one for switching high voltages with low-voltage transistors. In my station, I use two unmarked TO-220-type power transistors from a "40 for $1.98" special pack.
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Tie a 6800 to a five-level Teletype™.

Garry Caudell K4HBG
3125 Robin Lynn Drive
Ashland KY 41101

In an earlier article (March, 1978), I discussed the use of a simple search program. In this article, I'll explain hardware and software to tie an SWTPC 6800 to a Baudot Teletype™. Everyone probably knows the disadvantages of the old Baudot machines, such as being slow, having a limited character set, etc. However, on the plus side, they are cheap and compatible with ham radio operation. If you want cheap (but slow) hard copy, or if you want to use the CRT terminal as a glass Teletype, keep reading.

The simplest way to get hard copy is to use the standard SWTPC MP-S board. All you need to build is the clock divider (see Fig. 2). Unfortunately, this board uses an ACIA (6850) chip, and there is no way to tell it that you don't need all eleven bits when you really need only seven (five data bits plus start and stop bits). If you are willing to slow down the already slow printer, it will think that the extra bits are just long stop bits. Trying to copy this way would not work on anything that was sent at near-synchronous speed. The program would need to be changed to accommodate an ACIA (see listing 2 in Fig. 4).

The circuit I used to interface my SWTPC 6800 computer to my Model 15 Teletype is an expansion of the circuit used by Mark J. Borgerson in his article in 73 (November, 1976). It has a PIA (6820) controlling a UART (S-1883). All connections into the PIA are identical to those used by the MP-L board.

The clock for the UART is derived from the 600-baud clock divided by 13. If you are using the 1.843-MHz crystal recommended by Motorola for the MC14411 baud generator chip, this comes out slightly high. If you are using the crystal which SWTPC rec-
Release Yourself

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HARVEST

The winter ended, the grain steward reports the minimum grain amount necessary to feed your people; depending on how much of your reserves were eaten by rats, you may need to purchase additional grain. Underfeeding will cause many serfs to die, and will also severely lower the birth rate. If you fared the winter well, you may be in a position to sell surplus grain or to overfeed your people, which will cause a higher birth rate and attract serfs from less fortunate neighboring towns—something you should consider if you plan to purchase additional land for farming.

You can also speculate in land and grain at this time. The price may vary from year to year, but an average increase is certain.

TAXES

You must now decide the levels of taxation for your community. As in real life, the consequences of your decisions are far-reaching: Set the customs tax too high, and businesses will suffer; a high income tax won’t sit well with the wealthy; and an overburdening sales tax has got to cut down receipts at your markets. Experiment, and you’re sure to find a policy that will work well with your present economy—but changes will surely be needed as your community grows.

You’ve also got to decide a policy for justice. Will you be very fair (costs money, but is great for the economy) or outrageous (taking bribes, selling justice to the highest bidder)? A lenient stance will attract more serfs, while outrageous justice will soon have them fleeing to more pleasant surroundings.

MAP PHASE

The computer will now draw a detailed map of your area. From this map you will be able to determine the adequacy of your defenses, the ratio of workers to acreage, the number of woolen mills and market places, and the size of your castle and cathedral.

PUBLIC WORKS

Your treasury laden with the fruits of a year’s labor, you can now purchase a woolen mill or two, or invest in more market places. Maybe you’ll decide to increase the size of your castle. If you feel that more clergy support might hasten your rise to the throne, build another wing on your cathedral. If your land area has grown quickly, this might be the time to arm another unit of serfs for your regions’ defense. Your computer will now look back at what you’ve accomplished in the last year, and decide if you merit a higher title.

OBITUARY

At this point, the computer will check to see if you’ve reached “the fullness of time.” If so, it will print the year and cause of your death, and your highest rank obtained. Although the computer will no longer offer your turn, the statistics of your reign will be kept in the comparison table until the game’s end. Since it’s who reaches the throne first, or achieves the highest title before death who wins . . . you could still wind up the winner. In any case, you’re sure to end the game a little wiser—and chomping at the bit to play again.

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ommends, it will be slightly low. In either case, it is as close as the rest of the baud rates, if you follow SWTPC recommendations. I don't know why SWTPC did this.) This circuit works well and gives one less variable, as compared to using a tunable oscillator (one less confusion factor when trying to get the thing working).

The A-side of the PIA ties to the receive data side of the UART, with bit 7 used for a data ready indication.

CA2 is used to clear the UART.

The B-side of the PIA is used as an output to drive the UART, with bit 7 used as an input to poll the UART for a buffer empty signal. CB2 is used to strobe the UART to tell it when to transmit data.

I found it useful to connect the UART reset to the SWTPC reset (through a 7404 inverting gate). This may not be necessary, as most UART circuits do not require a reset, but simply ground this pin. I felt that if the UART did not need a reset, this would be well worthwhile to include.

Data in and data out are buffered by the 7404 gates and by 4N33 optical couplers.

In my system, the output is in series with the base of my loop-keying transistor. This allows the printer to

---

Fig. 3. Program listing 1.

#0130 MAX OTTICE
#0135

/* PROGAM TO CONVERT ASCII TO BARIO*/
#0136

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#0254

#0255

#0256

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#0283

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#0291

#0292
operate either from my ST-5 or the computer, without doing any switching. Similarly, the input is a resistor in the loop which allows either the keyboard or the ST-5 input to the computer.

Construction

I am sorry to say that I do not have a nice printed circuit board to build this gadget on. Mine is hand-wired on a piece of vectorboard which is the same size as the SWTPC I/O boards and has the same plug arrangement. For no good reason, I put it on slot 3.

Program

The program to convert ASCII to Baudot (see listing 1) is noteworthy only because of the ease of relocating it. If you have a block-move program, only the memory locations in lines 1130, 1210, and 1220 have to be changed. From here on, relative or indexed addressing is used.

The first part of the program (1040-1110) consists of a lookup table to convert Baudot to ASCII. In the table, the conversion is accomplished by pointing the index register at the start of the table and using the ASCII character (6-bit form) as an offset. Line feed and carriage return are handled as exceptions. No other control characters are allowed (bell might have been useful).

Space is handled as an exception because some machines are set up for unequal shift on space. In the program, space is handled as a letters character only.

The CINT (1120-1140) subroutine is used to restore the flag so that the PIA will be initiated after a reset.

OUTEE (1150) is the point to branch to in order to output a character in “A” accumulator (just like MIKBUG). The first thing it does (lines 1150-1160) is reject any lowercase ASCII. Next, it stores the index register and points the index register to the start of the conversion table (lines 1210-1220).

In line 1230, the program makes sure that we are talking about 7-bit ASCII and then saves the “B” accumulator (line 1240).

The test in line 1260 is to see if the PIA has been initialized or not. It does this by checking to see what is stored in LAST + 1 (line 1510). If it sees a negative value ($FF), it will go through the INT portion (1290-1340) which will initialize the PIA, clear the last flag, and put the printer in letters shift.

If it sees a nonnegative value, it will jump around this section. All this means that, if you have reset the computer, you need to restore the SFF in LAST + 1. This is the purpose of the CINT routine.

Lines 1350-1470 check for carriage return, line feed, and space. If it finds them, it substitutes values for them so they can be printed. Line 1472 rejects all other control characters. Line 1480 converts the character to 6-bit ASCII, and then it is stored to be sent later (1490).

In 6-bit ASCII, if the character is less than hex 20, it is a letter of the alphabet, so we should be in letters shift.

If it is greater than hex 20, we should be in figures shift. Line 1500 reduces the character to either a hex 20 or a zero value. This is compared to the value in LAST + 1 (line 1510) to determine if the printer is in the correct shift. If it is in the correct shift, the program jumps ahead to send the character; otherwise, the appropriate shift is sent (1550-1630).

ASEND (1640) branches to send the character then to SAVX (1680) to restore index register and “B” accumulator and return.

Lookup (1710) does the actual conversion and stores the Baudot character in SEND+1. In lines 1730-1750, the UART is tested to see if it is ready for a new character. 1760-1770 sends the character to the UART. 1780-1820 strobes the UART to tell it that the character can be sent.

Software to input a character is listed in the November article and will not be repeated here.

These two programs do not represent a complete system for RTTY operation, but rather a set of subroutines to be incorporated in such a system. A complete system would need a software FIFO and some form of sense switch operation, so you would automatically switch from the input program to the output program when your transmitter is keyed.

The program listed here can be used to give hard copy on your existing program.

The procedure for finding the correct places and the patching procedures were outlined in my earlier (March, 1978) article.

I would like to say that I am not sure how much of this is my own work and how much was Doug Schwab WA4ZV1’s. Anyhow, thanks to Doug, and thanks to the repeater gang.

Reference

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- Symmetry—Turn your TRS-80 into a kaleidoscope.
- Video Display—Follow a bumping cursor as your TRS-80 draws its own curves.
- Math Curves—Use these mathematical equations to life as the computer draws six different geometrical curves.
- Rug Patterns—A Never ending stream of symmetrical patterns that are sure to spark your imagination.
- All you’ll need is a Level I 16K TRS-80. Order No. 0003R $7.95.

BUSINESS PACKAGE I Keep the books for a small business with your TRS-80 Level I 4K. The six programs included are:
- General Information—The instructions for using the package.
- Fixed Asset Control—This will give you a list of your fixed assets and term depreciation.
- Detailed Input: This program gives you and record your general ledger on tape for fast access.
- Monthly and Year to Date Merge—This program will handle your monthly ledger data and give you a year to date ledger.
- Profit and Loss—With this program you can quickly get true balance and profit and loss statement.
- Year End Balance—This program will combine all your data from the profit and loss statements into a year end balance sheet.
- With this package, you can make your TRS-80 a working partner. Order No. 0013R $29.95.

BUSINESS PACKAGE II This package can change your TRS-80 into a full working partner for any businessman:
- Inventory—Maintain a computer based inventory for your company.
- Discount and Commission Percentages—Let your computer figure out mark up and discount calculations, sales tax and more. This is a perfect time saving package for any small business.
- For the TRS-80 Level I 4K. Order No. 0001R $7.95.

CAVE EXPLORING/YACHT/MEMORY These three programs are not only fun, but stimulating as well.
- Cave Exploring—Search for fabulous treasures as you explore the magic cave. It’s almost hypnotic!
- Yacht—A two player game of strategy and chance. The computer rolls the dice and keeps score.
- Memory—Two players can pit their memories in this program based on a popular television show. You’ll need a TRS-80 with Level I and 16K. Order No. 0010R $7.95.

CAR/CAT/RAPID TRANSPORT/RAIL This challenge game lets you take on the role of a car owner.
- Car Race—You and a friend can race on a choice of two tracks.
- Rat Trap—Trap the rat in his maze with your two cats.
- For one or two players.

STATUS OF HOMES/AUTO EXPENSES Two long-awaited programs that have got to save you money at work or in the home:
- Status of Homes—This program will allow you to keep track of all the expenses involved in building one house or an entire subdivision.
- Auto Expenses—Find out exactly what it costs you to drive your car or truck.

These programs require a TRS-80 Level I 4K. Order No. 0021R $7.95.

FAMOUS AMOS TRAP/AIR CRANE This four-game package is sure to provide hours of fun for the whole family.
- Hex—Turn your TRS-80 into a model of artificial intelligence by playing a simple game.
- Shuffle Card Decking—Land your shuffle deck on the starshaped field through dangerous gravity fields.
- Space Chase—Seek out and destroy the enemy delta that’s hidden in the star field.
- Sea Battle—You must find and destroy the enemy fleet.

This package requires a TRS-80 Level I 16K. Order No. 0015R $9.95.

DEMO I This package is just the thing to show your friends what your TRS-80 can do. Included are:
- Computer Composer—Compose and play music using only a standard ASCII file.
- Horse Race—Place your bet and cheer your pony to the winner’s circle.
- E.S.P. Test your powers of extrasensory perception.
- Hi-Lo Tic-Tac-Toe—Guess the secret number or get three in a row.
- Petals Around the Rose—Can you figure out the secret behind the five dice?
- Slot Machine—Turn your computer into a one-armed bandit. This program requires a TRS-80 Level I 4K. Order No. 0020R $7.95.

PERSONAL FINANCE I Let your TRS-80 handle all the tedious details the next time you figure your finances.
- Personal Filing—With this program you can control your income and outgoing expenses.
- Checkbook—Your TRS-80 can balance your checkbook and keep a detailed list of expenses for tax time.

This handy financial control package for the home requires only a TRS-80 Level I 4K. Order No. 0027R $7.95.

SPACE TREK IV Trade or wage war on a planetary scale. This package includes:
- Stellar Wars—Engage and destroy Tie fighters in your attack on the Death Star. For one player.
- Population Simulation—A two-player game where you control the economy of two neighboring planets. You decide, gun or butter, with your TRS-80 Level I 16K. Order No. 0002R $7.95.

DOODLES AND DISPLAYS II Wait until your children get a hold of this package:
- Doodling Pad—Draw pictures and save them on cassette tapes.
- Symmetry—An electric kaleidoscope that changes from black and white to color. It’s almost hypnotic!
- Drawing—Like Doodle Pad but for the serious artist. Over 40 user commands. The computer does the drawing, but those finicky fingers can’t tamper.
- Rug Patterns—Yes, it does design rug patterns and, with a choice of user or computer control, it can do a whole lot more.

For the Level II 16K TRS-80. Order No. 0042R $7.95.

RAMROM PATROL/ITE FIGHTER/KLINGON CAP Buck Rogers never had it so good. Engage in extraterrestrial warfare with:
- Ramrom Patrol—Destroy the Ramrom ships before they capture you.
- Tie Fighter—Destroy the enemy Tie fighters and become a hero of the new galactic age.
- Klingon Capture—You must capture the Klingon ship intact. It’s you and your TRS-80 Level II 16K battling across the galaxy. Order No. 0028R $7.95.

CARDS This one-player package will let you play cards with your TRS-80—talk about a poker face!
- Draw and Stud Poker—These two programs will keep your game sharp.
- No-Trump Bridge—Play this popular game with your computer and develop your strategy.

This package’s name says it all. Requires a TRS-80 Level II 16K. Order No. 0083R $7.95.

BOWLING LEAGUE STATISTICS SYSTEM This package is the answer to the players of harried bowling league scorekeepers. The Bowling League Statistics System will keep a computerized list of league data, team data, and league data for the entire season. It is extremely flexible and has a total of 16 different options to let you modify the program to suit your league’s rules. The program is very easy to use and has extensive “built in” aids to help you along. Requires TRS-80 Level II 16K. Order No. 0056R $24.95.

Level I and II BACKGAMMON/KENO Why sit alone when you can play these fascinating games with your TRS-80?
- Backgammon—Play against the computer. Your TRS-80 will give you a steady challenging game that’s sure to sharpen your skills.
- Keno—Enjoy this popular Las Vegas gambling game. Guess the right numbers and win big.

You’ll need a TRS-80 Level I or II. Order No. 0004R $7.95.

OIL TYCOON Avoid oil spills, blowouts and dry wells as you battle to become the world’s richest oil tycoon. Two players become the owners of competing oil companies as they search for oil and sell their companies. Requires a TRS-80 4K Level I or II. Order No. 0022R $7.95.

BOWLING Let your TRS-80 set up the pins and keep score. One player can pick up spares and get strikes. For the TRS-80 Level I 4K, Level I 16K. Order No. 0012R $7.95.

AIR FLIGHT SIMULATION Turn your TRS-80 into an airplane, you can practice takeoffs and landings with the benefit of full instrumentation. This one-player simulation requires a TRS-80 4K Level I 4K, Level I 16K. Order No. 0017R $7.95.

GOLF/CROSSOUT Have fun with these exciting one-player games. Included are:
- Golf—you won’t need a mashie or putter or a caddy, for that matter, to enjoy a challenging 18 holes.
- Crossout—Remove all but the center peg in this puzzle and your neighbors will call you a genius.

You’ll need a TRS-80 Level I 4K, Level I 16K. Order No. 0009R $7.95.
HAM PACKAGE This versatile package lets you solve many of the commonly encountered problems in electronics design. With your Level I 4K or Level II 16K TRS-80, you have a choice of:
- Basic Electronics with Voltage Divider—Solve problems involving Ohm's Law, voltage dividers, and RC time constants.
- Dipole and Yagi Antennas—Design antennas easily, without tedious calculations.

This is the perfect package for any ham or technician. Order No. 0007R $7.95.

BASIC AND INTERMEDIATE LUNAR LANDER Bring your lander under manual control. The Basic version is for beginners; the Intermediate version is more difficult with a choice of landing areas and rugged terrain. For one player with a TRS-80 Level I 4K, Level II 16K. Order No. 0001R $7.95.

SPACE TREK II Protect the quadrant from the invading Klingon warships. The Enterprise is equipped with phasers, photon torpedoes, impulse power, and warp drive. It's you alone and your TRS-80 Level I 4K, Level II 16K against the enemy. Order No. 0002R $7.95.

ELECTRONICS This package will not only calculate the component values for you, but will also draw a schematic diagram, too. You'll need a TRS-80 Level I 4K, Level II 16K to use:
- Tuned Circuits and Coil Winding—Design tuned circuits without resorting to cumbersome tables and calculations.
- 555 Timer Circuits—Quickly design astable or monostable timing circuits using this popular IC.
- LM 381 Preamp Design—Design IC preamps with this low-noise integrated circuit.

This package will reduce your designing time and let you build those circuits fast. Order No. 0008R $7.95.

SANTA PARAVIA AND FIU M ACCIO Become the ruler of a medieval kingdom as you struggle to create a kingdom. Up to six players can compete to see who will become the King or Queen first. This program requires a 16K TRS-80 Level I & II. Order No. 0043R $7.95.

PET**

QUICIC-4GO MOKU Play two ancient games on your modern PET. The two programs included are:
- Quicic—A multi-dimensional game of tic-tac-toe.
- Go-Moku—Line up five of your men while blocking the PET's moves. These one player games require 8K of memory. Order No. 0038R $7.95.

TREK-X Command the Enterprise as you scout the quadrant for enemy warships. This package not only has superb graphics, but also includes programming for optional sound effects. A one-player game for the PET 8K. Order No. 0032P $7.95.

MORTGAGE WITH PREPAYMENT OPTION/FINANCER These two programs will more than pay for themselves if you mortgage your home, or make investments.
- Mortgage with Prepayment Option—Calculate mortgage payment schedules and save money with prepayments.
- Financier—Calculate which investment will pay you the most, figure annual appreciation, and compute the cost of borrowing, easily and quickly.

All you need to become a financial wizard is an 8K PET. Order No. 0006P $7.95.

CASINO These two programs are so good, you can use them to check out and debug your own gambling system:
- Roulette—Pick your number and place your bet with the computer version of this casino game. For one player.
- Blackjack—Try out this version of the popular card game before you go out and risk your money on your own "surefire" system. For one player.

This package requires a PET 8K. Order No. 0014P $7.95.

CASINO II This craps program is so good, it's the next best thing to being in Las Vegas or Atlantic City. It will not only play the game with you, but also teach you how to play the odds and make the best bets. A one player game, it requires a PET 8K. Order No. 0015P $7.95.

CHECKERS/BACCARAT Play two old favorites with your PET.
- Checkers—Let your PET be your ever-ready opponent in this computer-based checkers program.
- Baccarat—You have both Casino- and Blackjack-style games in this realistic program. Your PET with 8K will offer challenging play anytime you want. Order No. 0022P $7.95.

TANGLE/SUPERTRAP These two programs require fast reflexes, and a good eye for detail.
- Tangle—Make your opponent crash his line into an obstacle.
- Supertrap—This program is an advanced version of Tangle with many user control options. Enjoy these exciting and graphically beautiful programs. For one or two players with an 8K PET. Order No. 0028P $7.95.

DIGITAL CLOCK Don't let your PET sit idle when you are not programming, put it to work with these two unique and useful programs:
- Digital Clock—Turn your PET into an extremely accurate time-piece that will enable you to display local time, time in distant zones, and split time clock for up to nine different zones.
- Moving Sign—Let the world know what's on your mind. This program turns your PET into a flashing graphic display that will put your message across. Order No. 0083P $7.95.

PENNY ARCADE Enjoy this fun-filled package that's as much fun as a real penny arcade—at a fraction of the cost.
- Poetry—Compose free verse poetry on your computer.
- Trap—Control two moving lines at once and test your coordination.
- Poker—Play five card draw poker and let your PET deal and keep score.
- Solitaire—Don't bother to deal, let your PET handle the cards in this "old favorite" card game.
- Exit-Em-Ups—Find out how many stars your gobbler can eat up before the game is over. These six programs require the PET 8K. Order No. 0044P $7.95.

GOLF Without leaving the comfort of your chair, you can enjoy a computerized 18 holes of golf with a complete choice of clubs and shooting angles. You need never cancel this game because of rain. One or two players can enjoy this game on the Apple with Applesoft II and 20K. Order No. 0018A $7.95.

DATA TAPES Use these high quality data tapes to record business or personal data. Four tapes per package. Order No. 0067 $7.95.

MIMIC Test your memory and reflexes with the five different versions of this game. You must match the sequence and location of signals displayed by your PET. This one player program includes optional sound effects with the PET 8K. Order No. 0039P $7.95.

PERSONAL WEIGHT CONTROL/BIORHYTHMS Let your PET help take care of your personal health and safety.
- Personal Weight Control—Your PET will not only calculate your ideal weight, but also offer a detailed diet to help control your caloric intake.
- Biorhythms—Find out where your critical days are for physical, emotional, and intellectual cycles.

You'll need only a PET with 8K memory. Order No. 0055P $7.95.

BASEBALL MANAGER This pair of programs will let you keep statistics on each of your players. Obtain batting, on-base, and fielding averages at the touch of a finger. Data can be easily stored on cassette tape for later comparison. All you need is a PET with 8K. Order No. 0062P $14.95.

Apple**

BOWLING/TRILOGY Enjoy two of America's favorite games transformed into programs for your Apple.
- Bowling—Up to four players can bowl while the Apple sets up the pins and keeps score. Requires Applesoft II.
- Trilogy—This program can be anything from a simple game of in-calc-loe to an exercise in deductive logic for one player. This fun-filled package requires an Apple with 20K. Order No. 0040D $7.95.

DOW JONES Up to six players can enjoy this exciting stock market game. You can buy and sell stock in response to changing market conditions. Get a taste of what playing the market is all about. Requires a PET with 8K. Order No. 0012P $7.95.

DUNGEON OF DEATH Battle 90 demons, cast magic spells, and accumulate gold as you search for the Holy Grail. You'll begin your quest in the Dungeon of Death and proceed through the sulfocating darkness. If you survive, glory and treasure are yours. For the PET 8K. Order No. 0084P $7.95.

***

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Golf

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***A trademark of Apple Computer Inc.

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Shipping and handling

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— when you call, they listen

From the folks who brought you the “Towerless ‘Tower.’”

Robert H. Walker K4FK
400 Tivoli Ave.
Coral Gables FL 33143

Roy D. Mazzagatti N4OG
18551 S. W. 204th St.
Miami FL 33187

Photos by WA4KIL

Hy-Gain’s “tiger on 20,” the popular 204BA 4-element monoband yagi, exhibits the excellent performance which can be obtained from a relatively small close-spaced yagi array. For over a decade, the one at K4FK has been performing flawlessly and giving no maintenance problems. Originally, the antenna was up 77 feet on a Rohn tower. A move to a new QTH in 1971 limited us to mounting it on a telescoping TV mast at heights between 12 and 20 feet (see Walker and Mazzagatti, “The Towerless ‘Tower,’” 73 Magazine, June, 1978). Even at such low heights, the 204 has proven itself competitive in pileups.

With the recent upturn in the sunspot cycle, we decided to try interlacing a 15 meter yagi with the 204BA on the Hy-Gain boom. According to The ARRL Antenna Book, “It is generally accepted that interaction, if any, is very minimal between bands which are not harmonically related.” Would this hold true in practice? Our empirical experimentation has essentially validated that quotation. The result has been a much more versatile antenna, with no degradation in 20 meter performance.

We began by constructing one 15 meter element and placing it near the boom. The SWR on 20 meters immediately jumped to 1.7 to 1 from 1.3 to 1. Moving the 15 meter element along the boom and rotating it in and out of the plane of the 20 meter elements produced no further changes. As soon as the 15 meter element was placed within a yard of the boom, the SWR climbed. We moved it further away, and the SWR returned to normal. We tried the same experiment using a 10 meter ele-

Photo A. A most unorthodox 204BA. Nine elements and two gamma matches radically alter its appearance!

Photo B. A view of the “business end.” The result is usually heard around the world.
The only thing we can't disguise is the professional quality of amateur antennas.

FREE decal just for fun!

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The price is $49.95 in the U.S. and Canada. Add $2.00 shipping/handling. California residents add sales tax.

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- Adjust it to your operating frequency quickly and easily.

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The Palomar Engineers R-X Noise Bridge tells you if your antenna is resonant or not and, if it is not, whether it is too long or too short. All this in one measurement reading. And it works just as well with ham-band-only receivers as with general coverage equipment because it gives perfect null readings even when the antenna is not resonant. It gives resistance and reactance readings on dipoles, inverted Vees, quads, beams, multiband trap dipoles and verticals. No station is complete without this up-to-date instrument.

Why work in the dark? Your SWR meter or your resistance noise bridge tells only half the story. Get the instrument that really works, the Palomar Engineers R-X Noise Bridge. Use it to check your antennas from 1 to 100 MHz. And use it in your shack to adjust resonant frequencies of both series and parallel tuned circuits. Works better than a dip meter and costs a lot less. Send for our free brochure.

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ment, and, interestingly enough, there was no effect on the 20 meter swr. Bringing a Hy-Gain DB10-15A 3-element trap duobander close to the 204 produced a similar effect to that produced by the 15 meter element alone. Obviously, there was some interaction. Was it sufficient to reduce the 20 meter efficiency?

We tested for any 20m degradation by mounting three 15m elements on the boom and then using the beam normally on 20m over a period of several weeks. The additional elements did not increase the interaction over that introduced by the initial element, and we could detect no difference in the beam's 20 meter operation. The 15 meter beam would function correctly, there appeared to be no reason why we couldn't interface it with the 204BA. It would be desirable to provide an easily-adjusted matching system for each of the yagis, however.

One thing which we had noticed over the years of using the antenna at extremely low heights was how profoundly its capacitive coupling to the building was reflected in impedance excursions during rotation. Most annoying—rotate the array a few degrees, and then retouch the transmitter tuning. The better the antenna and feedline are matched, the less pronounced this effect becomes.

**20 Meter Modifications**

Hy-Gain's beta match is an inductive "hairpin" type of matching device. We decided to replace it with a more easily adjusted gamma match. Commercially manufactured coaxial capacitor-style gamma matches are much easier to install and maintain than are those which require a separate air variable capacitor in a waterproof enclosure. Viking Instruments* and Gotham Antennas** both market such a gamma match. We settled on the Gotham unit because it is a lower-Q device, which makes adjustment easier and less critical. Additionally, the Gotham gamma match is mechanically stronger and doesn't tend to fill with water and short out, as did two of our Viking matches.

The Hy-Gain driven element is split at the center for use with the beta match. We made it into a one-piece element by wrapping heavy-duty aluminum foil over the plastic center insulators and out over the element.

*Viking Instruments, 73 Ferry Rd., Chester CT 06412.
**Gotham Antennas, 2051 N.W. 2nd Ave., Miami FL 33127

An ohmmeter check showed that since the driven element halves were installed in the element-to-boom bracket, continuity was excellent. The aluminum foil should be covered with electrical tape and waterproofed by coating the tape with a sealant such as a popular uncured silicone rubber compound. For good measure, we attached a piece of coax braid between the two element halves as well.

Make sure you obtain good continuity between the driven element and the boom as well, if you plan to attach your feedline braid to the bracket which mounts the gamma match to the boom. Otherwise, attach the braid to the center of the driven element, not to its mounting bracket. It's also a good idea to run a bolt through the gamma tube itself for attaching the coax center conductor rather than relying on the U-bolt as the instructions suggest.

The length of the driven element wasn't altered from Hy-Gain's CW specification. The beta match, being an inductive device, probably requires a slight shortening of the driven element. Our method of making the driven element into an electrically one-piece element effectively lengths it slightly. Therefore, resonance does not noticeably change. One additional benefit occurs as a result of this conversion. The 204BA will now display better bandwidth characteristics across the entire 20 meter band.

**15 Meter Construction**

Fig. 1 shows the spacing of both sets of elements along the boom. We had originally constructed the antenna with the 20 meter reflector mounted at one end of the boom, and the remainder of the elements spaced according to Hy-Gain's instructions. This left 2 inches of boom unused beyond the 20 meter second director. We chose to mount the 15 meter third director in this area to maximize its spacing. If you don't have room to do this on your particular 204BA, you can move that director inside of the 20 meter second director.

<table>
<thead>
<tr>
<th>Element</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reflector</td>
<td>23' 5-1/2&quot;</td>
</tr>
<tr>
<td>Driven Element</td>
<td>22' 6-1/2&quot;</td>
</tr>
<tr>
<td>1st Director</td>
<td>21' 6-1/2&quot;</td>
</tr>
<tr>
<td>2nd Director</td>
<td>21' 1-3/8&quot;</td>
</tr>
<tr>
<td>3rd Director</td>
<td>20' 8-1/4&quot;</td>
</tr>
</tbody>
</table>

Fig. 2. 15 meter element lengths.
The aluminum foil on the 20 meter driven element.

PHOTO D. White material on the gamma matches and over the electrical tape is GE Silicone Seal. It also protects the aluminum foil on the 20 meter driven element.

A wall thickness of .041 inches, while our 7/8-inch tubing has a wall thickness of .035 inches. This combination produces a nicely telescoping assembly.

**Adjustment**

The gamma matches are adjusted in the normal manner, 20 meters first, and then 15. A good starting point for the shorting strap is a distance of 10 percent of the total length of the driven element, out from the center of the driven element. Preset in this fashion, both sections displayed an SWR of less than 1.8 to 1 prior to any additional adjustment. Slide the coaxial capacitor part of the gamma match in and out until lowest SWR is obtained. Then move the shorting strap a half inch and readjust the coaxial capacitor. By alternating these adjustments, you should easily find a combination which yields an SWR of 1.2 to 1, or less.

It is ideal, of course, to adjust the gamma matches with the antenna in its final operating position. Most of us cannot accomplish this. We have found that the SWR changes only slightly once the antenna is installed if it has been carefully adjusted either on top of a ladder or pointed vertically into the air with its reflector resting on the ground.

**Performance**

Figs. 3 and 4 show the SWR curves on the 15 and 20 meter bands, respectively. It is quite permissible (although purists may disagree) to use the gamma matches to “fudge” the resonant frequencies a bit, if desired. Our matches were adjusted for lowest SWR at 21.125 and 14.025 MHz. The 20 meter performance remains, as far as we can observe, absolutely unchanged except for the previously mentioned improvement in bandwidth.

We have no way to measure the forward gain on 15 meters. However, “if you point it at ‘em and give ‘em a call . . . you usually get a reply.” The front-to-back ratio on 15 meters runs about 20 to 25 dB and the front-to-side is just about 40 dB.

**Some Thoughts**

We were so pleased with this project that we decided to try to add 10 meters as well. Predictably, the interaction was so bad that we had to forego our attempts to triband the 204BA. The 10 meter elements didn’t affect the performance on either 15 or 20 meters. We were just unable to make the 10 meter section perform as a beam. One set of adjustments gave us a slight bit of gain—off the reflector! Another set provided an omnidirectional pattern with signal levels about three S-units under a dipole. In no case did it make any difference whether the 10 meter elements were insulated from the boom or not. We would very much like to hear from anyone who successfully adds both 10 and 15 meter elements to a 204BA. That would surely be a most impressive tribander!

**Parts Availability**

In cooperation with Gotham Antennas, we are offering a complete kit to interlace five 15 meter elements with an existing 204BA. Elements, hardware, both gamma matches, and instructions are included. Please send an SASE for details.

**Bibliography**

Here’s a “Twist”
—an OSCAR antenna with a difference

Introducing the 8XY/2M.

Dave Ingram K4TWJ
Eastwood Village No. 1201 S.
Rt. 11, Box 499
Birmingham AL 35210

If you are one of the many amateurs who has experienced communication via our OSCAR orbital satellites, you know the challenge and enjoyment of satellite operations. The various aspects of OSCAR communications have something to catch nearly everyone’s fancy: convenient operating times, orbital calculations and tracking systems, duplex style operating, unobtrusive antenna setups, low TVI levels, etc. Amateurs with limited time available to enjoy on-the-air operations truly appreciate the pinpoint-accurate communication times synonymous with satellite passes. What else could one ask?

As with any station setup, the antenna system plays a major role in its performance. Quite simply, it’s what’s “up top” that counts! A poor skywire can undermine the most elaborate amateur setup, while an efficient antenna can make a mediocre setup perform like a million dollars. OSCAR setups are no exception to this rule. If you plan to fully enjoy OSCAR, you’ll definitely benefit from using an antenna designed for satellite operations. Such an antenna is the 8XY/2M 8-element, 2-meter “Twist” antenna distributed by Spectrum International.

I found that assembling the 8XY/2M antenna was a refreshing change from the usual time-consuming task of rigging clamps and measuring element mounting locations. This gem went through smoothly in an hour’s time, with heavy-duty bolts and wing nuts making hand-assembly a snap. Not a single tool was required until transmission lines were connected to

The Spectrum International 8XY/2M OSCAR antenna is mounted on a 30-foot push-up mast which is tilted 30 degrees. This “skyward tilt” bypasses elevation rotor needs.
the driven elements. Each element of the S.I. "Twist" is ¼-inch aluminum tubing which is precut and capped with color-coded tips to aid assembly. The boom is also predrilled and color-coded to ensure quick, foolproof assembly. All hardware for the antenna is preassembled, and an extra element-mount is included in case one becomes lost or broken. The massive boom-to-mast clamp could support a triband beam. Very nice! I must admit that this was the first time I've enjoyed (sort of) constructing an antenna.

The 8XY/2M antenna can be fed four different ways to obtain either vertical, horizontal, right-hand circular, or left-hand circular signal polarization. A ready-to-install phasing harness for circular polarization is available from Spectrum International, or you can fabricate your own harness from details supplied in various antenna books. Since I didn't care to kill time building a harness, I used the S.I. unit—and I'm glad I did.

If a fixed polarization is desired, the harness can be mounted at the antenna proper. If various polarizations are desired (for operating various modes of OSCAR), two transmission lines can be run from the antenna's driven elements and the phasing harness placed at the operating position. A coax switch can then be used to select the required polarization.

My Spectrum 8XY/2M antenna replaced a 2-month-old, 3-element array previously used for satellite work, and a significant signal improvement was realized. Suddenly, I was able to easily access the satellite and "stay into" the transponder for a longer period of time during each pass. I also noticed that my signal wasn't as prone to the heavy fades which were apparently due to polarization shifts during passes. This gain alone was worth the change to Spectrum's 8XY/2M antenna, as it allowed me to successfully operate slow scan TV via satellite.

When OSCAR 8 was placed in orbit, I decided to remove a few director elements from the 8XY/2M to reduce my ERP to this new "bird." This antenna change worked very well, but a couple of days later, OSCAR 8 lost sensitivity and I had to replace the removed elements. Hopefully this satellite problem is merely an overloading situation which will soon be rectified.

I truly feel that the 8XY/2M antenna was a prime factor in my operations of successfully transmitting the first SSTV pictures via OSCAR 8 during orbit 102. Since I have only one small TV rotor to use with the 8XY/2M, I bent the rotor-to-boom mast approximately thirty degrees. This tilt allows the antenna to "look skyward," and bypass elevation rotor requirements.

In conclusion, I think amateur satellite communication and Spectrum's 8XY/2M are an ideal combination which all amateurs would thoroughly enjoy experiencing. There's no better way of renewing one's interest in amateur radio than by trying a new aspect of communication.

The 8XY/2M antenna is available from Spectrum International, Inc., P.O. Box 1084, Concord MA 01742. This 16-element array (8 elements vertical, 8 elements horizontal) is in the $45 to $50 price class.
A Fortified 2m Whip — won’t bend in the breeze

Are you in need of a good 2 meter mobile antenna? How about an antenna for your base station? Or, do you just plain have the feeling that your station has become too commercialized and that a portion of your setup should be home-brewed? Then, why not try this antenna project? In actual checks, it was found to compare favorably with the commercially-made antennas tested. Whether you decide to use the antenna for mobile or base station operation, you’ll be pleasantly surprised with its performance. The antenna is easy to construct and tune, and, best of all, it’s inexpensive.

Design

One unique feature of this antenna is the construction of the whip. It consists of a 1/4"-diameter fiberglass rod with a shield of copper braid. This design was selected because it provided rigidity to minimize deflection during high winds or mobile operation. Research has shown that deflection of the flimsy-type whip causes degradation of the vertically polarized signal. In some instances, the efficiency of a 5/8-wave antenna actually becomes less effective than a 1/4-wave antenna.

The fiberglass rod is from the pennant-topped-type whip that is made for mounting on bicycles. Many retail stores have given away these whips as promotional items. They also are readily available from department stores and bicycle shops for approximately $1.25.

The impedance matching coil is 3 turns of no. 14 tinned copper wire wound on a wood thread spool from your XYL’s sewing basket. It is tapped 1-1/8 turns from the ground end. A small ceramic trimmer capacitor across the coil provides a precise match in conjunction with the base coil tap. The impedance matching circuit is protected from the weather by enclosing it in an empty plastic container. Fish food had come in the container we used.

Construction and Assembly

Since no tricky construction or special tools are needed, no problems should be encountered. The fiberglass rod is prepared by drilling the 1/16"-diameter hole from the bottom as indicated in the diagram. Another 1/16"-diameter hole is drilled on the side of the rod at point A. This should be drilled at a slight angle towards the bottom to make the routing of the coil tap wire easier. The depth of this hole is only to the extent of meeting with the hole previously drilled from the bottom. When drilling these holes in the fiberglass rod, it is important to use a sharp drill and not allow the drill to heat up. It is best to cut the whip to proper length after the coil form is secured in place.

Prepare the coil form and other parts as indicated. Check that the hole in the spool is of the proper...
diameter to permit the spool to slide on the rod. The notches filed into the coil form prevent the coil from slipping. The hole for the coil tap is displaced 1/8 of a turn from the alignment of the bottom notch.

After the coil form is prepared, feed the 20-AWG tap wire through the tap wire hole and out the bottom of the spool. Slide the form over the fiberglass rod and carefully route the tap wire through the drilled hole at point A and downward through the rod, out the bottom. Allow sufficient length for the tap wire to be soldered later in the PL-259 connector. Apply epoxy glue to the appropriate rod area, slide the coil form into its proper position on the rod, and take up any slack in the top wire. The final position of the coil form should be such that the tap-wire holes in the spool and the rod line up with each other, and the rest extends sufficiently below the bottom of the spool to accept the UG-176 adapter. To hold the tap wire securely in position, apply a small amount of epoxy to the tap wire opening in the spool and at the bottom of the whip.

Two holes must be drilled in the cover of the coil protector. A 1/4" hole in the center will permit it to be slipped over the bottom of the whip. With the cover in position on the whip, use the notch of the coil form for determining the position of the second hole. This is a 1/8" hole and should be drilled in the correct position to allow the ground end of the coil wire to pass through the cover and be soldered to the PL-259 connector. After both holes are drilled in the cover, epoxy the cover (threads towards the coil form) to the bottom of the wood spool. Position the feedthrough hole in the cover so that the tap occurs at 1-1/8 of a turn when the coil is added.

With epoxy applied to the bottom of the fiberglass rod, slide the UG-176 reducer onto the rod and up against the container cover. Check that none of the other parts has slipped from its proper position. At this point of construction, it is best to allow the epoxy to harden before proceeding.

After the epoxy hardens, the UG-176 reducer can be screwed into the PL-259 and the tap wire soldered in the center pin. Measure 42 1/2 inches from the top of the coil form and cut the whip to length.

The next step is to slide the copper braid shield over the fiberglass rod. Tinned braid is recommended. However, if this is not readily available, the shield from RG-8/U coax cable will work fine. If the braided shield is too snug to readily slip over the rod, the diameter of the shield can be enlarged by squashing the braid together a little bit at a time. If the diameter of the shield has to be enlarged to any extent, be sure to allow for the shrinkage in length that will occur. The braided shield is slipped over the full length of the rod down to the coil form. The shield can be snugged to the rod by running your hand tightly along the braid.

One end of the coil is secured by routing a 24" piece of 14-AWG wire through the hole in the cover and soldering it to the side of the PL-259 connector. With the end secured, the 3-turn coil can then be easily wound on the form and soldered to the whip shield. Solder the tap wire 1 1/8 turns from the coil bottom (ground) and the trimmer capacitor across the entire coil. Cut off the braid shield so that it extends 3/8" above the top of the rod; twist and solder. To protect the whip from the weather, shrink tubing, plastic electrical tape, or a protective spray can be used.

Mounting

For base station operation, I used a simple L-shaped aluminum bracket with an SO-239 connector, RG-58 cox, and four 19 1/4" ground radials. This arrangement is secured with U-bolts to the mast above a triband beam. For mobile operation, the bracket design is dependent on the type of car and individual desires. For my mobile operation, I mounted a simple bracket and connector arrangement directly to the luggage rack.

Tuning

The easiest method to tune the antenna is with a field-strength meter at a distance of approximately 2 to 3 feet. With the antenna connected and the transmitter keyed on an unused simplex channel, adjust the trimmer capacitor with a non-metallic screwdriver for a peak field-strength indication. The VSWR will be minimum at this point. Numerous antennas have been built, and on all occasions, VSWRs of less than 1.2 to 1 were obtained. The antenna, of course, should be situated away from all objects and as high off the ground as practical during tuning procedures.

With a 5/16"-diameter hole drilled in the bottom of the plastic container to accommodate the whip, slide the container over the whip and screw it into its cover. If the container affects the tuning of the antenna, drill a hole in its side and return the antenna with the container in position. With RTV, seal the top opening of the container, but not the bottom. The hole in the cover will help prevent any moisture from accumulating.

Do you want to generate conversation? Just mention on your local repeater the fact that you’re using a home-brew antenna.
Ageless Wonder: the Collinear Beam
—sure beats a dipole

Good results for a few dollars.

C. Stewart Gillmor W1FK
Spencer Road
Higganum CT 06441

Ever since the ready availability of aluminum tubing after the second World War, yagi beams have been popular with hams. More recently, quads have joined as popular antennas for the HF bands. These parasitic array antennas have a number of attractive features, including high gain, unidirectional radiation, and rotatability. Realization of their full potential, however, requires relatively expensive support equipment, including tower and rotor.

I have enjoyed using collinear wire beams, which give reasonably narrow bidirectional radiation patterns. These arrays are composed of elements arranged in a straight line.

Each element is connected to the next by a phasing stub so that all elements operate in phase. The collinear antenna is often used at VHF and UHF in vertical orientation, but at HF it is only practical to erect horizontal collinear antennas. Collinear antennas have long been used in military applications, or in any situation where need exists for a rugged, directive HF antenna which can quickly be erected and which can deliver good performance. Especially for the Novice or for the ham on a budget, the collinear should be considered because it is easy to construct and it is inexpensive.

Many antenna texts discuss collinear antennas, but few provide complete design information. Particularly omitted is information on impedances. Collinear antennas may use elements of varying electrical length, but most common is the one-half wavelength element. Collines may have as many as 6 elements. Because of mutual coupling and increasingly uneven current distribution obtained as one adds elements, most hams have built collinears with 2 or 3 elements. Highest gain is obtained if the antenna elements are spaced with 0.4 or 0.5 wavelengths of space between the ends of the elements, but this introduces construction problems. Less gain but much simpler design results from separating the elements only by use of an insulator.

I give design criteria below for 3-element 20 meter and 5-element 15 meter collinears, each of which requires less space to erect than an 80 meter dipole. I also give data on impedance characteristics at and near resonance to aid in selecting a suitable feedline. Many collinears are fed between the ends of the elements, where a very high impedance exists. In the antennas described below, feed occurs in the center of an element at a relatively low impedance, high current point. This permits a good match to 300- or 600-Ohm balanced lines. If one prefers, a 4:1, 6:1, or 9:1 ratio balun may be inserted so that the antennas may be fed directly with coax. My collinears are fed with balanced line, and a balun is introduced just outside the shack.

I was not able to find information on the impedances met when feeding collinears at current points, so I performed measurements on 3- and 5-element collinears suspended ¼ to 1 wavelength above ground. The impedances were measured on my Boonton 250-A “RX” meter. The impedance at resonance of the 3-element centered antenna was found to be 372 Ohms resistive; the 5-element antenna showed an impedance at resonance of 600 Ohms. Each of these antennas operates across an entire ham band with VSWR of less than 1.5:1 (±1% of design frequency), using no matching device except a

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Dimensions</th>
<th>½-wavelength in feedline</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A  B  C</td>
<td>coax V = 0.66  twinlead V = 0.82</td>
</tr>
<tr>
<td>21.2 MHz</td>
<td>11' 4&quot;  22' 7½&quot;  9' 6&quot;  15' 4&quot;  19' 0&quot;</td>
<td></td>
</tr>
<tr>
<td>14.15 MHz</td>
<td>16' 6½&quot;  33' 1½&quot;  14' 3&quot;  22' 11½&quot;  28' 6&quot;</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Dimensions as measured for 15 and 20 meter collinears. A = halves of center element; B = outer elements; C = matching stubs.
properly chosen balun. The transmission line is chosen to be an integral number of half wavelengths. Of course, a balanced line tuner may be employed and the balun omitted. One can also tap up and down the transmission line for impedance matching purposes if this method is desired.

It is worth pointing out that the velocity of propagation of electromagnetic waves along transmission lines varies with the dielectric material used in constructing the line or cable. This velocity factor (V) must be included in calculating electrical wavelength in various types of lines. For example, open-wire line can be assumed to have a velocity factor of nearly 1.0 (or perhaps more exactly, 0.95 to 0.975). Thus, a wavelength in free space is nearly the same as one measured along open-wire line. The coax cable usually used by hams has a V of 0.66, and most 300-Ohm polyethylene balanced line ("twinlead") has a V of 0.82. This means, for example, that a wave of 15 meters length in free space has a physical length in coax of about (0.66 × 15m) = 10 meters and a physical length in 300-Ohm twinlead of about (0.82 × 15m) = 12.3 meters. In the designs below, I use 300-Ohm twinlead for the ¼-wave matching sections.

The 3-element collinear achieves a gain of about 3.3 decibels over a simple half-wave dipole and has a beamwidth to the half-power points (where the field strength voltage drops to 0.707 of its maximum value) in the horizontal plane of about ±18°. This is for a horizontally oriented antenna, of course, and the radiation is greatest at right angles to the axis of the array. The 5-element antenna achieves a gain of about 5.3 decibels and a beamwidth of about ±10° or so. Each antenna’s horizontal radiation pattern is bidirectional with minor side lobes. I have designated the center element halves as “A” in the drawing (Fig. 1) and in Table 1, the pairs of outer elements as “B”, and the matching sections as “C”, for the case of the 3- or 5-element centered collinear.

Construction Hints

All half-wave elements should be of equal length in a given antenna. One can erect the center element and adjust it to exact resonance, if desired, then add the stubs and outer elements. Velocity factor V was found to be 0.95 for the 3-element collinear. The 5-element collinear resonated slightly higher than the calculated frequency; evidently a V of 0.95 overcorrects for end effects. I found V here to equal 0.975, and I give the actual determined dimensions for each antenna in Table 1.

I used home-brew nylon insulators which are 2 to 3 inches long and cut out of scrap. They are light and tough. One could also use Plexiglas™ or some other material or commercially-made ceramic insulators.

The phasing sections could be of open-wire line (remember, then, V would be about 0.95), but I chose 300-Ohm twinlead because the stubs tend to blow around in high winds and ladder line might twist up and short. (Also, I had a few scrap pieces of 300-Ohm twinlead in the shack.) The antenna elements themselves I made of odds and ends of #16 and #14 hard-drawn copper wire, but almost anything will do here.

Care should be taken to fasten the phasing stubs to the insulators so that they do not fatigue and break off. Solder the stubs closed at the ends. I suspended the collinears high in some maple trees using clothesline pulleys and ¼-inch nylon line. One has been up for two winters and has survived numerous ice storms and high winds. You might wish to silicone or wax the twinlead to minimize swr changes during rainstorms. I’m not fussy about these antennas, except that I make sure that I never erect an antenna near, over, or under a power line.

In Table 1, I have given actual dimensions for center frequencies of 14.15 MHz for the 3-element and 21.2 MHz for the 5-element antenna. I use these collinears for working into Europe with my Triton IV. The 15 meter collinear would make a dandy antenna for Novice DXing. If one has the space for an 80 meter dipole, then 2 or 3 hours invested in construction and erection of a multi-element collinear will probably result in surprise and pleasure that such a simple antenna brings such good results for only a few dollars. ■

---

Fig. 1. Centered multi-element collinear wire beam. A = ¼ wavelength (ft.) = 246 (0.95)ft/MHz; B = ½ wavelength (ft.) = 492 (0.95)ft/MHz; C = ¼ wavelength (ft.) = 246 (0.82)ft/MHz.

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Reader Service—see page 211
Three Baluns for a Buck
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Editor’s note: This article was written while the author was in Iran. He has since returned to the United States.

Donald E. Lively W6SJJQ
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Millington NJ 07946

Activating an HF radio station in areas of the world where hamming is not too common calls for a certain amount of improvisation. This is particularly true if station logistics have not been carefully planned prior to leaving home base.

Material Selection and Preparation

The problem facing this station was that of acquiring a balun for a three-band dipole and then a three-element beam. Experiments with a homemade balun in the US using the ferrite core of a defunct TV flyback transformer had been quite successful on 80 and 40 meters. It was decided, therefore, to see if the same approach would do for 20, 15, and 10. It figured that a core material able to handle the TV horizontal retrace without significant loss should be fairly good for HF radio transmission. Actual measurements through the finished balun at 28 MHz and lower frequencies show less than a $\frac{1}{2}$-dB attenuation.

Initial Construction

Actual construction was started in the following fashion. A burned-out flyback was obtained from a TV service shop, and all of the windings, plus sealing compounds, were removed. After disassembly, two C-shaped core halves remained. These are normally mated at their highly polished surfaces and clamped together to form a solid O-shaped rectangle. To avoid any shorted turn effects from the clamping arrangement, and to make unobstructed space for windings around the full core circumference, the two core halves are held together with an epoxy compound. A very thin film of steel-filled epoxy is used for this purpose—hopefully this minimizes discontinuities in the magnetic circuitry of the core.

Some further core preparation is still needed before putting windings in place. This includes removal of any sharp edges with a fine file or abrasive cloth (to avoid scratching the enameled wire). The last step of preparation is to place two layers of plastic or glass tape over the core—this gives a very smooth surface for the winding process.

The actual winding calls for considerable care if a low SWR is to be realized. Considerable experimentation took place to get best results—and two precautions turned out to be important in getting good balance and low loss: sym-
metrical placement of the turns and uniform "turn shape." The results of this care are uniformly distributed capacity within and between turns and equal inductance for each of the three trifilar windings.

The way the tight and uniform turns are achieved is to employ a modification of the "bobbin" technique (see Fig. 2) used on commercially-wound toroids. For this application, start with a single piece of about no. 20 gauge wire approximately 18 inches long. Thread the wire repeatedly through the core center until eight turns are in place. Distribute the turns evenly and clip all but about two inches on each end of the winding. Remove this temporary winding, straighten it, and measure its length. This will be the length of the permanent windings. Cut three lengths of no. 14 Formvar or similarly insulated copper wire and wind each one around a D-cell battery or similarly sized form to create the "wire supply coil" for the finished balun.

Next, take one of these coils and "screw" it onto the TV transformer core. Do this by spreading the turns and placing an end through the center hole, rotating the coil until it is all on the core. Straighten one end of the coil so that the 2" excess extends out from the core, then press tightly against the core this first turn of the "wire supply coil." Use your thumb to force each turn of the balun into shape against the core. Form each turn diagonally so that two turns are placed on each side. (Depending on where you wish to make your connection to the antenna and transmission line, you may start and finish at a corner or a side.)

Repeat the process for each of the next two windings. To keep the turns tight so that their final spacing can be evenly positioned, temporarily twist the two ends of each coil together. This will prevent any unwinding. Place a few drops of 5-minute epoxy glue at the point where windings start. When the windings are firmly set and evenly spaced, wire and solder them as shown in the diagram of Fig. 1. Be especially careful to make the connections between the windings symmetrical (to ensure equal inductance and coupling). Failure to do this will create a poor swr and increase loss. (An associate of mine has run tests on several commercial baluns and found that attention to this matter accounts for fairly wide variations in performance, particularly at the higher frequencies.)

You are now ready to attach the leads on the balun which connect it to the feedline and antenna. Mount a coax fitting at one corner, and for the feedline, and the flexible leads (short lengths of coax outer conductor braid) for the dipole connection.

Final Adjustments

With a short length of coax, connect the balun through an swr bridge to a transmitter with variable output carrier. Connect the flexible leads to a dummy load, being careful to keep them straight, symmetrical, and evenly spaced. (Pieces of RG-58 outer covering can be used to protect the leads from the weather and to avoid shorts during the tests.) Next, set the rf source on 28 MHz and apply enough power to get a good reading on the swr meter in the forward direction. (Run the power high enough to ensure that the transmitter output "looks like" its transmission-line drive impedance—with some solid-state rigs, this may vary at very low power settings.)

Switch the swr meter to reverse and observe the reflected power level—it should read 1:1.2 or less. If it's higher, remove the rf power and try even spacing any irregularities in the windings or significant spaces between adjacent wires in the individual turns. With careful dressing of the turns and connecting leads, this kind of performance can be realized.

The transformer (balun) is now ready for final assembly and mounting. Numerous schemes are appropriate. For my application, no enclosure was used, but just encapsulation in epoxy with a piece of vinyl tubing threaded through the center to tie the unit to the beam boom. (This was because an earlier model placed in a metal can arced to ground from a nearby lightning strike.) An appropriate form to contain the epoxy while it sets was made from the sides of a polyethylene detergent bottle. This material can be "welded" using a soldering iron to melt and join edges of individual pieces to form the desired shape of container.

Incidentally, the $30 cost refers to the wire—it has to be purchased locally. The epoxy is, of course, optional and is an added expense. The TV transformer core was a gift from a friendly Iranian TV repairman—a similar acquisition is no doubt possible anywhere.

The balun has worked fine and is superior to a mail-order kit which has been rebuilt numerous times but which has never given a satisfactory 10 meter swr when connected to a very load-match-sensitive Atlas 210X.
So You Want to Raise a Tower
— do it safely, do it right

A simple guide to an important subject.

James Wyma WA7DPX
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Casa Grande AZ 85222

Soon or later every ham has the desire to put up a tower. The intent of this article is to save you from some of the problems you can have by improper installation of your tower. These problems can result in loss of your tower and antennas, loss of your ham shack (a falling tower can do a great deal of remodeling to your shack), and last, but not least, loss of your or someone else's life. The first two losses can be corrected; the third can't!

First off, let's establish some basics. There are only two safe ways to erect a tower: with a crane or with a gin-pole. If you have the money, the first is the easiest. The second method is the one used by those of us who have more time than money.

Assuming that you have decided on the second method, you will have to do some tower climbing. There is one very important principle involved in tower climbing. Simply stated, it is: "If you are unable to strap a safety belt on the tower, let loose with both hands and lean back comfortably for a short nap, then keep both your feet on the ground."

If your legs are shaking, your hands are white from hanging on, and all you can think of is "I'm going to die," then you have no business on a tower!

Try the technique that I use. Tell yourself that once you have climbed more than ten feet, you probably will be killed if you fall. If you don't like this approach, you should get someone else to do the climbing.

Once you have doubled your life insurance—or found some tower rigger to do the climbing—you now have to decide where to put it. The ideal place is right next to the window in your shack, but this doesn't always turn out to be possible. Considerations governing tower location are as follows:

1) The guy-line anchors should be kept within your property boundaries, if at
all possible.

2) The anchors should be at a distance of at least two-thirds of the tower height away from the base of the tower, and, preferably, a distance equal to the tower height. Example: A 60' tower should have guy supports at a distance of 40' to 60' from the base. Three guy lines are generally used.

3) The guy-line anchors should be at 120° spacing from each other. If available, a surveyor's transit should be used to site their locations. Fig. 1 demonstrates this. Note that it is not necessary to have all the anchors in a circle (i.e., equal distance from the base). This is shown by point A' of Fig. 1. Every effort should be made to keep the anchors as close to 120° apart as possible. The more you deviate from this, the more vulnerable is the tower to twisting torque.

4) Guy lines should not be obstructed by power lines, trees, or parts of any building.

5) Be sure your community has no restrictions on tower erection; obtain a building permit if one is required.

6) Make sure there are no buried water, gas, or power lines in the areas where you plan to dig your base- and guy-anchor holes. Call the utility companies; they will locate them for you free of charge.

7) If at all possible, attach the tower to your house or shack. In most cases, this will classify it so that your home-owner's insurance will cover it. Check with your agent to see if this applies to your policy, and, if it does not, ask him about a separate liability policy. In most areas, a tower is considered an attractive nuisance for juveniles, and if a child is hurt on your tower, you are at fault even though it is on private property. If your tower falls on a neighbor's house, more than "Gee, I'm sorry about that!" is usually required to fix the damage.

8) Determine that the ground where your base and anchors will be is solid enough to hold them in place. Freshly-excavated ground should be avoided. (Quicksand, mud, and earthquake faults also should be avoided.)

Now that we have the basics out of the way, let's get started on putting this thing up. The tower foundation and the guying are the two most important parts of your whole installation. Don't take short cuts in either of these areas. A few bucks saved on cheap concrete or junky guy lines could cost you thousands of dollars in the long run.

The type of ground (clay, sand, soft dirt, or whatever) and the height of the tower will determine how much concrete you need for the base and guy-line anchors. A very good place to get this information is in the Rohn tower catalog. You can probably obtain a copy of it from Rohn or your Rohn dealer. This will give you a lot of valuable information on how and where to guy your tower and how big to make your holes for concrete. Under no circumstances should the base or anchors contain less than ¼ yard of concrete.

The specific information in this article is pertinent to most towers, but it is specifically related to the Rohn 25G tower. This is one of the most popular ham towers and the one with which I have the most experience.

In Photo B, you can see what I prefer for the tower base. Note that the concrete sticks up above ground level. This is accomplished by making a frame out of 2 x 4s, with the 4" side vertical. There are a number of reasons for doing this: looks, maintainability (grass trimming), and, most important, leveling. If your base plate isn't level, it will be nearly impossible to level the tower.

Speaking of the base plate, it is a good investment to make. At $40 to $45 per section, it is a very expensive practice to bury part of the tower in concrete. With my system, should you decide to move, the base plate can be taken with you. (Most people would rather not take a yard of concrete with them to get the tower section cemented in it.)

You will notice that the base plate is held in place by one 5/8" x 18" galvanized bolt in the center. If you are unable to find one at your hardware store, try your local power company. These bolts are used quite extensively for power-pole hardware.

After you have poured the concrete in your base hole and tamped the air out of it, the bolt is inserted. Don't wait too long to put the bolt in, or your concrete won't hold it too well. If you are a pessimist, a 3" flat washer welded to the end of the bolt before putting it in the concrete will add holding power.

Do not attempt to put the base plate in place until after the concrete has set. Also, be careful not to bump your cement form when pouring the concrete.

Two-inch pump rods were installed to stop cars from running into the tower.

Once the base has cured (at least a week, and preferably longer), the
Generally, the first two towers can be bolted together and set in sections can be bolted.

Next, let's look at the guy-line supports. Photo C shows two types of guy-line supports. At the bottom of the picture is a Rohn guy anchor. This piece is cemented into the ground with just a few inches of shaft and the eye sticking out above the ground. (See your Rohn catalog for recommended installation of this device.)

Also in the picture is a pole with the lines attached to it. In this case, a 2"-diameter solid-steel pipe (a well pump rod) is used. If you check with a local pump repair company, you will find that pieces of rod that have been removed from wells are available for a couple of bucks each. Don't take your Volkswagen over to load up three lengths of this pipe, however. A 10' piece of pump rod weighs over 300 pounds!

If you are unable to find the pump rod, a piece of 3" or 4" pipe will do equally well, with the pipes filled with concrete for extra strength, if desired.

The use of the pole has several advantages over the use of the guy anchor. The main advantage is that the lines are above ground so that people won't trip on them or hang themselves on them.

The hole for the anchor was 2' x 2' x 2 1/2' deep. This left 7 1/2' of pipe above ground, and, in most cases, this is plenty. If a driveway is crossed, you may need to go higher than that. If so, I recommend you use concrete-filled 4" pipe rather than a pump rod. In any case, to make sure that they don't move, the pipes should be placed in the hole before pouring the concrete. The pipe also can be guyed with wire or rope attached to stakes in the ground.

Before calling your Redi-Mix company for a load of concrete, be sure that you have everything prepared. If the driver stands around while you put the pipe in the ground and guy it, you'll find that your bill will have a substantial charge for "stand-by" on it.

Photo D shows a close-up of how the guy lines are attached to the pipe. The piece of metal welded to the pipe is one of the equalizer plates in the Rohn EP-2534-3 package. When ordering, get 5 EP-2534-3 packages. There are 2 plates and hardware in each kit. Three sets will be used as standard equalizer plates, three of the remaining four plates will be welded to the pipes and the last plate always can be used as a paper weight.

Unless you are an extremely good welder, you should have the plates put on at your local welding shop. Tell the welder you want a very strong weld, to hold guy wires which will hold up a tower.

A few more points and tips: (1) All of the hardware shown comes with the equalizer plates, but, when ordering, be sure you get the correct plate for the number of guys that you will have. An EP-2534-3 is for two or three guys. An EP-2534-5 is for four or five guys. (2) When you set the guy-line pipe in the ground, be sure that the equalizer plate is facing toward the tower. It is very hard to rotate the pipe once the concrete has set. (3) If you want a little extra safety, you can weld a 12" x 12" plate to the bottom of the pump rod to make it harder to pull out of the concrete.

Once you have the base and guy supports poured in concrete, the next thing is to sit back and take a well-deserved break while the concrete cures. This will give you time to catch up on your reading of those back issues of 73. After a couple of days, you can sand the rust off your guy pipes and spray them with Rust-o-Leum, or some other rust-inhibiting paint. The silver paint seems to last the best of the colors I've tried.

Now that you are well rested and raring to go, we will start putting the tower up. We previously men-
The 100 HH and 500 HH hand held frequency counters represent a significant new advancement, utilizing the latest LSI design... and because it’s a DSI innovation, you know it obsoletes any competitive makes, both in price and performance. No longer do you have to sacrifice accuracy, ultra small readouts and poor resolution to get a calculator size instrument. Both the 100 HH and 500 HH have eight .4 inch LED digits — 1 Hz resolution — direct in only 1 sec. or 10 Hz in .1 sec. — 1 PPM TCXO time base. These counters are perfect for all applications be it mobile, hilltop, marine or bench work.

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tioned the gin-pole. Photo E shows a picture of the gin-pole, for those of you who don't know what one is. It consists of an aluminum pipe about 13' long, a clamping device, and a pulley at the top of the pole. (If you know someone who works at a radio shop, you may be able to borrow their gin-pole.)

While you are out scrounging around, you also will need a good safety belt (not a World War I surplus job). Remember, your life literally depends on the belt. If it goes, you go; if your belt breaks, you will be in for a big letdown. Another need is good rope. You will need a piece as long as twice the height of the tower, plus about 30'.

Before you get gung-ho to start putting up the tower, take a few minutes to inspect the tower sections. If any of the mating ends appear to be at all bent, check to be sure that they will mate with another section of tower. If severe damage is evident, turn in a claim to the trucking company and request replacements. While you're checking out the tower, locate the mounting hardware. You will find a plug in one of the lower legs of the tower. Pry it out, tilt the leg, and catch the nuts and bolts as they slide out. There should be two sizes of nuts and bolts, and three of each size. Be sure to count all the hardware to make sure you're not short, and then place it in the pouch of your safety belt.

Two other things can be done to make the tower sections easier to put together. The first is to take a 1 1/2'' piece of rod a foot or so long and grind a blunt point on it. Very gently drive this into the female (lower part of tower) ends of the tower sections. (Don't get carried away or you will split the tower legs open.) Photo F shows this being done. The second is to drive a drift punch through each of the bolt holes in the tower. Drive the punch in from both sides of the holes. The reason for these steps is to clear out any excess galvanizing that may be clogging the holes. (All Rohn towers are hot-dipped galvanized after they are assembled.) Under no circumstances should you use a drill to ream out the holes.

You now are ready to start putting up the tower sections. If you are doing the climbing, be sure that your ground man is reliable. Your life literally rests in his hands. If you say "whoa" and he "let's go," you have a big problem.

The man on the tower always calls the shots—he is the boss. If you can get hold of a pair of walkie-talkies, it will save you from laryngitis from yelling to each other. And let your ground man do as much of the physical work as possible.

The number one rule is safety. Tower work is no place to be horsing around. Before you take one foot off the ground, make the following point emphatically clear to everyone: If anything breaks, comes loose, or drops, don't try to stop it or catch it. Should anything go wrong, get your butt out of the way. A piece of mangled-up tower can easily be replaced. A mangled body is not so easily replaced.

The man on the tower should have the following equipment with him before he starts climbing: (1) Safety belt, boots, and gloves. (2) Two wrenches for each of the two bolt sizes on the tower. (A ratchet and socket help a lot.) (3) A drift punch and hammer. These are used to help align the bolt holes. (4) All of the nuts and bolts for all of the tower sections. (5) A small pulley which can be used to raise the gin-pole from one section of the tower to the next. (6) A work platform, if used.

Item six is not a requirement, but it can make the tower work a lot easier and save a lot of wear and tear on your feet and back. (See Photo G.) Once again, I wish to emphasize that very important point: If you can't relax while doing tower work, stay on the ground. There is no way...
that you can hold on with one hand and work with the other. Tower work requires both hands and all of your attention.

Your first job is to place the gin-pole at the top of the first section. Carry the pole up the tower with the pole in the lowered position, or use the small pulley. Once you have it in place on the tower, you can raise the pole. Be sure to place the clamp on a tower leg so that sections can be pulled up without obstructions being in the way.

The clamp should be positioned so that it faces away from the tower. The pulley should be rotated so that it faces toward the inside of the tower. Do not use pliers to tighten any of the clamp screws on the gin-pole; hand-tight is sufficient on all three screws. Photo H shows a picture of the gin-pole clamped in place on the tower.

While you are mounting the gin-pole, your ground man should be tying the rope to the next section of the tower. The rope should be tied approximately two-thirds of the way up the section. If it is tied too high, you will have trouble placing the sections in place. Photo I shows how I tie the rope on. You will notice that this is a slip knot. Many people have looked at this and said, "It won't work." I have used this knot to send up over 500' of tower sections and never has it come loose.

Once you have the third section of tower in place, the first set of guy lines should be attached. I personally recommend that if you put up thirty feet or more of tower, it should be guyed. The Rohn catalog gives recommended guying heights for various tower heights. While you are working on the third section of tower, have your ground man getting the guy lines ready. Each line should be prepared as shown in Photo J before it is sent up to you. The loop should be about three inches long, and two cable clamps (minimum) should be used at each loop.

When you have the gin-pole ready (you can do this before moving the pole if you want), have the loop sent up to you on the gin-pole line. Each line should be taken to the turnbuckle it attaches to and measured before cutting. The turnbuckles should be screwed to the maximum out position before measuring. Do not try to pull the guy line tight when you are measuring it, but leave plenty of slack. The lines can't be tightened until all three lines are attached.

Leave a couple of feet extra so that the cable clamps can be fastened. When you cut the guy cable, be sure to tape both sides of the cut with electrical tape before you cut it. A small pair of bolt cutters does a good job of cutting the cable.

After the first line is attached, have the second one prepared and sent up. After all three guys are attached, have the second one prepared and sent up. After all three guys are attached, the tower man should come down, because the next job is easiest when done by all hands—preferably with four men. Have one man on each of the guy lines, and the fourth man at the tower, with a two-foot or longer level. It is best to use a ladder, so that the level can be placed on the middle of the second section or higher (15' from the ground). The level man should not stand on or hold onto the tower when he is leveling it. Each turnbuckle should be tightened until the tower is level. Take at least two perpendicular readings (90° from each other) on each leg to ensure that the tower is level. The first set of guys is very important. If the tower is not properly leveled at this point, you may never get it straight.

If you turn the turnbuckle all the way in and still need more tightening, then back it all the way out, loosen the cable clamps, pull the cable until it is tight, re-clamp, and start tightening the turnbuckle again. When properly tightened, the guy lines still should have a fair amount of slack. You should be able to shake the cable and have a small amount of ripple in it.

If the cables are too
tight, you stand a good chance of losing your tower. The theory is that of the reed in the wind. A reed will bend in the wind and not be broken, but a rigid plant will snap off because it is unable to give. A properly-guyed tower will have a small amount of sway to it. And remember that if you put up your tower in winter, you will need less slack than you would in the summer!

Continue to put additional sections of tower and guy lines on until the tower is completed. Additional sections of tower are leveled in the same manner. The only exception is that, rather than using a level, the level man should look up each leg of the tower. A section that is not level will stand out very noticeably. If you're not sure, have several people sight up the tower and level until the general consensus is that it is straight.

When all sections of tower have been installed and leveled, the turnbuckles should be safety-wired. This prevents movement of the lines from working the turnbuckles loose. The method I prefer to use is the "figure-8" safety wiring. This can be seen in Photo L.

Another feature you may want to add to your tower is a skirt on the bottom section. Remember, your tower is classified as an "attractive nuisance." The skirting I used can be seen in Photo J. The best way to make this is to take a section of tower to a local air conditioning contractor and ask him to make you a piece of metal 8' long to cover the tower. You can have him attach it to the tower, or do it yourself. The best way to attach it is to use pop rivets. Be sure to leave space at the top and bottom of the section so that the mounting bolts can be installed.

The only remaining part of the job is the antenna and feedline installation. Since there are so many types of antennas and mountings, I will not attempt to go into installation of them. If you intend to use a rotor, contact your Rohn dealer. He probably can fix you up with a rotor mount and thrust bearings that are made for the tower.

Two words of caution on feedlines: (1) There seems to be quite a bit of unjacketed Heliax available that has been removed from commercial service. If you run across any of it, take it if it is given to you, proceed to your nearest scrap metal yard, and sell it for the value of the copper. Under no conditions do you want to use it on your tower. When you place two dissimilar metals together and place them in an electromagnetic field, you have created a fantastic TVI generator. This is the reason that it was removed from commercial service. And (2), watch for kinks in the outer shield. If it is kinked, there is a 98% chance that the cable is ruined. If you need a good attenuator, it is fine. However, most people find it to no advantage to have a 3-dB attenuator in their feedline.

If you are planning to buy a complete tower, you can buy a package that has the tower, guy lines, turnbuckles, equalizer plates, and cable clamps. This could save you some time and money. Check with your Rohn dealer about the package tower before you buy all the pieces individually.

Be sure that the tower you buy will handle the wind loading and weight for the antenna system that you plan to use. If you plan to use the pump-rod guying technique, be sure to order two extra equalizing plate kits. Also, check to see that there is sufficient guy line to meet your guying needs. The packages are set up for the ideal guying, but there is a very good chance that your installation will need more cable.

I hope that this article has given you some insight into the proper methods of erecting a tower. I claim neither to have covered every possible condition you may encounter nor that this is the only way to put up a tower. All I can say is that these are some of the most acceptable methods I’ve tried in 15 years.
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Antenna Output Impedance: 50-75 ohms, unbalanced

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IF Rejection: Better than 70 dB (160, 80, 20-10 m); Better than 60 dB (40 m)
Audio Output Impedance: 4-16 ohms
Audio Output Power: 3 watts @10% THD (into 4 ohms)

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FT-101ZD TRANSCEIVER

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years of putting up ham and commercial towers.

If you have any suggestions or questions, I will be glad to respond to them. If you wish and expect a reply, send an SASE. Good luck, and remember the final words of Harry Splash, the tower rigger: "I knew that I should have replaced that worn strap on my safety belt!"

Note: Thanks to Deborah Coyle for proofreading and typing this article, and to Sue (WB7CXE's YL) for help with the photo work.

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**Photo K.** A “figure-8” safety wiring for turnbuckles.

**Photo L.** A skirting at the bottom of the tower lessens the “attractiveness” of your “attractive nuisance.”

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**TUBES & LINEAR PARTS**

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Author's Note: To prevent possible adverse heating effects in the arm tissue, it is important that power input to antenna described in this article be limited to 10 mW.

James C. Gaddie
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A human arm may be made to act as an antenna for a communications system. It has been done by using an energy coupler made of two strips of copper foil fastened to a strap and wrapped around the wrist. Apparently, the wrist strap can efficiently transfer radio-frequency energy to or from the arm. A prototype of the antenna coupler was built and found suitable for both sending and receiving very-high-frequency signals. The goal of the developers is to build a body-worn communications system for the deaf blind, and it was with this purpose in mind that the prototype unit was built and tested. Other potential applications for the compact coupler include body-worn two-way local communications systems for police and as part of a portable personal communications system that could communicate via satellite.

The copper-foil strips of the wrist-strap coupler shown in Fig. 1 are rectangular, 5 in. (13 cm) long and \( \frac{1}{2} \) in. (1.3 cm) wide. They are placed 7/16 in. (1.1 cm) apart and are fastened to the underside of a wrist strap made of an electrically insulating material. A thin insulating material


Fig. 1. Wrist-strap coupler of radio-frequency energy consists of two strips of copper fastened to an insulating material. Wires at the midpoints of the strips lead to the radio-frequency device that can act as a transmitter or receiver.
strip is also placed over the straps as a protective cover. Such an insulator can be added to the wrist strap because the copper strips need not be in direct contact with the skin for the rf signals to be coupled to or from the arm.

For connecting the coupler to a transceiver, or receive- or transmit-only unit, a small wire is attached to the edge of each copper strip at a point equidistant from the ends of the strip. Each wire is then routed through a hole in the insulating material to the upper surface of the strap. In addition, a fastener must be attached to the strap so that it can be pulled snugly against the wrist.

Radio-frequency energy couples to or from the arm through the electrical capacity between the arm and the copper strips. Electrical impedance characteristics of the antenna are shown in Fig. 2. The radiated field strength, with the strap driven by a 170-MHz, 10-mW transmitter, was found to be slightly greater than that from a well-designed loop antenna built with a 16- by 11- by 3-mm ferrite core and driven by the same transmitter.

Fig. 2. Electrical impedance characteristics of the wrist-strap antenna coupler were measured with a General Radio 1710 rf network analyzer. Varying the widths of the copper strips will produce somewhat different characteristics.
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This switch features 3 outputs, power rating of 2KW PEP, VSWR less than 1.2:1 up to 150 MHz & grounds all unused antennas. In 27315. Add 1.10 shipping & handling.

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B&W 375 coax switch
Featuring power rating 1000W AM and 2000W SSB, connectors are UHF type, dial plate supplied, has 5 outputs. Grounds all unused antennas & has VSWR of less than 1.25:1 up to 150 MHz. In 27300. Add 1.10 shipping & handling.

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CUSHCRAFT AMS-147 FM mobile 2m mag mount antenna
A MHz wave length antenna with 3 dB gain for SWR operation over 144-148 MHz FM band. Move center freq. 1 MHz. Matched to 50 ohms. Complete with coax & connector.

34.95 Call for yours today

CUSHCRAFT ARX-2 2m antenna
Three 1/4 waves in phase and a 1/8 wave matching stub. Extremely low angle of radiation for better digital coverage. Tuneable over a broad free range. Matched to 50 ohm coax.

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B&W 550 A 5 position coax switch
Features power rating of 1000W AM and 2000W SSB UHF type, 5 outputs. VSWR less than 1.2:1 up to 100 MHz. With very little insertion loss. In 27308. Add 1.10 shipping & handling.

17.50 Call today

B&W 550A-2 2 position coax switch
This unit features 2 outputs, power rating of 2KW PEP, VSWR less than 1.2:1 up to 100 MHz. B&W wall mount and Dial plug plate available. In 27303. Add 1.10 shipping & handling.

14.95 Call today

DENTRON Big Dummy load
Now you can tune up off the air with the Big Dummy! A full power dummy load, it has a flat SWR over full frequency coverage from 1 to 305 MHz and a high grade of industrial cooling oil furnished with the unit. Fully assembled. Cal it out the QRM factor now.

29.50 Call today

HY-GAIN HB-MAG 287 Hy-band foldover antenna
A magnetic mount antenna with the unique fold over for mounting on back of cars, wave ratchet foldover adjusts through a 180 degree arc and holds its position at speed up to 120 mph. Less than 1.41 VSWR 144-148 MHz power rated to 150W. 3 dB gain. DC grounded.

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BENCHY-1 ibmatic paddle
The Ultimate ibmatic paddle. Features solid silver contact points, full range adjustment, non-skid feet and heavy steel black textured base. Add 1.35 shipping & handling. Item No. 31103

39.95

BENCHY-2 ibmatic paddle
The By-2 has all the features of the By-1 but comes with chrome base. Add 1.35 shipping & handling. Item No. 31701

49.95
DDRR Dipole for VHF
—experiment!

Seeking selectivity.

Selectivity in an antenna is becoming increasingly important as the bands compress under the load of more and more stations. Reception is where this is most desirable. Front-end overload, we have learned, will cause big problems to over load, we have learned, most desirable. Front-end overload, we have learned, will cause big problems to communications circuit when off-channel signals are strong. Directional-type antennas, of course, are the answer unless we need to cover everything around us. The DDRR, or directly driven ring radiator, developed by its inventor, J.M. Boyer (with patents assigned to Northrop), has high selectivity. Because of this, it also is a low-noise device. This makes two good reasons for its superior performance. (73 Magazine for August and September, 1976, goes into detail of its design and advantage. There have been many other articles written about it over the years.) Two drawbacks are noted when the chips are down. One is the size of the ground plane for the monopole design; the other is the cost of the conductor material for low-frequency use.

Tuning can be another problem where its use for high-power transmission is contemplated. Very high voltage and current are the prices of the trade-off for high selectivity.

What Is It?
Boyer suggests the DDRR dipole in his September (part two) article. This version does without the big ground plane, as would any dipole. So here we have a quarter-wave open transmission line formed into a shape which "leaks" and radiates rf. I first built one of these for ten meters and made it so it operated on its highest frequency (no added capacitance) and at a fixed frequency. A/B checks with the spaced rings mounted vertically compared very well with those of a horizontal folded dipole at the same height and with the same orientation. Pretty good for an antenna on ten meters which is 30 cm "long" and 84 cm in diameter (see 73, April, 1965, “Double Hula,” Peter Lovelock).

The Two Meter DDRR Dipole
To make the two meter model, I dug out an old ¼-inch tubing coil from a long-forgotten final and annealed it in the fireplace, then cleaned and polished the surface after stretching it between a car bumper and a stout post. 33 inches comes to a half wave. This is then folded on a one-inch-diameter rod or mandrel at exact center. The quarter-wave line is formed on a can to make a circular double ring or transmission line of about 5 inches diameter. This will resonate above the 148 MHz end of the band. I made a simple tuning arrangement of a 4-inch piece of #20 (0.8 mm) Teflon™-covered flexible wire. This is formed into a U to slide into the open ends of the line. When

Fig. 1. Two meter DDRR dipole.
**1-800-228-4097**

**Communications Center**
443 N 48th Street
Lincoln, Nebraska 68504
In Nebraska Call (402) 466-8402

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# Antenna Sale!

**HY-GAIN**

<table>
<thead>
<tr>
<th>Antenna</th>
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<th>Special</th>
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<tr>
<td>TH6DXX Super Thunderbird</td>
<td>$299.95</td>
<td>$239.95</td>
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<tr>
<td>TH3MK3 3 el. 10-15-20M beam</td>
<td>$229.95</td>
<td>$179.95</td>
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<tr>
<td>TH3Jr 3 el. 10-15-20M beam</td>
<td>$149.95</td>
<td>$129.95</td>
</tr>
<tr>
<td>Hy-Quad 2 el. 10-15-20M Quad</td>
<td>$229.95</td>
<td>$179.95</td>
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<tr>
<td>205BA 5 el. &quot;Long John&quot; 20M beam</td>
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<td>$229.95</td>
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<tr>
<td>155BA 5 el. &quot;Long John&quot; 15M beam</td>
<td>$169.95</td>
<td>$139.95</td>
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<td>105BA 5 el. &quot;Long John&quot; 10M beam</td>
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<tr>
<td>204BA 4 el. 20M beam</td>
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<tr>
<td>204MK5 5 el. conversion kit</td>
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<tr>
<td>153BA 3 el. 15M beam</td>
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<td>103BA 3 el. 10M beam</td>
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<td>402BA 3 el. 40M beam</td>
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<td>BN-6G Balun for beam antennas</td>
<td>$15.95</td>
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<tr>
<td>TH2MK3 2 el. 10-15-20M beam</td>
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**MOSLEY**

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<tr>
<td>ATV-4 10, 15, 20, 40 Mtr. Vertical</td>
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<td>ATV-5 10, 15, 20, 40, 80 Mtr. Vertical</td>
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<tr>
<td>ARX-2 2 Mtr. Ringo Ranger</td>
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<td>AR-6 6 Mtr. Ringo</td>
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<td>ARX-220 220 Mhz. Ringo Ranger</td>
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<td>ARX-450 435 Mhz. Ringo Ranger</td>
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<td>A144-11 11 ele. 144-146 Mhz. beam</td>
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**CUSHCRAFT**

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<td>A147-22 22 ele. Power Pack</td>
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<td>A144-10T 2 Mtr. &quot;Twist&quot; 10 ele.</td>
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<td>A147-20T 2 Mtr. beam</td>
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<td>A430-11 432 Mhz. 11 ele. beam</td>
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<td>A432-20T 430-436 Mhz. Beam</td>
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**HUSTLER**

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<td>$259.95</td>
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<td>4-BTV 10-40 Mtr. Vertical</td>
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<td>5-BTV 10-80 Mtr. Vertical</td>
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<tr>
<td>RM-75 75 Meter Resonator</td>
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<tr>
<td>RM-75S 75 Meter Super Resonator</td>
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<tr>
<td>G6-144B 2 Mtr. Base Colinear</td>
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<td>G7-144 2 Mtr. Base Colinear</td>
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**WILSON**

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<td>System Two 4 ele. 10, 15, 20 Mtr. Beam</td>
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<td>System Three 3 ele. 10, 15, 20 Mtr. Beam</td>
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<td>WV-1 10-40 Mtr. Vertical</td>
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**TAYLOR**

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<td>HQ 10-40AV 10-40 Mtr.</td>
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**ROUTERS**

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<td>T2X Tailwinder $199.95</td>
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<tr>
<td>Alliance HD 73 $109.95</td>
<td>$109.95</td>
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</table>

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*Reader Service—see page 211*

127
pushed in, the frequency should more than cover the 2 meter band. See detail B in Fig. 1.

A length of small-diameter coax may be coupled tightly to the closed end of the open line. Mine was fed through a separate matching U-shape of the same tubing soldered to the closed end of the line. A good match was obtained by varying the size of the link (see drawing). A 50-Ohm match comes at an area of less than that formed by the 180 degree half turn at the closed end of the line. The \( \frac{1}{4} \) -inch line thus formed needs no insulators for support.

Mounting of the completed antenna may be done in several ways. Mine was made of a pedestal a few inches long and to feed the coax through. This was mounted breadboard fashion on a piece of hardwood. A BNC coax connector was fastened to this piece. A tuning arrangement was made to slide the Teflon tuning \( U \) in or out to cover the band of interest. The selectivity curve was measured using a signal generator, a counter, and an FM receiver. The antenna frequency was left fixed and the receiver and generator were moved together across the antenna frequency.

While vertical polarization is the way most of our present two meter signals leave the antenna, things happen that make the polarization somewhat different at the receiving end. By orienting the receiving antenna, it is often possible to null out an interfering signal. By going a step further, I made the mounting adjustable in azimuth and elevation. This also can be done in various ways—mine is a breadboard way to test the idea. Aiming it works well and can reduce multipath and QRM.

Conclusions

While the amount of selectivity afforded by the DDRR will not come up to that of a multipole filter, it is worthwhile in that it is ahead of the front end—aiding in the signal-to-noise problem. An undesired signal off to one side is noise, too.

Do not try transmitting with the device with the tuning method described except with very low power. It will not pass the smoke test.

Broadband antennas are very convenient (discone, rhombics, and tribanders), but who needs all these unwanted signals going up and down the feedline? Phased DDRR elements could improve selectivity as well as gain.

A selective antenna should make a big difference to you.
ANTENNA SYSTEMS

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NEW HIGH PERFORMANCE TRI-BAND BEAMS AS GOOD AS FULL-SIZE MONO BAND ANTENNAS. These beams employ hybrid system which is a combination of separated full-size driven element for each band individually and Hi-Q trap parasitic elements. These feature result high radiation efficiency, high power rating and excellent VSWR in entire band width.

<table>
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<tr>
<th>MODEL</th>
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<td></td>
<td>10m</td>
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<tr>
<td>ANTENNA GAIN</td>
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<td>20m 8.5dB</td>
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<tr>
<td></td>
<td>15m 8.5dB</td>
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</tr>
<tr>
<td></td>
<td>10m 8.0dB</td>
<td>10m 8.0dB</td>
</tr>
<tr>
<td>FRONT BACK RATIO</td>
<td>25dB</td>
<td>20.25dB</td>
</tr>
<tr>
<td>MAX POWER INPUT</td>
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<tr>
<td>VSWR</td>
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<td>1.5</td>
</tr>
<tr>
<td>IMPEDANCE</td>
<td>50Ω</td>
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<tr>
<td>MAX ELEMENT L</td>
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<tr>
<td>BOOM LENGTH</td>
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<td>BOOM DIAMETER</td>
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<td>TURNING RADIUS</td>
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<tr>
<td>WIND RATING</td>
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<tr>
<td>SUITABLE MAST</td>
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</tr>
<tr>
<td>WEIGHT</td>
<td>234lb</td>
<td>171lb</td>
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“SWISS QUAD” VHF SERIES

SQ-22 TWO METER DUAL QUAD

ANTENNA GAIN AND FRONT TO BACK RATIO ARE WELL IMPROVED WHEN TWO ELEMENTS ARE DRIVEN AT ONE TIME WITH PHASE DIFFERENCE COMPARED TO A SINGLE DRIVEN ELEMENT SUCH AS A CONVENTIONAL QUAD OR YAGI. THE SQ-22 PROVIDES THE OWNER WITH SUCH FEATURES SIMPLE ASSEMBLY AND LIGHT WEIGHT.

KEN PRO ROTATORS

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Repeater Association and the Northern Chautauqua Amateur Radio Club will hold their Lake Erie International Hamfest on Sunday, July 1, 1979, at the fairgrounds in Dunkirk, New York. A large flea market area and plenty of free parking will be provided. Tickets are $4.00 at the gate or $3.00 in advance. RV hookups are available. For information on advance sales of the campground, see direction from I-90, write to Dick Brinkerhoff W2BHEF, 123 5th St., Dunkirk NY 14048.

The Louisville Area Computer Club will hold its 4th annual ComputerfestTM from June 29 through July 1, 1979, at the Bluegrass Convention Center, Louisville, Kentucky. Activities include a flea market, seminars, and exposition, as well as forums for the entire family. Seminar and program admission is $4.00. Pre-registered Ramada Inn guests ($29.00, single; $34.00, double) receive free admission. For advance mail information, write Computerfest '79, Louisville Area Computer Club, PO Box 70355, Louisville KY 40270, or phone Tom Eubank, Chairman, at (502)-895-1230.

The Arkansas Army MARS meeting will be held on June 30-July 1, 1979, at the Independence County Fairgrounds, Batesville, Arkansas. There will be a fish fry on Saturday and a pancake breakfast on Sunday. Camping and motel rooms will be available. For further information, contact Robert Glines WB5KJK, 19 Broadway, Box 97, Floral AR 72534, or phone (501)-345-2880.

Bellefontaine OH

The Champaign Logan Amateur Radio Club, Inc., will hold its annual hamfest on Sunday, July 1, 1979, at the Logan County Fairgrounds, South Main Street and Lake Avenue, Bellefontaine, Ohio. There will be free admission and door prizes. Trunk and table sales are $1.00, and there will also be a bid table. Talk-in on 146.52. For more information, contact John L. Went WB5FK, Box 102, West Liberty OH 43357, or Frank Knoll W9JS, 402 Lafayet-ette Ave., Urbana OH 43078.

Dunkirk NY

The Northwestern New York

Marion County Fairgrounds, on the southeast corner of Indiana at the intersection of Interstate 74 and 465, Indianapolis, Indiana. There will be commercial exhibitors and dealer displays for a fee of $30.00 per booth. The commercial building will be open from 12:00 noon until 9:00 pm on Saturday and will reopen at 7:00 am on Sunday. Camper hookup facilities are available on the fairgrounds for overnight parking if you arrive on Saturday. A food and drink vendor will have a setup outside, while a professional caterer will have facilities inside. For more information, write to the Indianapolis Hamfest, PO Box 1002, Indianapolis IN 46206.

Canton OH

The fifth annual Hall of Fame Hamfest will be held on Sunday, July 15, 1979, at Stark County Fairgrounds, Canton, Ohio. Tickets are $2.50 in advance and $3.00 at the gate. Mobile check-in on 19.79 or 40.52. For information, write John Soha W8KU, 62 S. Franklin St., Wilkes-Barre PA 18707, or phone (717)-823-3101.

Guanaajuato MEX

The first annual ARARM-LMR will be held at Guana-juato, Mexico, from July 19-21, 1979. Guanajuato is located 230 miles north of Mexico City. Registration will be US $13.00. A package will be available for US $40.00 and will include 2 banquettes, 1 dinner dance, sight-seeing, theater, and gifts. Drawings will be held, with a grand prize being an SSTV setup. A total of 500 prizes will be given away. The US $40.00 includes registration. Hotels are available with prices ranging from US $10.00 and up for a double room. English-speaking guides are available from the University of Guanajuato. Talk-in on 147.62/63, 146.10/70, and 149.22/82. HF/SSB frequencies will also be operating, and we
Ever notice how other magazines published in the field of radio electronics are just like the ones before them—same old subjects, same predictable view, same old editorials?

Each issue of 73 is an entirely new book: over 194 pages including over 25 articles of new material each month, separate and special, unlike all that have come before it. 73 led the way in developing the use of solid-state circuitry and was the first to promote SSTV, radioteletype, computer applications for radio communications, and single sideband, to name a few. In addition, the staff of 73 is working on another scoop that you won't want to miss.

In one issue you might find building projects and information on antennas, moonbouncing, and mountaintopping. In the next issue you might read about computers, radioteletype, traffic handling, and satellites. This is a hefty magazine, with more articles each month than any two of the other ham magazines combined, and we pay more for an article than any other ham magazine.

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Tennamatic: An Auto-Tuning Mobile Antenna System
— works all of 40 and 75

Farewell to fading.

Would you like to operate your mobile station over the entire 40 and 75 meter phone bands with a vswr not exceeding 1.15 to 1? With a Tennamatic, you can convert a high-Q narrow-bandwidth mobile antenna into a wide-bandwidth system. This means that you can use transceivers having solid-state finals and obtain full output power on any frequency in the 40 or 75 meter phone bands without any manual tuning operations. All you have to do is select frequency, start talking, and the Tennamatic will tune your mobile antenna system to resonance automatically, ensuring maximum field strength. Of course, if your transceiver has tubes in the final, you will still have to retune it when you QSY. Specifications for the Tennamatic are listed in Table 1.

History
About two years ago, I met Don Johnson W6AAQ, and I adopted his “big DK” mobile antenna system. He subsequently described it in his October, 1976, 73 Magazine article entitled “Build a Weird 2 Band Mobile Antenna.” His antenna neatly solved the problem of needing to change antenna loading coils when band-hopping between 40 and 75 meters. It also proved to be an exceptionally efficient radiator compared to the commercials, but it was still limited to only a few kHz of usable bandwidth on each band, and I wanted full band coverage.

To obtain full band coverage, I added a motor-driven roller inductor at
the base of the antenna and a control switch at the driver's seat, allowing me to QSY the antenna resonant frequency. This worked beautifully for about six months until I ran off a freeway one day while watching a field strength meter as I was peaking the antenna. Luckily, no damage was done, but the experience convinced me that for safety's sake I had to get out of the loop. This conclusion required me to design a servo system.

**Design Requirements**

I decided that the tuner would be required to tune automatically over all of the 40 and 75 meter phone bands and use easily-obtainable parts. The parts count was to be minimized to keep reliability high, complications associated with limit switches were to be avoided, and the power handling capability had to be at least 350 Watts PEP. It had to be easy to duplicate, present a pleasing appearance, and the control head had to be capable of being mounted on the side of an Atlas and be visually compatible. Last of all, the servo system had to be uniquely simple, have a 3- or 4-kHz deadband so it would not hunt or jitter around in the voice pass band, provide constant motor torque while tuning, and operate reliably over a plus ten-to-fifteen-volt supply voltage range.

**The System**

These design requirements led to a system consisting of two units. One unit is a control head and the other is the tuning unit. The tuning unit is a device detector and a servo system which drives a permanent-magnet dc gear motor. The motor turns a roller inductor taken from a surplus T21/ARC-5 or T22/ARC-5 command transmitter. The tuning unit also contains a toroidal impedance-matching transformer which ensures a good impedance match between the antenna and coaxial line. The control head has direction indicators, an automatic/manual operation switch, an automatic/manual indicator, a manual slewing switch, and an impedance-match selector switch. The units are shown in the photographs.

**The Circuit**

The circuit which I designed is depicted in Fig. 1. To understand its operation, it is best to start with an explanation of the servo system and work backwards toward the input. The system that I selected is known as a "bang bang" servo system in aerospace circles. It is either off or on in one direction of rotation or the other and provides full motor torque when on. Fig. 2 is a simplified diagram of the servo. It uses two LM311N voltage comparator integrated circuits connected as a window comparator. The circuit states listed in Fig. 2 simply say that if the input voltage (Vin) is a positive voltage between the upper and lower threshold voltages, the outputs of both comparators will be at supply voltage. If Vin either exceeds the upper threshold voltage or is less positive than the lower threshold voltage, one or the other comparator's output will be low. The low-state output is about one-half volt positive.

Referring back to Fig. 1, it will be seen that the comparator outputs are connected to diagonally-opposite transistors. When a comparator switches on and its output goes low, it turns on the associated transistors, resulting in one side of the motor being clamped to ground while the other side is clamped to the positive supply, turning the motor on. The upper comparator drives the motor in the direction which reduces inductance, raising the antenna system resonant frequency. The lower comparator drives the motor in the opposite direction, increasing inductance and lowering the antenna system resonant frequency.

![Fig. 1. Tuning unit schematic. The output transistors and motor are discussed in the text.](image1)

![Fig. 2. Window comparator servo simplified diagram.](image2)

![Fig. 3. Window comparator regulated-voltage divider.](image3)
Fig. 4. The control head assembly connects to the Jones-type plug, P1, through 20 feet of TV rotator cable. The diodes are Radio Shack part number 276-1101.

Fig. 5. Tuner unit wiring diagram.

Fig. 3 shows the input circuit to the voltage comparators. The comparators must operate with their inputs positive with respect to ground, making it necessary to reference the phase detector to a point above ground. This reference point is the junction of the two 470-Ohm resistors. The output of the phase detector is connected to $V_{IN}$ and will be a voltage which will swing positive or negative with respect to the reference point, causing the comparator inputs to swing above $V_{UT}$ or below $V_{IT}$, depending upon the off frequency condition existing at the time. The voltage divider is zener regulated to hold the switching thresholds constant. The voltage drops across the two 470-Ohm resistors set the width of the deadband to 3 kHz on 75 meters and 4 kHz on 40 meters.

The phase detector compares the phase relationship between the current flowing in the antenna circuit and the voltage from the antenna circuit to ground. When the input frequency is higher than the antenna system resonant frequency, the phase detector produces a dc output voltage across the two 100k load resistors which is positive with respect to the slider on the trimpot. Conversely, if the input frequency is lower than the antenna system resonant frequency, the output dc voltage is negative.

The trimpot is adjusted in operation to cause the phase detector to find exact resonance. It compensates for the inductive reactance inserted by the toroidal antenna impedance-matching transformer. The reduced output from the low side of the phase detector caused by the trimpot results in need for incremental downward QSY on 75 meters with pauses to allow the servo system to catch up. Even so, a QSY from 4000 kHz to 3800 kHz takes less than 30 seconds.

The impedance-matching transformer is necessary with the DK antenna because of its low input impedance at resonance. The taps are set at the 10-Ohm point for 40 meters and at the 14-Ohm point for 75 meters. These low input impedance values are excellent indicators of the low-loss characteristics and high performance of the antenna. Relay K1, a Potter and Brumfield KT11D 12 V dc 5-Ampere contact relay, selects the appropriate tap and is controlled by a manual switch on the control head.

Fig. 4 depicts the schematic of the control head. All of the switches, diodes, and 12 V dc indicator lamps are from Radio Shack. Switch S1 provides for switching the tuner into the automatic or manual mode and is a push-on/push-off switch. S3 provides capability to

Mounting details of the roller inductor, gear motor, and shaft coupler illustrate the mechanical simplicity of the unit.
manually slew the tuner up or down in frequency. It is a DPDT center-off-type switch. I have found that I use it rarely in operation, but it is nice to have in case you need it. It is needed during the installation adjustments. S2 operates the antenna-matching transformer tap-selector relay. No power on/off switch is provided, as power is taken directly from the transceiver. This prevents inadvertently leaving power on the tuner unless, of course, you forget to turn the transceiver off when you leave the car.

Construction

The photographs of the tuner reveal how simple the unit is to duplicate. It is built on a standard 2” x 4” x 8” aluminum chassis, and the motor bracket, end panels, cover, and bottom plate are easily constructed in the home workshop. Several W6s have built the tuner and made Plexiglas™ covers so that they can see the roller coil go into operation when they QSY. The layout I selected results in minimum antenna-circuit wire length and should be duplicated as closely as possible.

Don’t get innovative by trying to reduce conductors in the control cable. You can quickly get into trouble because the voltage comparators are sensitive to rf and to ground loops and will go “ape” if you unknowingly build in a ground loop as a result of a circuitry change. Also, keep some spacing between the control cable and the coaxial line, as rf pickup in the control cable can lead to erratic operation. The wiring diagram is shown in Fig. 5. The only precaution here is to note the direction of the antenna wire as it goes through the hole in the toroidal phase-sensing transformer. If it goes through from the wrong side of the printed circuit board, the tuner will drive away from resonance.

Antenna-Matching Transformer

A T-106 red toroidal core, obtained from either G.R. Whitehouse or Amidon Associates, both of which advertise in several amateur magazines, is the heart of the transformer. Fig. 6 provides all necessary details for construction. The sleeve for securing the taps is a model airplane copper gas line obtained from a hobby shop and cut to length with a hacksaw. Should you desire to use an antenna other than the big DK, you must determine the antenna input impedance in Ohms at resonance with an antenna noise bridge and then determine the correct tap position from Table 2. If you don’t use the DK, you will still have to change loading coils when changing bands.

Phase-Detector Transformer

Construction details of this transformer are depicted in Fig. 7. When winding the transformer, be sure that the wires remain parallel to each other without any crossovers. Also, count each pass through the hole as a turn.
This neat installation of the tuning unit in the left rear window of my station wagon permits a short lead-in from the ball mount outside.

Remember that it is impossible to wind a half turn on a toroid. This transformer need not be dipped in General Cement Red Glypt, although you may do so if you wish.

**Gear Motor**

The gear motor which I used and recommend is a Magna-Torc™ permanent-magnet 24 V dc motor with a type B gear reduction unit. Operated in the Tennamatic, this motor will turn the roller inductor at approximately one revolution per second. The motor is manufactured by the Hansen Manufacturing Co., Princeton, Indiana 47670. It may also be obtained from Hartfield, Ken- nan, and Freytag, PO Box 328, Fremont CA 94536. The motor is expensive at about $21.50 per copy; however, it is the smallest and neatest solution to the drive-motor problem and well worth it.

Others who have built this tuner have found various surplus motors or used window crank-up motors obtained from auto wrecking yards. These high-current motors are quite bulky, do not allow neat packaging of the system, and also require the addition of relays to the output of the tuner, since the transistors can not drive them directly. These surplus motors do have the advantage of being cheap, however.

**Shaft Coupler**

The shaft coupler mates the gear motor drive shaft to the thumbwheel on the end of the roller inductor. It is made of aluminum turned out on a lathe and is simply bolted with three 6-32 machine screws to the thumbwheel. Fig. 8 provides the dimensional details. One of the photographs shows how it looks when the motor and roller coil are coupled together.

**Printed Circuit Board**

Fig. 9 depicts the printed circuit board. Be sure that you watch the polarity of the phase-detector diodes when you insert them. Also, it is a very good idea to use integrated circuit sockets instead of soldering the integrated circuits directly into the board. The four output transistors can be Poly Paks green-body PNP power-tab transistors, part number 92CU2227, or Radio Shack PNP power-tab transistors, part number 276-1641. Both types are rated at 35 Watts with suitable heat sinking. Heat sinking is not required in this application.

If you use the Poly Paks transistors, bend the tabs at right angles to the body of the transistors to ensure that they clear other components mounted on the board. Make the bend about a quarter inch from the body of the transistor. Test them carefully for leakage before you solder them because I have found that about 25% of them are too leaky to work properly in this circuit. They will cause the directional indicator lights to light even when the system is at resonance. I’ve had no trouble with Radio Shack transistors.

The photograph of the underside of the chassis shows the printed circuit board as installed in the tuner. The trimpot was mounted on the foil side of the board because, when three-quarter-inch stand-

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**Table 1. Tennamatic specifications.** *Full carrier inserted. On SSB, the slew rate is slightly slower due to speech pauses.*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency range</td>
<td>75m—200 kHz</td>
</tr>
<tr>
<td></td>
<td>40m—300 kHz</td>
</tr>
<tr>
<td>Slew rate</td>
<td>75m—6 kHz/sec.</td>
</tr>
<tr>
<td></td>
<td>40m—40 kHz/sec.</td>
</tr>
<tr>
<td>Minimum Δf</td>
<td>75m—requires 3 kHz QSY to activate tuner</td>
</tr>
<tr>
<td></td>
<td>40m—requires 4 kHz QSY to activate tuner</td>
</tr>
<tr>
<td>Maximum Δf</td>
<td>75m—50 kHz (QSY of 200 kHz in four increments of 50 kHz req uires less than 30 seconds)</td>
</tr>
<tr>
<td></td>
<td>40m—200 kHz (QSY of 200 kHz requires less than 5 seconds)</td>
</tr>
<tr>
<td>Vswr</td>
<td>typically 1.15 to 1 or better after tuning completed</td>
</tr>
<tr>
<td>Modes</td>
<td>automatic/manual</td>
</tr>
<tr>
<td>Input voltage</td>
<td>10 to 15 V dc, negative</td>
</tr>
<tr>
<td>Input current</td>
<td>420 mA at 13.8 V dc while tuning; 125 mA at 13.8 V dc after tuning completed</td>
</tr>
<tr>
<td>Power rating</td>
<td>350 Watts PEP</td>
</tr>
</tbody>
</table>

---

**Fig. 8. Shaft coupler.**
offs for supporting the board are used, the screwdriver access hole in the side of the chassis falls midway in the side.

I have a few extra printed circuit boards available at $5.00 each for those who prefer not to make their own.

**Installation**

Mount the tuning unit as close as possible to the base of your antenna. Connect the base of the antenna to the tuning unit with insulated AWG #12 or #14 wire. Do not under any circumstances use coax to connect the antenna to the tuner! Make sure that you ground the tuning unit to the car body by means of sheet metal screws or a short bonding strap. Use 50-Ohm coaxial cable to connect the tuning unit to your transceiver. RG-58A/U is satisfactory, and the length is not critical.

One photograph shows how I mounted the tuner in my station wagon. After mounting the control head to the transceiver (I used Velcro® fastening tape), connect the control head power lead to the transceiver so that the transceiver power switch will control application of power to your Tennamatic.

**DK Antenna Adjustment**

After installation of your Tennamatic, your DK antenna (or other antenna) must be retuned to be resonant on approximately 4025 and 7325 kHz. For this adjustment, the roller inductor must be slewed to minimum inductance using the manual slewing switch. Next, you must determine the antenna resonant frequency on both 75 and 40 meters using your vswr bridge or field-strength meter. Resonance will be lower than it was before the Tennamatic was installed. Don't overlook changing the impedance-matching tap when you change bands looking for resonance.

Now that you know where the antenna system resonances are, you can proceed to raise them by removing turns from the loading coil, shortening the whips, or by a combination of both methods. If the two resonances are as low as 3900 kHz and 7150 kHz approximately, you may find it better to remove a turn or two from the bottom of the loading coil and one or more turns from the top of the loading coil in order to minimize the amount that must be trimmed off the whips. Remove turns only one at a time. Be sure to check the resonant frequency on each band after each adjustment because they interact, and it is essential that you do not go too far. By the time resonance is approaching the upper band edge on 75 and 40 meters, you should have determined the number of kHz per inch of frequency change you get with each inch cut off. The kHz-per-inch figure will be different for each whip. After reaching 3995 kHz and 7295 kHz, cut off an additional increment from each whip determined by dividing 30 kHz by the number of kHz per inch for each band. This will complete the antenna tuning procedure.

**Tuner Trimpot Adjustment**

This adjustment is made to cause the tuner to tune for maximum field strength (coincident with minimum vswr). When adjusted on 40 meters, it will also be correct on 75 meters. Adjust as follows:

1. Make sure your vehicle is at least fifteen feet away from other vehicles, trees, buildings, or metallic objects.
2. Turn the trimpot fully counterclockwise, and...
Table 2. Transformer taps required for various antenna input impedances to match 50-Ohm coaxial line.

<table>
<thead>
<tr>
<th>Antenna input impedance</th>
<th>Winding A turn number</th>
<th>Winding B turn number</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.13</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>4.08</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>5.17</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>6.38</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>7.72</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>9.18</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>10.78</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>12.5</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>14.34</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>16.33</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>18.43</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>20.66</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>23.02</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>25.51</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>28.13</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>30.87</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>33.74</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>36.73</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>39.86</td>
<td>11</td>
<td></td>
</tr>
</tbody>
</table>

then preset it six turns clockwise.

3. Turn on your transceiver. Place it in the tune mode with carrier inserted on the 40 meter band.

4. While watching a field-strength meter or vswr indicator, tweak the trim pot until you observe maximum field strength or minimum vswr. The Tennamatic must be in the automatic mode for this adjustment. Your unit is now ready to operate.

Operating Results

With a year and a half of operating experience, the Tennamatic has demonstrated that high-Q mobile antennas are extremely sensitive to the environment around them. For example, a dense fog will lower the antenna system resonant frequency on 75 meters by as much as 25 kHz, but the Tennamatic will compensate by rolling the inductor to less inductance. I leave it in the automatic mode at all times while driving, and, as long as I am talking, it will compensate quickly for the detuning caused by passing trucks, cars, trees, freeway overpasses, bridges, and residential power line drops as you drive under them. The result is that most of the characteristic mobile fade, which I now realize is due to antenna detuning, is eliminated. The result is such a strong steady mobile signal that I frequently have to convince my contact that I am really mobile!

There is one thing that the Tennamatic cannot compensate for. That is another 75 or 40 meter mobile parked up to twenty feet away. The mutual coupling between antennas, reflected signal, and phase shifts cause it to go “ape.” So, if you build one, don’t proudly try to demonstrate it when parked near another mobile.

Acknowledgement

I would like to acknowledge with my thanks the numerous suggestions made by Don Johnson W6AAQ as this project proceeded through the breadboard, prototype, final design, and evaluation phases. I also wish to express my grateful appreciation for the photography provided by Jerry Fulstone WA6EJV. ■
What's unique about the PLL circuit in the TS-120S?

A single-conversion PLL (phase-locked loop) system is employed in the TS-120S. Only one crystal is required, instead of a heterodyne crystal element for each band, resulting in simplification of circuitry, and a marked improvement in overall stability. The single-conversion PLL system also improves the spurious characteristics during transmission and reception, and makes IF shift operation and mono-dial indication available on any model.

The VCO frequency is obtained from the PLL circuit by synthesizing the VFO and CAR frequencies and reference oscillating frequencies of 10 MHz and 500 kHz supplied by the counter. Bandswitching is accomplished by changing the preset value of the programmable divider in the PLL. Therefore, when switching bands, the frequency (except, of course, the 1-MHz and 10-MHz order digits) remains the same. The frequencies for each band and PLL stage are shown in the table.

First, MIX (3) mixes the CAR and VFO frequencies, using a double balanced mixer to reduce spurious signals. The output of MIX (3), after passing through a bandpass filter (BPF 3) is applied to the input of MIX (1) on the 3.5 and 7.0-MHz bands. On the 14-MHz and WWV bands, MIX (2) mixes the output of MIX (3) with a 10-MHz signal from the counter-unit oscillator. On the 21 and 28-MHz bands, MIX (2) mixes the output of MIX (3) with a 20-MHz signal from a doubler connected to the counter-unit oscillator.

The output of MIX (2) or MIX (1) on the 3.5 and 7.0-MHz bands is mixed with the VCO output at MIX (1), providing output frequencies shown in the table. The output passes through a lowpass filter (LPF 1) and is amplified, and the resulting digital signal is divided by a programmable divider, producing a 500-kHz output.

“Information” from the band switches is converted into BCD signals in the counter and the division ratio as shown in the table is preset. The loop-filter consists of transistors mounted on the outside to minimize signals. A Motorola MC4044P functions as the phase comparator. Five VCO circuits with high-output transistors cover all of the bands.

If the output of the phase comparator unlocks, VCO output is switched off to prevent emission at unwanted frequencies and, at the same time, the digital display blanks to warn the operator.

What is the concept of the TS-120S digital counter for displaying frequencies?

The TS-120S digital counter employs a VFO frequency counting system. First, the VFO frequency is mixed with a 5-MHz signal obtained from the reference oscillator chain and is converted to 0.5 to 1 MHz. This signal passes through a lowpass filter, is amplified, buffered, and shaped into a digital (square) wave, passes through a 1-second gate circuit, and is applied to a four-digit counter. The signal is counted from 10 Hz to 100 kHz and is fed to a preset counter to derive the carrier output. The 100-kHz order digit presets at 0 to display the operating frequency on the 3.5, 28.5, 29.5, and WWV bands, and at 0 for display on 7.0, 14.0, 21.0, 28.0, and 29.0 MHz. The 1-MHz and 10-MHz order digits are determined by a matrix operating with bandswitch information.

The counter outputs are switched by the multiplexer and converted from BCD to seven-segment information by the decoder to light the fluorescent display tubes. The large digits have good luminous intensity and a dark filter, providing fatigue-free viewing over long operating periods. The display can be read easily, even in the car and other sulit locations.

The reference oscillator produces a 10-MHz signal and performs time-base division, and generates gate pulses, latch pulses, and reset pulses, which are applied to the counter. The PLL circuit produces 10-MHz and 500-kHz outputs. The marker circuit produces a 100-kHz signal which synchronizes the 25-kHz multivibrator to output a marker signal as accurate as the reference frequency.

The 1/10 division at the first stage of the count-down chain utilizes low-power Schottky TTL, and other divisions use CMOS ICs for low-power consumption and minimum spurious emission. With the IF shift circuit, the VFO frequency is independent of both transmitting and receiving frequencies. When the VFO frequency is counted, the operating frequency is indicated as accurately as the reference oscillator frequency, provided that the 10-MHz reference is calibrated to WWV.

True operating frequencies are displayed accurate to three digits (100-Hz order), regardless of CW transmitting and receiving frequencies or the position of the band switch or mode switch. When the VFO is tuned to the extent that the 1-MHz and 10-MHz orders are switched (beyond the band edge), these digits are blanked out.

**Frequencies for Each Band and PLL Stage**

<table>
<thead>
<tr>
<th>BAND</th>
<th>RANGE (MHz)</th>
<th>VCO (MHz)</th>
<th>MIX (1) INPUT (MHz)</th>
<th>MIX (1) OUTPUT (MHz)</th>
<th>DIVIDER RATIO</th>
<th>OCBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>WWV</td>
<td>16.5-15.0</td>
<td>23.33-23.83</td>
<td>24.33-24.83</td>
<td>1.0</td>
<td>1/2</td>
<td>1 1 1 0</td>
</tr>
<tr>
<td>3.5</td>
<td>3.5-4.0</td>
<td>12.33-12.83</td>
<td>14.33-14.83</td>
<td>2.0</td>
<td>1/4</td>
<td>1 1 0 0</td>
</tr>
<tr>
<td>7</td>
<td>7.0-7.5</td>
<td>15.83-16.33</td>
<td>14.33-14.83</td>
<td>1.5</td>
<td>1/3</td>
<td>1 1 0 1</td>
</tr>
<tr>
<td>14</td>
<td>14.0-14.5</td>
<td>22.83-23.33</td>
<td>24.33-24.83</td>
<td>1.5</td>
<td>1/3</td>
<td>1 1 0 1</td>
</tr>
<tr>
<td>21</td>
<td>21.0-21.5</td>
<td>29.83-30.33</td>
<td>34.33-34.83</td>
<td>4.5</td>
<td>1/9</td>
<td>0 1 1 1</td>
</tr>
<tr>
<td>28</td>
<td>28.0-28.5</td>
<td>36.83-37.33</td>
<td>34.33-34.83</td>
<td>2.5</td>
<td>1/5</td>
<td>1 0 1 1</td>
</tr>
<tr>
<td>28.5</td>
<td>28.5-29.0</td>
<td>37.33-37.83</td>
<td>34.33-34.83</td>
<td>3.0</td>
<td>1/6</td>
<td>1 0 1 0</td>
</tr>
<tr>
<td>29</td>
<td>29.0-29.5</td>
<td>37.83-38.33</td>
<td>34.33-34.83</td>
<td>3.5</td>
<td>1/7</td>
<td>1 0 0 1</td>
</tr>
<tr>
<td>29.5</td>
<td>29.5-30.0</td>
<td>38.33-38.83</td>
<td>34.33-34.83</td>
<td>4.0</td>
<td>1/8</td>
<td>1 0 0 0</td>
</tr>
</tbody>
</table>
Add Solid-State Braking to the T²X
—a worthwhile improvement

Tame your Tailtwister.

The T²X "Tailtwister" rotor by CDE is quite a piece of machinery. It’s a heavy-duty rotor capable of turning an antenna system with 26 square feet of wind load, has a coast-down pre-brake action, and has a wedge brake system that keeps the rotor from slipping when not in use. As an added safety feature, power is not delivered to the directional controls until the wedge brake has been released.

In order to get the rotor to turn, you must press the brake release switch on the control unit, holding it down while pressing either the clockwise or counterclockwise direction switch. Once the antenna reaches its destination, the direction switch must be released first, followed by the brake release switch after the antenna has coasted to a stop. If you should let go of the brake release switch before releasing the direction switch, or if both switches are released simultaneously, the wedge brake will immediately engage, bringing the system to an abrupt stop, placing undue strain on the rotor, mast, antenna system, and the tower itself.

Holding onto the brake release switch until the rotor has had plenty of time to coast to a stop is much easier in theory than in actual practice. What this means is that sooner or later you could have troubles, unless you can guarantee that the wedge brake won't be constantly slamming into the gears of a moving rotor.

One solution to this problem is to electronically delay the engagement of the wedge brake for a small period of time after the rotor has stopped turning.

The circuit I designed to accomplish this consists of four ICs, one optoisolator, a small power supply, and a solid state relay. All the parts, with the exception of the power transformer, filter capacitor, and bridge rectifier, are mounted on a 5⅛" x 2⅜" perfboard using standard wire-wrapping techniques. The entire circuit fits in the rotor control unit, and no modifications to either the rotor or the outside appearance of the control unit are required.

The power to the rotor's brake solenoid and directional circuitry is switched by a Grayhill Solid State Relay, which takes the place of the brake release switch in the original schematic—see Figs. 1(a) and 1(b). The SSR is ideal for this application for a number of reasons:

1. Its zero voltage turn-on and zero current turn-off characteristics plus its 3000-volt-per-microsecond transient protection allow it to switch a 110-V-ac inductive load at 4 Amps without the contact arcing found in a mechanical relay.

2. It will switch with 5 V dc of control voltage and draw less than 5 mA of current, making it compatible with TTL.

3. It physically separates
The digital control circuitry from the load by means of optoisolation, protecting the logic from any spikes that might be generated by the brake solenoid.

4 Its small size (1 cubic inch) enables it to be mounted directly on the perfboard, producing a very compact modification in the rotor control unit.

The rest of the circuitry on the perfboard (Fig 2) determines the amount of time the SSR will remain energized. When the brake release switch (S3) on the front panel is closed, the reset (pin 4) on the NE555 timer goes low, as does pin 6 on the 7409, turning on the SSR, releasing the wedge brake, and applying power to the rotor's directional controls. When the switch is released, the 74121 (which is triggered on the negative-going edge of its input pulse) applies a one-shot to the NE555, which in turn goes high at its output. This keeps pin 6 of the 7409 low, allowing the SSR to remain energized for approximately five more seconds. The five-second delay is determined by the RC combination of the 3.3-megohm resistor and the 1-µF capacitor on the NE555 and can be lengthened or shortened by increasing or decreasing the values of these components.

The input to the digital circuitry is physically separated from the rotor's direction control voltage by an optoisolator (U5) whose diode is wired in series with the LED directional indicators on the control unit—see Fig. 1(b). By the way, the optoisolator drops the total current in each directional LED by only 1 mA and therefore does not affect the original brightness of the indicators. If either one of the rotor's directional controls is pressed while the wedge brake is released, current will flow through the diode of the optoisolator. This causes the output of the optoisolator to go low (Fig. 2), resetting the NE555 and keeping the SSR energized.

Releasing the directional switch triggers the 74121 which pulses the NE555 and holds the SSR on for another five seconds. As a result, it is no longer necessary to hold down the brake release switch once the circuit has been energized. The wedge brake will not engage unless all three front panel switches have remained open for five seconds. Closing any one of the switches during the five-second delay resets the timer and repeats the cycle upon release of the switch.

In building this circuit, I used a 1k resistor network in place of mounting separate pull-up resistors, but there is room to mount the ¼-Watt resistors separately on the perfboard if you don't have a network handy. It should be noted also that I have connected the primary of the digital logic power supply transformer—Fig. 1(b)—before the rotor control unit "Off/On Switch" (S1) so that power is supplied to the ICs continuously. Although you might prefer to make the connection after the switch, this will tend to energize the brake solenoid as soon as power is applied to the box. Powering the ICs constantly (the digital logic draws considerably less than 100 mA) not only prevents this,
but also is better for the ICs in the long run since they are not subjected to surges that accompany the application of voltage to the unit.

When connecting the wire-wrap wire to the SSR "control" pins, use the wire-wrap tool to make the connection, but make sure you solder the wire to the pins. Normally, solder is not necessary with the wire-wrapping technique, but the pins on the relay are round as opposed to the square wire-wrap pins, so solder should be used to ensure a solid connection.

Since all of the circuitry, with the exception of the power transformer, bridge rectifier, and 1000-µF filter capacitor (Fig. 3), is built on the perfboard, the digital logic can be checked for any wiring errors before connecting it to, or mounting it in, the rotor control unit. The 78L05 voltage regulator will handle up to 35 volts on its input (although it runs much cooler with the 6.3-volt supply used in this project) so you can temporarily power the perfboard with the output of a standard 12-V-dc supply. Attach a logic probe or voltmeter to pin 6 of the 7409 (since the 7409 has an open collector output, pin 6 must be connected to pin 1 of the SSR and pin 2 on the SSR must be connected to +5 V dc in order to get the proper readings). You should get a high-level logic state on the probe or a little under 5 volts on the voltmeter. Grounding pin 1 or pin 2 on the 7400 should change the reading to a low-level logic state (under 1 volt on the voltmeter). When you remove the ground, the reading should stay low for about 5½ seconds before returning to its original state.

If the circuit checks out correctly, disconnect the leads on the brake release switch (S3) and solder them to the "load" pins on the SSR. Now you can mount the board on the bottom side of the control unit's chassis and hook up the power supply as shown in the schematics in Figs. 1(b) and 3. Connect a lead from one contact on the brake release switch to pin 2 of the 7400 and a lead from the other contact to ground. Unsolder the leads from connection points 2 and 5 on the control unit's printed circuit board (the board is numbered) and connect them both to pin 2 (the cathode) on the optoisolator (U5). Connect a lead from pin 1 on the optoisolator (U5) to connection point 2 on the printed circuit board. Connection point 5 is not used. This completes the modification of the rotor control unit.

Although I made this modification on the Tailtwister rotor, the schematic for the control unit is very similar to the schematic of the Ham II and Ham III rotors. I have not modified these rotors, but this circuit should work with them and is worth checking into. The only real difference between the Ham II/Ham III schematics and the Tailtwister schematic is that the Tailtwister has the three front panel LEDs (two red ones for direction indication and one green one for an indication that the wedge brake has been released). These could be added quite simply if desired—see Figs. 1(a) and 1(b)—using three 1.5k ¼-Watt resistors and three HEP1004 (1N34A-type) diodes. Although the direction indicators are not really necessary, the brake release LED does indicate the status of the wedge brake and I would recommend that you install it if you plan to use the brake delay circuit. It should be a simple matter to mount the extra components on the perfboard.

In all, the addition of an electronic brake delay circuit makes a good rotor better and may save you from the headache of rotor troubles at a later date.

**Parts List**

**ICs**
1. SN7400 (U1)
2. SN7409 (U2)
3. SN74121 (U3)
4. NE555 (U4)
5. IL 1 or equiv. optoisolator (U5)
6. uA78L05 5-volt voltage regulator

**Resistors**
1. 7k, ¼-Watt, 10%
2. 10k, ¼-Watt, 10%
3. 3.3 megohm, ¼-Watt, 10%

**Capacitors**
1. 1000 µF, 35 volts
2. 10 µF, 35 volts
3. 5 µF, 35 volts
4. 1 µF, 35 volts
5. 0.1 µF, 35 volts
6. 0.01 µF disc ceramic

**Miscellaneous**
1. 1 Power transformer, 6.3 V at 300 mA (Radio Shack 273-1384)
2. 1 Bridge rectifier (Radio Shack 276-1151 or equiv.)
3. 1 SSR Grayhill Inc., 561 Hillgrove Ave. La Grange IL 60525, Part no. 7052-04-B04-F ($21.00)

**Sockets**
2. 8-pin wire-wrap sockets
3. 14-pin wire-wrap sockets
4. 1 Transistor socket for voltage regulator (Radio Shack 276-548)
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Compact Beams for 20 or 15
—build these when your quad bites the dust

Light, neat, rugged.

My tower is just 11 feet from my neighbor’s property line. The further I stay away from his television antenna, the better, lest I cause him TVI. I, therefore, have long wanted a 20 meter beam that, while a monobander, would not have a spread so long as to go outside my yard.

I do not like the regular 20 meter quad, as it is too big and floppy and somewhat unsightly, besides being easily damaged by the wind. I did not want to buy a triband beam, since I cannot operate 15 or 10 meters. I have only a three-band rig.

At one time, I had a 15 meter quad up for a couple
I might mention a few booby traps I found as I went along. The first was that the stored tubing had been stopped up by insects and egg sacs. I used a 5/8 × 2 two meter mobile whip with the ball removed to poke out some of the debris. I then put my mouth to the small end, holding fingers over the hole which had been cut for wire in the old quad, and blew.

This worked with one arm, but not with two others. I tried poking wire through, but the wire was not stiff enough. I finally banged the large end on the concrete floor of my patio, and finally 8 cocoons fell out. I know now that I should have cleaned out the 15 meter quad arms before putting the two arms together. It would have been easier to handle them.

I then tried to push some #14 stranded wire through, but it kept catching on the end of the smaller inside arm. I took some #18 tinned wire and poking it through from the small end of the tubing, and it didn't buckle as it did when trying to force it the other way. I ran it through, twisted the end to the #14 Belden 8000, and pulled it back through.

I put a length of nylon tubing over the wire to keep it from being shorted to the bolts which held the clamps on the fiberglass arms.

I had cut the wire by formula to 16 1/2 feet for the 14,200 MHz. I thus had 5 1/2 feet left after reaching the end of the 11-foot arm. This I had to bend back. I put one of the short arms into the spider after placing the other 11-foot arm in the clamps. This I used in the upper arm of the spider. The lower arm of the spider was not used.

I could have left the upper arm unused and put the 6 1/2-foot arm in the downward position. This I decided against for two reasons. It would have brought the 5 1/2 feet of excess wire back toward the metal tower, and by using the upward position, it furnished a support for the ends of the 11-foot arms. They did not sag, but I felt that they would be subject to more wind vibration if turned down.

I pounded a 3-foot length of 1 1/4-inch pipe into the ground and placed the 8-foot boom with the attached spiders and center T-fixture in the pipe. This gave me a position for attaching the arms and stringing the 1/4-inch nylon rope supports. The patio was too short, and the egg crate roof was so low that I could never have gotten the completed beam out. Even in the yard I was short of space, but I managed, even with shrubs and trees. I drilled a 1/4-inch hole in the tops of the vertical arms and threaded 1/4-inch nylon rope through. I pulled enough through to reach the ends of the wire, and then tied a knot each side of the vertical arms to keep the rope from slipping. I used a 6-inch length of 7/8-inch PVC pipe with holes drilled in the ends for insulators. I probably did not need the insulators with about 7 feet of nylon rope and a fiberglass support, but habit made me use them. I would probably not use them again, so I suggest you don't bother.

I fastened a Kirk balun to the lower quad spider arm, and it made a fine installation. However, after spending several hours trying to figure out why the SWR was about 10:1, I opened up the balun and found that one of the wires, after 20 years of use, had finally broken. I just put it up without a balun. I think a balun might have helped in some ways, but it seems to work well, anyway. I had used a hose clamp to attach the balun to the arm, and it was a neat job. If you use a balun, try this.

I used 31 feet, 4 inches for the director, which is 95%
of the 33-foot length of the driven element. I used a director instead of a reflector because it requires less boom length for the same gain and needed less extra wire pulled back toward the support. There was about 4 feet, 8 inches to pull back on each end.

I checked the SWR on the ground, and it was 2 1/4:1 from about 14.200 MHz to 14.350 MHz, except that it dropped to 2:1 in the area of 14.250 MHz. I figured that this would improve when it was up in the air, and it did. At the height of 43 feet, it dropped to 1.5:1 when it was up in the air, and it was 2:1 pulsed back on each end.

I have no rotator yet, so I wanted to face the beam SW. It needed to be attached to a mast to raise it about 5 feet above the 38-foot tower. I had 8 feet of 1 1/2-inch heavy wall aluminum tubing, and I inserted a similar length of 1 1/4-inch steel tubing inside to make a stiff mast. I drilled a hole and inserted a metal screw to hold the tubing together.

I had planned that we drill the mast for the T-fixture when it was up in the sky, but my friend, Bill Burns WABJE, who was going to raise it for me, wanted to drill it on the ground. I think he regretted it when he carried it to the tower. I had told him the beam weight was about 12 pounds, I thought I had easily carried it on the ground.

While he was carrying it up in one arm and climbing with the other, he stopped to rest a couple of times, and he said it was more like 25 pounds with the attached masting. I recommend that you wait until it is on the tower and drill it before lifting the mast up to the desired height. I let it stick out 5 feet above the tower, which gives me enough inside the tower to attach a rotator.

I later wished I had done one more thing. I should have slipped the wire through a short piece of Teflon extending 4 inches outside the end of the fiberglass arm. This would help prevent the chafing of the wire by the sharp edge of the tubing and might keep the wire from breaking. It probably will last at least a couple of years, though. There is not much pull on the wire, since I did not draw it up very tight, so perhaps it will last longer.

It makes a lot neater arrangement than a 20 meter quad, and up in the air it looks nice.

I used a quarter wavelength of RG-59/U as a matching section from the driven element to the RG-8/U coax lead-in. I guessed that the beam impedance would be about 20 Ohms, and this would raise it to 40 Ohms. This would give an SWR of 1.25:1, so the 1.5:1 final measurement was not far off.

When I got a chance to test it, I first called CQ and a California station came back and said that I had a "really strong signal" in his location. Next, I went in a pileup and got a reply, after only two calls, from P291S in Papua, New Guinea. He said I was 5 x 9. It was a new country for me. The band was going out, so I went to bed.

The next night I tried to talk to a friend, Dale WD8VTD in Jamestown, Ohio, about 19 miles away, but he was off the side of my beam and we were really weak. While I was listening for him, Hans S5M6CVX called me and wanted to know my Ohio county. When I told him Fayette, he wanted a QSL card. He gave me 5 x 7 and he was 5 x 8 here. I guess that my front-to-back is probably about 12-15 dB, so it seems I can work Europe off the back OK.

I usually work 40 meters from about 0600 to 0900 GMT, so I don't get on 20 until late. Thus I work mostly Pacific stations.

Last night I called Harry VK3XI and he came back on the first call. He said the band was going out and my beam must be pretty good, as he would not otherwise have been able to work me. He was 5 x 7 here.

I am running just about 800 Watts PEP, so I am very pleased with the results. I think I could have done well with just a 15 meter quad alone and a 1 1/2-inch boom, but I used what I had. My 15 meter quad boom was only 1 1/2 inches x 5 feet long, so I wanted a longer boom. There is no reason why you can't make your own beam from scratch with bamboo or even 1 x 2 wood and a plywood spider. The fact that there is a support for the arms, and the shortened length, bring up many possibilities for a light, cheap beam or even a dipole.

The director is not connected to the boom. The boom is 8 feet long and 2 inches in diameter—a very husky beam.

After seeing my 20 meter compact beam, Kenny Long WB8NGX wanted a 15 meter like it, and I had four arms left, so I decided to build one for him. I used lightweight spiders and a boom from a Kirk 15 meter quad, and of course, I didn't need such a long wire. I only used about 22 feet of wire for a 15 meter beam, so I decided to thread the wire just to the ends of the arms and bend them back an inch, both to hold them taut and to allow for corona prevention. I then had only about 1 foot, 5 inches left in the center.

I pulled this out along another short fiberglass arm, about 18 inches long. See Fig. 5. Then I fastened the wire to the binding posts on a short fiberglass strip. I bolted this to the arm and then added another strip for a spacer. This kept the wire from touching the metal of the spider arm. This was for the driven element.

For the director, I had only about 5 inches left on each side. I used a short piece of PVC tubing bolted to the arm to hold this piece. This wire was not broken, nor was it grounded to the boom. The boom is 6 feet long.

The beam is a very light, neat, and rugged affair. I guessed that it weighed about 7 pounds. I carried it over to Kenny Long's house on the top of a car, not even tied down. We held it down by hand, sticking our arms out the windows.
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A vote for the bends.

There are two things which I look for in a vertical antenna: simplicity (no traps or hats) and availability of parts. A quarter-wave vertical for forty meters fits both of these criteria, but it is often overlooked when antenna construction is contemplated.

There are also two schools of antenna construction: the oak (make it so rigid and strong that it just cannot be destroyed by wind, earthquakes, snow, ice, or whatever) and the willow (able to bend, flex, and take all of the above and spring back). Since the "oak" method never did work for me, this antenna is of the "willow" configuration. It is made of lengths of concentric tubing and ends in a whip.

To determine how much tubing we will need, we have to figure out how long a quarter wave is at forty meters. Using $\lambda/4(\text{feet}) = 246/f$ (MHz) and then converting the fraction of a foot which remains to inches, we get $\lambda/4 = 33'10"$ for a center frequency of 7.265 MHz. Any center frequency can be chosen by placing that frequency in place of $f$ in the formula.

Construction

Now let's get down to business. The aluminum tubing is available locally in most areas in concentric sizes from 2" to 3/8". I had a 3'x1-1/2"-o.d. piece of tubing on hand, so this was the logical place to start. Now, all we need is 30'10" more. Five 8' sections of tubing were used: 1-1/4", 1", 3/4", 1/2", and 3/8" o.d. After slotting the ends with a hacksaw and clamping the ends with hose clamps, I had 30' of tubing in 6' sections with approximately 2' of each inside the lower tube. An 18" whip was clamped to the top, and the already-on-hand 3'x1-1/2" tube was attached to...
Hy-Gain 3806
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- Separate microphone and speaker elements for enhanced audio
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- Specifically gasketed case seals out water, dirt and corrosive salt air
- Watertight, high-impact ABS plastic case—ribbed for non-slip grip
- Top-mounted controls for instant access

Accessories:

<table>
<thead>
<tr>
<th>Model No.</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>3007</td>
<td>Nicad Battery Pack</td>
<td>$31.95</td>
</tr>
<tr>
<td>1104</td>
<td>Touch Tone Pad</td>
<td>$44.95</td>
</tr>
<tr>
<td>1106</td>
<td>AC Battery Charger</td>
<td>$9.95</td>
</tr>
<tr>
<td>1107</td>
<td>Cigarette Lighter Adapter Cord</td>
<td>$9.95</td>
</tr>
<tr>
<td>1108</td>
<td>Antenna Adapter Cord</td>
<td>$9.95</td>
</tr>
<tr>
<td>1110</td>
<td>Carrying Case (Leather)</td>
<td>$17.95</td>
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<tr>
<td>1111</td>
<td>Carrying Case (Vinyl)</td>
<td>$9.95</td>
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<tr>
<td>269</td>
<td>Rubber Duck Antenna</td>
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</tr>
<tr>
<td></td>
<td>Crystal Gemicares</td>
<td>$3.95</td>
</tr>
</tbody>
</table>

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Don WBØYEZ Ken WDØEMR
Denny WØQR Eli KAØCEJ
Bill WBØYHJ John WBØMTS
Joe WAØWRI Blaine WBØQLH
Jim KAØCRK Bob WBØRQZ
the bottom. Now we have either a very long trout rod or a slightly-oversize quarter-wave antenna for forty meters.

Ground is an important part of a quarter-wave antenna, so ground mounting was chosen. A piece of redwood 3" x 4" x 1/2" was found and painted to match my fence. Holes were drilled in appropriate place for U-bolts to hold the vertical to the redwood, and a test fitting showed that the antenna could be securely fastened to the redwood. A couple of large nails were driven into the bottom part of the redwood mount to give the concrete more to grab on to. A 24"-deep hole was dug in an inconspicuous corner of my yard and filled with a 60-pound bag of concrete. The prepared hunk of redwood was then placed in the wet concrete and propped up so that it would be straight when the concrete set. A bolt was put into the bottom of the antenna so that the center conductor of the coax feed could be connected. Another bolt was placed in the redwood mount to serve as a junction point for the ground system. (This bolt must be insulated from the radiating element.)

The Ground System
Some of us have a good ground (swamp or salt marsh) and others don't (rock or sand). My worst-case ground was 120 #18 wire radials, each a little more than a quarter-wavelength long, splayed out sunburst-style around the base of the antenna. The ground system which I wound up with was three radials, six feet long, terminating at B' ground rods. These three radials were joined at the antenna base on another B' ground rod. I used #10 wire to interconnect the ground rods and the short run to the bolt which was previously placed for ground connection on the redwood mount. To be sure, there was a difference in vswr obtainable, but the simpler ground system was satisfactory for my area.

Adjustment
Connect one foot or less of 52-Ohm coax to the antenna, connecting the center conductor to the vertical radiator and the ground braid to the ground connection on the redwood. Connect the vswr meter and the transmitter. Take a reading at the low end of the band, one at the middle, and one at the top. This should be enough to give you an idea of whether to shorten or lengthen the element. If you have built the antenna as described, you will probably have to shorten it a bit. This is best at the top sections. Do your fine tweaking with the whip. You have to take the antenna down each time you want to adjust it, so, by all means, take notes to help you make as few adjustments as possible. When this was done, an swr of 1.2 to 1 was obtained at 7.265 MHz and the swr did not go above 1.6 to 1 in the forty meter band. This was quite acceptable to me. The swr on the top end of fifteen meters was around 2 to 1—not bad for a bonus band.

This antenna has performed well at this QTH and was used when I was net control for the infamous swap net. Using only an FT-101 "barefoot," I was quite well heard in all of southern California, Arizona, and northern California as well. The antenna is also good for DX on forty and fifteen meters because of its low angle of radiation.
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Marine-Band Activity
—a complete guide

Between 160 meters and 10 meters, we amateurs generally think in terms of the six HF amateur bands. There are, however, a great many other services operating in those large gaps between our bands. Most hams are aware of some of those other users, such as shortwave broadcasters (Voice of America and Radio Moscow are two examples), if for no other reason than the QRM they cause on the 40 meter phone band at night!

A partial list of the HF band population would include such services as land mobile (U.S. Corps of Engineers, on 5,015 kHz, for example), special industrial, on 4,637.5 kHz (mineral exploration), forestry (in the Pacific Northwest, primarily), and, of course, the military of all nations.

But there is one other major service, one of the oldest, known as the maritime service; that is the subject of this article.

Why is the maritime (or marine) service worth listening to? Because it usually provides the most interesting listening of the communications services (which excludes the broadcast service) and it is the busiest (and therefore easiest to tune in). Also, since it was the first regular user of radio, ship radio has an aura of romance and adventure.

SOS and Mayday—cries for help across the sea—are still heard today, although (thankfully) less frequently than in the past. The famous ship disasters of the last seven decades electrified the public and brought a fleeting fame to the “sparks,” as ship operators were known.

Before the SOS was accepted, the most common call for help was CQD, which was made famous in 1909 by Jack Binns, radio officer of the British ship Republic. His heroism saved most of the passengers of his doomed ship, which had been rammed by the S.S. Florida one day out of New York. Working by candlelight in the January cold, he remained at his key for a continuous 36-hour shift. He delayed his escape from the sinking ship until he knew that help was at hand, risking his life to save the lives of many others.

From the first radio call for help from the British Goodwin Sands lightship in March, 1899, through the famous Titanic tragedy and the Morro Castle, whose smoldering hulk became a tourist attraction when it beached near Asbury Park, New Jersey, boardwalk in the mid 1930s, to the Andrea Dorea and the oil tanker sinkings of today’s TV news, the tradition of the radio operator’s staying at the key until the last possible minute (sometimes losing his life as a result) has remained constant.

I remember following the terrible events of the Texas tower which sank off New Jersey in the early 1960s, from the first Mayday signal to the last announcement that the tower had disappeared with all hands in the horrified sight of the rescue ship. There was a violent gale and there was no way of effecting a rescue. The frequencies used were 2,182 kHz and 500 kHz for phone and CW, both easily heard on an old Navy receiver. That was my introduction to marine radio.

Of course, these tragic
Fleet chat, river tugs, still very interesting. Some informational information, fishing Guard or nearby ships with typical SSB traffic, heard on mundane by comparison, but still very interesting. Some typical SSB traffic, heard on almost any day, would include oil well drilling operational information, fishing fleet chatter, river tugboats, tankers and freighters talking to their home ports or arranging for supplies at their next port, and international radio telephone (phone patch) conversations. I often receive German and English marine operators at my Chicago home. If you wish to copy CW, telegrams, ship supply orders, news, weather, and ship arrival times can be heard if one knows where to listen.

Now that I have (hopefully) aroused your interest and curiosity, you are probably wondering where to listen, so here is a fairly complete guide to the marine bands. The information is as accurate and up-to-date as possible, being derived from a combination of sources, one of which is the rule book of the International Telecommunications Union—a source of many FCC regulations. To this is added my own experience in working with marine radio as HF-SSB consultant for a large Chicago-based company and as an SWL.

The maritime service is divided into several operational categories, four major frequency bands, and two events are luckily less common today, due to the availability of search planes and fast boats and the fine job done by the Coast Guard. Yet there are about two or three Mayday calls on 2,182 kHz in a week in the Gulf of Mexico alone. Most are promptly solved by the U.S. Coast Guard or nearby ships with no loss of life.

The bulk of traffic is more mundane by comparison, but still very interesting. Some typical SSB traffic, heard on almost any day, would include oil well drilling operational information, fishing fleet chatter, river tugboats, tankers and freighters talking to their home ports or arranging for supplies at their next port, and international radio telephone (phone patch) conversations. I often receive German and English marine operators at my Chicago home. If you wish to copy CW, telegrams, ship supply orders, news, weather, and ship arrival times can be heard if one knows where to listen.

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The maritime service is divided into several operational categories, four major frequency bands, and two

<table>
<thead>
<tr>
<th>Voice signal</th>
<th>Morse equivalent</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mayday</td>
<td>SOS (3 times)</td>
<td>Distress—when there is immediate danger to life or property. Has priority over all other signals. Preceded by &quot;autolarm&quot; when time permits.</td>
</tr>
<tr>
<td>Pan</td>
<td>XXX (3 times)</td>
<td>Urgency—when safety of life or vessel is threatened or if a less immediate danger exists (sickness, out of fuel in open water and no immediate danger, &quot;man overboard,&quot; etc.).</td>
</tr>
<tr>
<td>Securite</td>
<td>TTT (3 times)</td>
<td>Safety—when a danger to navigation (hulk in channel, buoy missing, severe weather) exists.</td>
</tr>
<tr>
<td>(Voice)</td>
<td>Auto-alarm</td>
<td>Sent before Mayday or SOS when time permits, to attract listeners.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Channel</th>
<th>Frequency*</th>
<th>Channel</th>
<th>Frequency*</th>
</tr>
</thead>
<tbody>
<tr>
<td>4A</td>
<td>4136.3 kHz</td>
<td>22A</td>
<td>22,094.5 kHz</td>
</tr>
<tr>
<td>4B</td>
<td>4139.5 kHz</td>
<td>22B</td>
<td>22,098.0 kHz</td>
</tr>
<tr>
<td>4C</td>
<td>4434.9 kHz</td>
<td>22C</td>
<td>22,101.5 kHz</td>
</tr>
<tr>
<td>6A</td>
<td>6210.4 kHz</td>
<td>22D</td>
<td>22,105.0 kHz</td>
</tr>
<tr>
<td>6B</td>
<td>6213.5 kHz</td>
<td>22E</td>
<td>22,108.5 kHz</td>
</tr>
<tr>
<td>6C</td>
<td>6518.6 kHz</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Priority signals for voice and Morse.

<table>
<thead>
<tr>
<th>Channel</th>
<th>Frequency*</th>
</tr>
</thead>
<tbody>
<tr>
<td>8A</td>
<td>8281.2 kHz</td>
</tr>
<tr>
<td>8B</td>
<td>8284.4 kHz</td>
</tr>
<tr>
<td>12A</td>
<td>12,421.0 kHz</td>
</tr>
<tr>
<td>12B</td>
<td>12,424.5 kHz</td>
</tr>
<tr>
<td>12C</td>
<td>12,428.0 kHz</td>
</tr>
<tr>
<td>16A</td>
<td>16,565.0 kHz</td>
</tr>
<tr>
<td>16B</td>
<td>16,568.6 kHz</td>
</tr>
<tr>
<td>16C</td>
<td>16,572.0 kHz</td>
</tr>
</tbody>
</table>

2-MHz frequencies

<table>
<thead>
<tr>
<th>Frequency*</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,182 kHz</td>
</tr>
<tr>
<td>2,638 kHz</td>
</tr>
<tr>
<td>2,670 kHz</td>
</tr>
<tr>
<td>(U.S.C.G.)</td>
</tr>
<tr>
<td>2,738 kHz</td>
</tr>
</tbody>
</table>

Table 3. HF ship-ship (plus limited coast) simplex channels. *Carrier frequencies are listed; listen on USB. The above 2-MHz frequencies are not, strictly speaking, in the same category, but are often used for similar purposes.

<table>
<thead>
<tr>
<th>City</th>
<th>Primary coast transmit</th>
<th>Primary coast receive</th>
<th>Secondary coast transmit</th>
<th>Secondary coast receive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boston</td>
<td>2506 kHz</td>
<td>2406 kHz</td>
<td>2450 kHz</td>
<td>2366 kHz</td>
</tr>
<tr>
<td>New York</td>
<td>2590 kHz</td>
<td>2198 kHz</td>
<td>2522 kHz</td>
<td>2126 kHz</td>
</tr>
<tr>
<td>Miami</td>
<td>2514 kHz</td>
<td>2118 kHz</td>
<td>2490 kHz</td>
<td>2031.5 kHz</td>
</tr>
<tr>
<td>New Orleans</td>
<td>2598 kHz</td>
<td>2206 kHz</td>
<td>2482 kHz</td>
<td>2382 kHz</td>
</tr>
<tr>
<td>Galveston</td>
<td>2530 kHz</td>
<td>2134 kHz</td>
<td>2450 kHz</td>
<td>2366 kHz</td>
</tr>
<tr>
<td>San Francisco</td>
<td>2506 kHz</td>
<td>2406 kHz</td>
<td>2450 kHz</td>
<td>2003 kHz</td>
</tr>
<tr>
<td>San Pedro (L.A.)</td>
<td>2566 kHz</td>
<td>2009 kHz</td>
<td>2466 kHz</td>
<td>2382 kHz</td>
</tr>
<tr>
<td>Seattle</td>
<td>2522 kHz</td>
<td>2126 kHz</td>
<td>2482 kHz</td>
<td>2430 kHz</td>
</tr>
<tr>
<td>Hawaii</td>
<td>2530 kHz</td>
<td>2134 kHz</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Great Lakes</td>
<td>2514 kHz</td>
<td>2118 kHz</td>
<td>2550 kHz</td>
<td>2158 kHz</td>
</tr>
<tr>
<td>Mississippi</td>
<td>2782 kHz</td>
<td>2782 kHz</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Table 4. 2-MHz marine operators.
fundamental station types—fixed (coast) and mobile (ship) stations.

Of primary interest to the amateur or SWL are the frequencies, of course, but a summary of the other information will prove useful, enabling the listener to find the type of station he would like to hear.

The basic operational division is that of radiotelegraph (CW) and radiotelephone (phone) operations. These two divisions are interspersed in alternating subbands throughout the 2-26 MHz portion of the spectrum, plus the VLF bands below 500 kHz (exclusively CW except for some weather broadcasts and foreign broadcasting) and the VHF-FM main band which is exclusively phone. RTTY and special data are used a great deal, but are difficult for most SWLs to decode.

An important fact to keep in mind, with regard to ship and shore stations, is that most of their frequency assignments are duplex (actually half-duplex, or two-frequency simplex, at the ship station), with the two stations transmitting and receiving on different frequencies. This is true of many marine channels, from VLF to VHF. An example, WOO 8-26 (WOO is “Ocean Gate Radio” in New York), is given below under “Reading the Tables.” The reason for this duplex operation is that the shore stations usually

<table>
<thead>
<tr>
<th>Station location</th>
<th>Station callsigns</th>
<th>Typical frequency***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Azores</td>
<td>CUG</td>
<td>6,393.5 kHz</td>
</tr>
<tr>
<td>Cuba</td>
<td>CLQ</td>
<td>6,435.0 kHz</td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>HIA</td>
<td>8,642.0 kHz</td>
</tr>
<tr>
<td>England* (Portishead)</td>
<td>GKI**</td>
<td>12,858.0 kHz</td>
</tr>
<tr>
<td>Halifax</td>
<td>CFH</td>
<td>12,726, 8,697 kHz</td>
</tr>
<tr>
<td>Greece</td>
<td>SVA</td>
<td>12,689, 12,859 kHz</td>
</tr>
<tr>
<td>Italy</td>
<td>IAR</td>
<td>8,670.0 kHz</td>
</tr>
<tr>
<td>Japan</td>
<td>JOG</td>
<td>8,706.0 kHz</td>
</tr>
<tr>
<td>Philippines</td>
<td>DZK</td>
<td>8,568.0 kHz</td>
</tr>
<tr>
<td>U.S.A.—East</td>
<td>WSL, WSC**</td>
<td>6-, 8-, 12-MHz bands</td>
</tr>
<tr>
<td>U.S.A.—West</td>
<td>KFS**, WNU</td>
<td>6-, 8-, 12-MHz bands, 4,310 kHz</td>
</tr>
<tr>
<td>Honolulu—CC</td>
<td>NMO</td>
<td>9,050, 13,655 kHz</td>
</tr>
</tbody>
</table>

Table 6. Selected CW shore stations. *Sister station of GCN (phone). **Also listen 420-500 kHz. ***Operate many frequencies. See Table 8 for band limits.
There are also a number of simplex channels, such as 2,182 kHz for calling and Mayday use, and 4,125 kHz for ship-to-ship or limited coast station usage. These frequencies are spread throughout the range of 2-27 MHz, but the most useful for the average listener are between 4 and 17 MHz, providing high activity both day and night and allowing both sides of the conversation to be heard with one receiver, even far inland. Table 3 lists these simplex channels by number and frequency, while Table 4 lists the most interesting duplex channels by band, station, and frequency. Morse operation is found on the frequencies listed in Tables 6 and 8.

Although not the main purpose of this article, in the interest of completeness I have included several tables listing all the marine bands from VLF to VHF. One last
### Assignable working frequencies for high-traffic ships

<table>
<thead>
<tr>
<th>Limits (kHz)</th>
<th>Assignable working frequencies</th>
<th>Limits (kHz)</th>
<th>Calling frequencies d)</th>
<th>Limits (kHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4,172.25</td>
<td>4,172.5 -- 4,177.5</td>
<td>4,178</td>
<td>4,178.5 --- 4,186.5</td>
<td>4,187</td>
</tr>
<tr>
<td></td>
<td>11 frequencies spaced 0.5</td>
<td></td>
<td>17 frequencies spaced 0.5</td>
<td></td>
</tr>
<tr>
<td>6,258.25</td>
<td>6,258.75-- 6,266.25</td>
<td>6,267</td>
<td>6,267.75--6,279.75</td>
<td>6,280.5</td>
</tr>
<tr>
<td></td>
<td>11 frequencies spaced 0.75</td>
<td></td>
<td>17 frequencies spaced 0.75</td>
<td></td>
</tr>
<tr>
<td>8,341.75</td>
<td>8,342-- 8,345</td>
<td>8,356</td>
<td>8,357--○-- 8,373</td>
<td>8,374</td>
</tr>
<tr>
<td></td>
<td>14 frequencies spaced 1</td>
<td></td>
<td>17 frequencies spaced 1</td>
<td></td>
</tr>
<tr>
<td>12,503.25</td>
<td>12,504--12,513--12,517.5</td>
<td>12,534</td>
<td>12,535.5--12,559.5</td>
<td>12,561</td>
</tr>
<tr>
<td></td>
<td>-- -- -- 12,532.5</td>
<td></td>
<td>17 frequencies spaced 1.5</td>
<td></td>
</tr>
<tr>
<td>16,680.5</td>
<td>16,662--16,672--16,684--16,690</td>
<td>16,712</td>
<td>16,714 -- -- 16,746</td>
<td>16,748</td>
</tr>
<tr>
<td></td>
<td>25 frequencies spaced 2</td>
<td></td>
<td>17 frequencies spaced 2</td>
<td></td>
</tr>
<tr>
<td>22,184.5</td>
<td>22,187------------------------</td>
<td>22,222.5</td>
<td>22,225--22,265</td>
<td>22,267.5</td>
</tr>
<tr>
<td></td>
<td>18 frequencies spaced 2</td>
<td></td>
<td>17 frequencies spaced 2.5</td>
<td></td>
</tr>
</tbody>
</table>

### Assignable working frequencies for low-traffic ships

<table>
<thead>
<tr>
<th>Limits</th>
<th>Assignable working frequencies</th>
<th>Limits</th>
<th>Assignable working frequencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>4,187.5 -- 4,208</td>
<td>4,231</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4,208.5 -- 4,229</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>84 frequencies spaced 0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group B</td>
<td>6,281.25-- 6,312</td>
<td>6,345.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6,312.75-- 6,343.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>84 frequencies spaced 0.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8,375</td>
<td>8,416</td>
<td>8,458</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8,417</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>84 frequencies spaced 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12,562.5</td>
<td>12,624</td>
<td>12,689</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12,825.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12,887</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>84 frequencies spaced 1.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16,750</td>
<td>16,832</td>
<td>16,916</td>
<td></td>
</tr>
<tr>
<td></td>
<td>16,834</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-- -- -- 16,916</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>84 frequencies spaced 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22,270</td>
<td>22,320</td>
<td>22,370</td>
<td></td>
</tr>
<tr>
<td></td>
<td>22,322.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-- -- -- 22,370</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>41 frequencies spaced 2.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Calling frequencies d)

- 4,178.5 --- 4,186.5
- 17 frequencies spaced 0.5
- 6,267.75--6,279.75
- 17 frequencies spaced 0.75
- 8,357--○-- 8,373
- 17 frequencies spaced 1
- 12,535.5--12,559.5
- 17 frequencies spaced 1.5
- 16,714 -- -- 16,746
- 17 frequencies spaced 2
- 22,225--22,265
- 17 frequencies spaced 2.5

### (RTTY and data)

**Ship stations**, wide-band telegraphy, facsimile, transmission systems:

- 4,142.5 - 4,162.5 kHz
- 6,216.5 - 6,244.5 kHz
- 8,288 - 8,328 kHz
- 12,431.5 - 12,479.5 kHz
- 16,576 - 16,638.5 kHz
- 22,112 - 22,160.5 kHz

**Ship stations**, oceanographic data transmission:

- 4,162.5 - 4,166 kHz
- 6,244.5 - 6,248 kHz
- 8,328 - 8,331.5 kHz
- 12,479.5 - 12,483 kHz
- 16,638.5 - 16,640 kHz
- 22,160.5 - 22,164 kHz

**Ship stations**, narrow-band direct-printing telegraph data transmission systems:

- 4,166 - 4,172.25 kHz
- 6,248 - 6,258.25 kHz
- 8,331.5 - 8,341.75 kHz
- 12,483 - 12,503.25 kHz
- 16,640 - 16,660.5 kHz
- 22,164 - 22,184.5 kHz

**Coast stations**, wide-band and manual telegraphy, facsimile, special and data transmission systems and direct-printing telegraph system:

- 4,231 - 4,361 kHz
- 6,345.5 - 6,514 kHz
- 8,459.5 - 8,728.5 kHz
- 12,689 - 13,107.5 kHz
- 16,917.5 - 17,255 kHz
- 22,374 - 22,624.5 kHz

---

Table 8. Frequencies assignable to ship radiotelegraph stations using the maritime mobile service bands between 4 and 27.5 MHz.
note on the calls you will hear is that the callsigns follow the same general assignments as amateur calls and a three-letter call is that of a shore station, while a four-letter or letter/number combination is usually that of a ship. Finally, in order to help you read the tables, the following section explains the channel designation numbering system and summarizes what information can be found in the various tables.

Reading The Tables

Many of the frequencies listed have channel designations after the frequency. These refer to the band and number of channels on a particular band. Therefore, a channel labeled “410” tells us that it is a 4-MHz channel, and refers to a particular frequency. Stating the channel as WOM 410, however, tells us that this is a 4-MHz channel of the Fort Lauderdale, Florida, high sea station and is registered as being 4090.9 kHz (ship transmit)/4385.3 kHz (ship receive). These are always half-duplex frequencies.

### U.S. channels

<table>
<thead>
<tr>
<th>Channel</th>
<th>Frequency (MHz)</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ship</td>
<td>Coast</td>
</tr>
<tr>
<td>16</td>
<td>156.800</td>
<td>156.800</td>
</tr>
<tr>
<td>6</td>
<td>156.300</td>
<td>156.300</td>
</tr>
<tr>
<td>22</td>
<td>157.100</td>
<td>157.100</td>
</tr>
<tr>
<td>13</td>
<td>156.650</td>
<td>156.650</td>
</tr>
<tr>
<td>17</td>
<td>156.850</td>
<td>156.850</td>
</tr>
<tr>
<td>7</td>
<td>156.350</td>
<td>156.350</td>
</tr>
<tr>
<td>8</td>
<td>156.400</td>
<td>156.400</td>
</tr>
<tr>
<td>9</td>
<td>156.450</td>
<td>156.450</td>
</tr>
<tr>
<td>10</td>
<td>156.500</td>
<td>156.500</td>
</tr>
<tr>
<td>11</td>
<td>156.550</td>
<td>156.550</td>
</tr>
<tr>
<td>18</td>
<td>156.900</td>
<td>156.900</td>
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<tr>
<td>19</td>
<td>156.950</td>
<td>156.950</td>
</tr>
<tr>
<td>67</td>
<td>156.375</td>
<td>156.375</td>
</tr>
<tr>
<td>77</td>
<td>156.875</td>
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<tr>
<td>75</td>
<td>156.975</td>
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<tr>
<td>72</td>
<td>156.625</td>
<td>156.625</td>
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<tr>
<td>15</td>
<td>156.700</td>
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<td>9</td>
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<tr>
<td>69</td>
<td>156.475</td>
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<td>70</td>
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<td>71</td>
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<td>72</td>
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<td>78</td>
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<td>24</td>
<td>157.200</td>
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<td>25</td>
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<td>161.850</td>
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<td>26</td>
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<td>27</td>
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<td>161.950</td>
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<tr>
<td>28</td>
<td>157.400</td>
<td>162.000</td>
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<td>84</td>
<td>157.225</td>
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<td>85</td>
<td>157.275</td>
<td>161.875</td>
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<tr>
<td>86</td>
<td>157.325</td>
<td>161.925</td>
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<tr>
<td>87</td>
<td>157.375</td>
<td>161.975</td>
</tr>
<tr>
<td>88</td>
<td>157.425</td>
<td>162.025</td>
</tr>
</tbody>
</table>

### Weather

<table>
<thead>
<tr>
<th>Channel</th>
<th>Frequency</th>
<th>Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>WX1</td>
<td>162.550</td>
<td>NOAA primary weather channel</td>
</tr>
<tr>
<td>WX2</td>
<td>162.400</td>
<td>NOAA secondary weather channel</td>
</tr>
<tr>
<td>WX3</td>
<td>161.650</td>
<td>Canadian weather channel (ITU channel 21)</td>
</tr>
</tbody>
</table>

Table 9, VHF.
Table 10. Summary of marine bands.

<table>
<thead>
<tr>
<th>Band (kHz)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>14-160</td>
<td>VLF, Morse, shared with radio navigation and direction finding</td>
</tr>
<tr>
<td>255-285</td>
<td>VLF, Morse, shared with radio navigation and direction finding</td>
</tr>
<tr>
<td>410 ± 5</td>
<td>Reserved for direction finding</td>
</tr>
<tr>
<td>415-525</td>
<td>MF-low, Morse—most common</td>
</tr>
<tr>
<td>500</td>
<td>“SOS” and calling</td>
</tr>
<tr>
<td>3400-3800</td>
<td>In some parts of world, shared with amateur service</td>
</tr>
<tr>
<td>1605-2850</td>
<td>Morse and voice—primarily old ship frequency band in early days; mostly being replaced for short range by VHF</td>
</tr>
<tr>
<td>3155-3400</td>
<td>Voice, Morse—less common in U.S.</td>
</tr>
</tbody>
</table>

Table 11. High seas Navy and Coast Guard stations.

For another example, WOO 811 is one of the 8-MHz channels for New York’s (actually located in New Jersey, near Atlantic City) Ocean Gate Radio (8226.0T/8749.9R). Table 4 provides a listing of many of the major world high seas stations and their frequencies. There are two other types of channel numbers: for HF ship-to-ship (a number and letter combination), and for VHF-FM (a simple channel number). These are to be found in Tables 3 and 9, respectively.

In order to find the emergency frequencies quickly, they are listed separately in Table 1, followed by the types of emergency or priority signals heard on them in Table 2.

For those who have receivers or receivers with spare bands, the various bands, channel breakdown schemes, and voice as well as Morse operation are to be found in the remaining tables.

That’s it. Pick out where and what you want to hear, tune it in, and enjoy the excitement and fascination of the marine bands.

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<table>
<thead>
<tr>
<th>VAC-40/75---$54.50</th>
<th>VAC-20/40/75---$74.50</th>
<th>VAC-10/15/20/40/---$104.50</th>
</tr>
</thead>
<tbody>
<tr>
<td>VAC-20/40---$54.50</td>
<td>VAC-15/20/40---$74.50</td>
<td>VAC-15/20/40/75---$104.50</td>
</tr>
<tr>
<td>VAC-15/20---$54.50</td>
<td>VAC-10/15/20/40/---$74.50</td>
<td>VAC-10/15/20/40/75---$104.50</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Model</th>
<th>Frequency Range</th>
<th>Proportional Oven</th>
<th>Accuracy Over Temperature</th>
<th>50Hz To 75MHz</th>
<th>75MHz To 500MHz</th>
<th>500MHz To 1GHz</th>
<th>Number Of Digits</th>
<th>Size Of Digits</th>
<th>Power Requirements</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>C700</td>
<td>50Hz to 700MHz</td>
<td>2PPM 0° to 40°C</td>
<td>50MV</td>
<td>1GMV</td>
<td>NA</td>
<td>8</td>
<td>5 Inch</td>
<td>115 VAC-BATT 8 to 15VDC</td>
<td>3&quot;H x 8&quot;W x 6&quot;D</td>
<td></td>
</tr>
<tr>
<td>C1000</td>
<td>10Hz to 1GHz</td>
<td>1PPM 0° to 40°C</td>
<td>20MV</td>
<td>1GMV</td>
<td>&gt;50MV</td>
<td>9</td>
<td>5 Inch</td>
<td>115VAC-BATT 8 to 15VDC</td>
<td>4&quot;H x 10&quot;W x 7&quot;D</td>
<td></td>
</tr>
</tbody>
</table>

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the blame, so I can understand the need to choose the one long against the project in an even split. It was an ambitious project which might have managed to die on its own accord without the jugular being cut by Tenney, but that we'll not know for sure, and so, should amateur radio lose frequencies at WARC this fall, we certainly know where to point the finger. My own evaluation is that the project to interest African countries in the benefits of amateur radio to their people would have worked, just as it did in Jordan, and could have made a decisive difference at Geneva, perhaps getting some backing for the US proposal for even more amateur bands.

Future historians interested in getting facts on these ARMA meetings should contact me for copies of the tapes. It's all there for you to use and listen through.

FM STARTED IT

The Japanese had no serious foothold in the US with ham gear until the advent of FM and repeaters. I would like to point out that when I started pushing FM in 73 Magazine back in 1968, I made it clear that US manufacturers of ham equipment knew what I was doing and the impact that I expected it to have. They ignored my predictions, feeling that FM never would be a significant factor in the ham market.

This reminded me of my similar failure to interest the major firms in getting into shortwave back in 1955 when I saw that one coming. I talked with Hallicrafters, Hammarlund, National, etc., about it and none of them had any interest at the time. It took Central Electronics to get things moving and the big firms came along when there was no other choice.

By leaving the FM field open to imports, the US industry made it possible for them to set up importing and marketing in this country on a large scale. By laying the foundation for the 70% penetration we see today. If ARRL were truly adventurous and try to lead the market instead of follow it, they can sell everything they can make.

CANADIAN HUINKS

Having received some sanctimonious letters from Canada in response to my criticisms of the IARU, pulling what appears to be a con job on the Canadians, I had someone look into the state of affairs of the supposed incorporation of a Canadian League and nothing could be found filed with the Canadian government. This would lead a naive person like me to suspect that all those promises of untying the apron strings are the usual baloney.

When looking over the list of officers for Canada, I see W2HD listed as their vice president. I dunno why Canadians put so much stock in carpetbaggers and prefer to be run from the US instead of from Canada. Perhaps they are still too weak to stand on their own? Yet, which way is the money flowing? Is it going to Canada or from... and I'm kidding there, because I know as well as you which way the money goes... into the bottomless pit down in Connecticut.

MEMBERSHIP DISASTER

The League officials were wearing very worried looks at Dayton. It was difficult to even get them to come forth with a warm smile. It seems that the $18 fee has brought renewals almost to a halt. Now hams are taming a gimlet-eyed look at what they are buying. They see a magazine with few interesting articles... they see a lot of back-patting news which is stale before they even get the magazine... and ads.

The directors have been trying to get the magazine beefed up, but as the editor complained at Dayton, hardly anyone will write for QST anymore. They just don't have the articles—except those from the few staffers who have not yet left the magazine.

SUNSPOT MADNESS

It has not been with a little smugness that we've been watching the sunspot cycle to see how well it would correspond with the model predicted by our resident expert, John Nelson... particularly compared with the predictions for this cycle by the many other experts in the field.

Probably one of the real sleepers in the radio publishing field has been John's book, The Propagation Wizard's Handbook ($6.95 from Radio Bookshop, Peterborough NH 03458). John was virtually the only expert in the field to have accurately predicted this cycle as it has evolved—and his prediction was way out in left field. He predicted a very low sunspot number for this cycle, with the appearance of a very few large spots instead of the myriad of small spots which comprise the past cycles... and he has been absolutely right!

The Nelson book is now being ordered in larger numbers by the scientists at NASA and at some 500 places where the National Bureau of Standards runs a propagation laboratory. Nelson's predictions have been right on the nose, while the government predictions have been noticeably short on accuracy.

There is nothing really new about the Nelson system. He's been using it for about 30 years and has described it in many articles down through the years. When I first ran into some of the planets having an influence on sunspots, some 25 years ago, it made a lot of sense to me. I met John when he was giving a talk on his system at a long Island ham club. I was impressed by his cautious approach and penchant for rigorous attention to details. I noted that only his predictions seemed to stand up, while those of the Bureau of Standards and George Jacobs (VOA) would be frequently in serious error. When John said conditions were going to be hot, that was the time to take a vacation. When he said they would be hot, you made sure your antenna was working right.

Oh, what value are these long-range predictions? John wrote an article a few years ago telling us what we could expect from the eleven meter CB frequencies during this cycle... and his predictions have been most accurate. Since this cycle has run its course, and whether it was a prediction made before my time or a prediction based upon history and was predicted by John this way, the effects on both the CB frequencies and the ham bands have been remarkably different from past cycles. Knowing about this ahead of time is valuable in making rules and planning activities. Is it worthwhile to put a lot of development time and money into ten meter repeaters? That depends on propagation.

TURKEY CLUB

One club and one club only refused to cooperate with the ham clubs in the greater St. Louis area on the recent ARRL March hamfest. Their excuse was that it was an ARRL club they refused to support any amateur activity where Wayne Green was going to talk.

Annoyed, I heard about this, I wrote to the club and offered to come to St. Louis a day early and go to a special club meeting where the members could have an opportunity to meet me with their beeps and have an opportunity to find out the truth of things they believed on trust from the ARRL. The club flatly refused to face me. Failing in that, I tried to get a meeting with the head of the club and this was agreed upon.

Came the time for the meeting, the only time this chap could make it, at 10:00 pm the night before the hamfest, and he sure didn't show up. I sat and waited for almost an hour, but no message and no club president. I was worn out after a full day of television appearances, meeting the mayor of St. Louis, and other meetings. When the chap didn't show, I went to bed to get rested up for the busy hamfest on the day to come. I had to be very early to set up our booth, get set for my two major talks that day, etc.

Suddenly, the phone rang... our friend had finally gotten to the hotel. He got angry when I said I wouldn't get dressed again and come down to argue with him for an hour or so. I had gone to a lot of trouble to make the time available for him. I said I was too busy. I was already playing a good part of the night and thus make my talks the next day less entertaining just because he was unable to keep an appointment.

Phooey.

MARCH WINNER

"The NCX-Match" was a close winner over K6IQL's "The 10-GHz Cookbook" in our March Reader Service card balloting, so Rick Ferranti W4NCKX1 (Newton Centre MA) will be receiving our $100 bonus check for being the author of that issue's most popular article.

Ham Help

I would appreciate it if anyone could help me connect a Heathkit HG-10B VLO to my Swan S500CX to be used as an outboard vlo.

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Sure, we take trades on new equipment! Call or write.
We're Burning to Make "Hot" Deals!!
from page 14

Program 1 (continued).

Certain characters, not represented in ASCII, are stored at their location. This directs the program to use the special table (SPLTBLO), located from $80 to $A6. The table is organized as a three-byte, fixed-format table in which each byte is the ASCII character, and the next two are the Baudot codes for the two-letter symbol for each ASCII code.

The main program starts at $100 by setting up the stack and using the PIA, addressed to port 7, as an output. A character is input through the monitor's input routine and used as the index for the table. If the retrieved character is $FF, the ASCII code needs a special character representation, and a branch to SPLCHR is executed. A retrieved null, $00, initiates a branch loop with no output produced. One more test and we're ready to fly. If the retrieved character is a space ($20 in Baudot), a check is made on the running total characters in the line. If it is greater than sixty, forget the space and send a carriage-return, line-feed sequence. If it is not a space, hoary—we put it out.

First things first: the MSB is shifted into the carry bit, where it can be used to set or reset the software flip-flop used to monitor case. This was well diagrammed last month and will not be detailed here. Each of the five data bits is then shifted out and sent sequentially, after a character START bit is sent and a STOP bit, 33 milliseconds of pure MARK, is plastered on at the end.

Now things are going to get a bit tackier. Each data bit must be sent for exactly 22 ms. The timing is set in a software delay loop, called MSEC10, set for approximately an eleven ms delay.

Since this delay is produced by loading a number into the index register and decrementing it, the speed of the computer's clock can make a significant difference in the delay. For the "original" SXTPC 6800, with the MP-A CPU board, the clock speed is roughly 902.255 kHz, and a delay constant of $0480 is used. If you have the MP-A2 clock speed may be anything from about 900 kHz to 1.5 MHz. To find the constant that is right for your system, enter Program 2 into your computer and type "G". Time, exactly, the interval, in seconds, between the "B" and "E". Use the formula shown in Fig. 1 to calculate your delay constant. Remember, this is hexadecimal arithmetic. Work through the example to be sure you've got it right.

One more thing to do before we can use the program on the
The Scanning Memorizers

FT-127RA
(220 MHz)
FT-227RB
(144 MHz)
FT-627RA
(50 MHz)

The FT-127RA, FT-227RB and FT-627RA, FM transceivers, allow scanning and expanded memory coverage for the demanding VHF FM operator. All feature up/down scanning capability with control from the microphone; the scanner will also search for a busy or clear channel. Four memory channels are available — two for simplex, three for repeater channels, one for a split of up to 4 MHz. Other performance features are similar to those of the renowned FT-227R.

OPTIONAL EQUIPMENT
Keyboard Microphone: YM-22 for FT-127RA and FT-627RA; YM-23 for FT-227RB (YM-22 standard feature with FT-227RB) • Squelch Unit • FP-4 AC Power Supply

CPU-2500R/K 2 M FM Transceiver
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The age of computers has entered the amateur scene with the announcement of the CPU-2500R/K 2-meter FM transceiver. Controlled by a 4-bit central processing unit (CPU), the CPU-2500R/K contains a scanner, 4 memory channels, manual or automatic tone burst, an optional sub-audible tone squelch, and 25 watts output.

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air: Interface it. The data is coming out of bit 0 (the LSB) of the A side of a PIA interface on port 7. This TTL level signal represents MARK with a high and SPACE with a low. If you have an ST-6 or equivalent, interfacing may be accomplished easily, adding only one diode, as described several months ago for the test generator. Other interfacing schemes could include an optoisolator or reed relay. Remember, though, don't allow the loop voltages access to the computer or you will have a smoking pile of expensive "junque."

If all goes well, when you load the program, adjust the delay constant, and accomplish interfacing, any character struck on the keyboard should come out in Baudot on the other end.

Now, one last hooker: If you are using an MP-C "control interface" (the one that was supplied with the computer if it had an MP-A CPU board) and you type in a character while one is sending, you will get garbage. This is an unfortunate result of the software UART written into the MKBUGTM or SWTBUG monitor to handle serial data through a PIA interface on port 1. Yes, I know we are doing essentially the same thing on port 7, but that is the problem. While the system will support one character at a time, it will not support two running at the same time. The solution is to take one of the I/O structures out of a software UART and into a hardware UART, or ACIA. The easiest way to do this is to add an MPS-2 interface for control on port 1. Now, characters input during an output are simply ignored. Not an ideal solution, but adequate for this simple program.

Next month, we'll... no, I'm not going to tell you! There are some surprises in store for you...
'79 ARRL NATIONAL CONVENTION
Baton Rouge, Louisiana

Louisiana Council of Amateur Radio Clubs

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July 20, 21, 22, 1979

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Baton Rouge, LA 70821

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Looking West

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more fitting than this contact. Fate had been very kind indeed.

The station operates under the call sign W6RO—W6 "Rolling Ocean"—as a tribute to one of the founding members of the club sponsoring the overall Queen Mary wireless operation. Amateurs wishing to operate from the Queen Mary can do so in one of two ways. Those living in the area and wishing to serve as scheduled volunteer operators can contact the Associated Radio Amateurs of Long Beach and make their intentions and availability known. However, if you are planning a trip to Los Angeles and would like to operate the station, you can take the Queen Mary tour and, when it gets to the wireless room, locate the operator in charge and explain your desires. You will have to present your original amateur license and some additional identification before you will be permitted to operate. Guest operating periods will be approximately 15 minutes in duration.

Currently, two motion pictures are in production which in part are being done aboard the Queen. One is the epic film "Titanic," scheduled for release late next year. The other hits much closer to home. In early September or thereabouts, the ARRL will be releasing its new film, "The World of Amateur Radio," produced by Emmy Award-winning filmmaker Dave Bell W6AQ. Thanks to Nate and his organization, Dave was able to film the narration sequences (which feature NBC News correspondent Roy Neal W6DUE) aboard the Queen Mary.

Dave has made one request of the amateur community now that the news of the new film has been made public. It will be several months before the film is ready for distribution. Please do not call either Dave or the ARRL requesting the film until its availability has been announced. The initial prints are destined for showing at the World Administrative Radio Conference in Geneva in order to underline the attributes of the worldwide amateur service. Eventually, there will be enough prints for all of us to see, so it is suggested that you monitor QST, HR Report, The Westlink Amateur Radio News, and this column to find out the availability date. Your cooperation in this regard is deeply appreciated.

THE "THEY-WON'T-LET-220-DIE" DEPARTMENT

The 220-SMA of southern California has gone on record as being willing to take any action necessary to ensure that the 220-to-225-MHz amateur band never falls into the hands of maritime interests. To show that they really mean business, what is called a "WARC Action Committee" was formed at their April 22 meeting, with Ray Von Neumann K6PUW as its chairman.

At present, a number of directions are being considered, although two tend to offer the most promise of at least marginal success. The 220-SMA may well have hired a Washington-based attorney by the time this reaches print. His job will be to go into federal court and either file a direct appeal on the matter or request an injunction barring the use by our WARC delegation of the portion of the US WARC proposal dealing with the 216-to-225-MHz spectrum. It is the 220-SMA's contention that both the FCC and the maritime services may have violated the Federal Administrative Procedures Act in regard to the preparation of that portion of the document. One lawyer explained to me that if the 220-SMA were successful in obtaining such an order, then our delegation would be barred from discussing or voting on issues brought before WARC dealing with that spectrum. This could place the US in a rather awkward position at the conference later this year, but the same legal expert did say that he did not feel the 220-SMA could obtain such an order. I thus suspect that any legal action will come in the form of an appeal. Only time will tell where the 220-SMA will go if they choose this route at all.

Another direct offensive action they are considering—one I expect to see initiated quickly—is filing a formal Petition for Rulemaking with the FCC requesting the immediate transfer of currently unused maritime VHF spectrum to the amateur service. The feeling is that the

A new triband addition to the Queen Mary. (Photo by KH6IAF)

Joe Rudi W6PVA, baseball player with the California Angels, makes the first official QSO from W6RO. Looking on is Nate Brightman K6OJC, of the Associated Radio Amateurs of Long Beach, the club which installed the gear. (Photo by W6VGQ)

TV actor/comedian Stu Gilliam WD6BFU operates W6RO, the new amateur station aboard the Queen Mary. (Photo by W6VGQ)
New MFJ 3 & 1.5 KW Versa Tuners
Run up to 3 KW or 1.5 KW PEP and match everything from 1.8 thru 30 MHz: coax, balanced line, random wire. Built-in balun.

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need for this can be easily documented by showing the overall inactivity in current VHF maritime operations and the current growth patterns in VHF amateur activity. Basically, the 220-SMA is at a time that it is time to stop being on the defensive and become outward and aggressive in fighting to save our spectrum. They hope to rally support not only from 220-MHz users, but also from the overall amateur community. Already, some words of support have been voiced, such as the following statement issued by the Jet Propulsion Laboratory’s Amateur Radio Club: “The Jet Propulsion Laboratory’s Amateur Radio Club supports the 220-SMA of southern California in its efforts to keep the 220-to-225-MHz band an amateur one. To this end we have pledged our support.” The JPL ARC did more than just add a bit of encouragement. They also provided the facilities and hosted the meeting.

THE “NAVY-TO-THE-RESCUE — ADVICE” DEPARTMENT

The 220-SMA sent copies of its since-denied Petition for Reconsideration to several government agencies in addition to the FCC. Among those who received copies were the nation’s military branches. Just prior to the April 22 meeting at JPL, the 220-SMA dropped what might best be described as a bombshell. It had been contacted by the Chief of Naval Operations and had been told that neither the Chief’s office nor the Naval Telecommunications Frequency Management Group had ever been informed of any proposed reallocation of the 216-to-225-MHz spectrum. As it turns out, the Navy has a rather vested interest in this spectrum. It operates what is known as the Space Surveillance Network, a worldwide communications network that keeps track of all space debris resulting from US space operations. In fact, the Space Surveillance Network utilizes frequencies from 216 through 233 MHz, according to an SMA-220 spokesman, and is what is termed a “long-term, high-monetization investment naval operation.”

Needless to say, the Navy is more than just a bit upset over finding out that it may be evicted along with the amateur service from spectrum in which it has a definite interest. Apparently, it is upset enough to have ordered the Telecommunications Frequency Management Group to start a detailed investigation of the matter and report their findings back to the Chief’s office. What seems to have irritated them the most were the official statements contained in the WARC position paper itself, rhetoric that said this proposed transition had been cleared with the military prior to its inclusion. If this is the case, I wonder whose military the FCC and maritime services cleared it with. According to the Navy, it wasn’t ours.

THE “I-NEED-A-FOREIGN-CORRESPONDENT” DEPARTMENT

Is there an amateur in Geneva, Switzerland, who happens to read Looking West? If so, I need your help. I need a volunteer to act as a Looking West correspondent during the World Administrative Radio Conference later this year. His or her job would be to sniff out any hint of what’s going to happen at the conference in relation to VHF/UHF spectrum matters, write a summary of the meetings, and forward it to me for inclusion in this column. If you can help both the time and interest, drop me a line at the address given at the column’s top and we can go from there.

THE “BIG-CHANGE-AT-WEST-LINK” DEPARTMENT

Actually, there has been more than one change, but the one that affects most Westlink service users is the discontinuance of their “Cassette Exchange Program.” Effective immediately, the cassette program has been replaced by an automated telephone system that permits those wishing to obtain the weekly newscasts to simply dial a telephone number in order to obtain the information.

There were two reasons for News Director Jim Hendershot to make this decision. First, the Westlink Newsletter Service has grown far larger than he ever expected. This is a free, non-profit service, but he found himself spending virtually every free moment duplicating tapes. He could have gone to a high-speed duplicating house to have this work done, but it would have meant giving away the free aspect of the operation and possibly charging upwards of $100 or more annually for the service. This he did not want to do.

Second, there have been ongoing postal problems. Not a week had gone by when a subscriber didn’t call to complain that his tape had not arrived or that it arrived too late to air that week. Consequently, Jim has dropped the cassette exchange system.

There has been a second big change at Westlink. Alan Kaul W6RCL, Bill Orenstein KH6IAF/6, and I recently produced a 20-minute documentary entitled “The Peril to 220,” which presented two main aspects of the current situation in that spectrum. The response to that special was so positive that Jim asked us to continue producing such programs on a monthly basis. We have accepted the assignment. In fact, currently in production are programs dealing with the OSCAR satellites, DXing from DX lists, and handling malicious interference.

To accomplish this, a second Westlink studio is being assembled at Bill’s office in Hollywood; by midsummer, we should be in production. Distribution will also be via a dial-in telephone number. We will also be setting up another telephone number so that amateurs can leave input for either DXing from DX lists or the monthly “magazine of the air.” Those interested in obtaining either or both of these services should contact Jim at the Westlink Lab, 8331 Joan Lane, Canoga Park CA 91402. Jim no longer must limit the service to repeaters and bulletin stations, so the service is available to just about anyone.
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For Continental Specialties Corporation, already well known as a manufacturer of professional digital troubleshooting instruments, their first kit-style test instrument logically emulates their line of logic probes. Both as a kit and as a probe, the CSC Model LPK Logic Probe Kit represents an excellent value.

The kit instructions are exceptionally well-written, offering step-by-step assembly procedures. Solder, wire, and all miscellaneous hardware are included in the kit—along with the printed circuit board, case, and all components, of course—leaving no extras to buy. Even beginning-level kit-builders can assemble the LPK quickly.

Once assembled, the LPK offers respectable performance as a logic probe. It is circuit powered through attached clip leads. Hi, PULSE, and LO LEDs display logic states and transitions. The high logic state is defined as 70% or more of the supply voltage, the low state as 30% or less, making the probe compatible with most digital logic technologies or families. With its high (300,000-Ohm) input impedance, circuit loading is minimized.

With the LPK, even very narrow pulses can be detected. Internal circuitry stretches pulses as short as 300 nanoseconds into 1/10 second flashes of the PULSE LED; pulse trains at repetition rates up to 1.5 MHz keep the PULSE LED flashing.

The LPK includes self-protecting circuitry which permits the power leads to be connected in reverse or to as much as 25 V dc without permanent damage; the probe tip, similarly, can contact ±50 V continuously or 110 V ac for up to 15 seconds without permanent damage to the probe.

As a troubleshooting tool, the LPK holds its own against any logic probe in all but very high speed applications. As an educational venture for the kit-builder, it should be noted that the LPK, while a digital tool, is based on analog circuitry, offering a unique opportunity to see how the two disciplines merge.

The LPK Logic Probe Kit is available through selected local distributors both in the US and around the world.

For more information, or for the name of your nearest CSC stocking distributor, call Continental Specialties Corporation, 70 Fulton Terrace, New Haven CT 06509; phone (203) 624-3103, TWX (710) 465-1227; Reader Service number C9.

IC INSERTION TOOL

The new Model MOS-2428 DIP inserter handles all MOS, CMOS, and regular 24- and 28-pin ICs. This unique new insertion tool also aligns bentout pins. Simply rock the IC on the straightening saddle to align the pins. Press the tool over the IC to pick it up, then simply place the tool onto the socket and depress the plunger for instant and accurate insertion. The tool features heavy chrome plating throughout for reliable static dissipation. It includes a terminal lug for attachment of a ground strap. The MOS-2428 IC Insertion Tool is available from your local electronics distributor or directly from OK Machine and Tool Corporation, 3455 Conner Street, Bronx NY 10475. Reader Service number O3.

FSK-1000 DEMODULATOR FROM IRL

"This is not a sedan or a truck. This is a sports car."
That's how the engineers at iRL describe their new FSK-1000 demodulator. The FSK-1000 is a new, sophisticated, two-tone limitless demodulator which offers selectivity as narrow as 55 Hz in each of its matched, selectable-bandwidth, active-filter tone channels. Although it includes such "tricks" as continuously adjustable shift, dual-mode autostart, and a keyboard-activated switch, the designers insist, "We don't want a family sedan dressed up with mud flaps and raccoon tails. We want to give the serious HF or VHF operator a TU with the best raw performance available anywhere."

The FSK-1000 has both high-voltage current loop and low-voltage (RS-232 compatible) outputs to interface readily with mechanical teleprinters, computers, or both. Recently, tuning requires a careful touch with the narrow filters switched in, but this gives the serious operator the selectivity he needs when the QRM gets really bad.

The rear end of the circuitry utilizes 48 operational amplifiers (twenty FET types) and a host of other devices. Complete details are available from iRL dealers or by writing iRL, 700 Taylor Road, Columbus OH 43230. Reader Service number 127.

NEW RTTY TERMINAL FROM HAL

HAL Communications is proud to announce a new compact and low-cost RTTY terminal—the DS2000 KSR. The new terminal features operation with Baudot, ASCII, and Morse code (Morse code is not an optional feature) and incorporates many of the features of more expensive terminals. A new 72-character line by 24-line display format, two 32-character programmable "Here Is" messages, and CW identification at the touch of a key simplify operation. A terminal-status line keeps the operator aware of data rate, data code, and other terminal conditions. Text is transmitted one word at a time and editing is possible anywhere in the line being composed. All terminals are controlled by a combination of a control key and a key from the top row of the keyboard. Other deluxe features such as unshift-on-space, synchro nous, character, key programmed, and autostart, and both QBF and RY test messages are available at the stroke of a key. Connect the DS2000 KSR to a standard 220-volt 200 VA OC (maximum) current loop for Baudot and ASCII operation. Morse output is accomplished via a transistor switch to ground for keying either "gridblock" or "cathode" circuits. An optional Morse receive board (MR2000) is available for reception of Morse code at rates from 1-175 wpm and is customer installable allowing purchase at any time. An optional 9-inch diagonal measure video monitor is also available. The terminal weighs 6 lbs. (2.75 kg) net (10 lbs/4.55 kg shipping) and comes in an attractive blue and beige cabinet. Contact HAL Communications Corp., PO Box 365, Urbana IL 61801, for further information.

ROHNO 25 FOLD-OVER TOWER

When an amateur thinks of towers, chances are that he thinks of Rohn. And for good reason. Rohn has been building towers for a long time, providing amateurs with a variety of top-quality models at a reasonable price.

Recently, when I needed a new tower, my thoughts turned naturally enough to Rohn. Getting out their catalog, I thumbed through it to see just what they had to meet my particular requirements. After a few minutes of browsing, I decided that the 48-foot No. 25 Fold-Over was just what I was looking for.

Among the considerations I had in mind while choosing a new tower was that it get my beams clear of adjacent buildings and trees but not be so tall as to stand out prominently from its surroundings. As a result, I concluded that it should be approximately 50 feet high. And, since I prefer to keep my feet firmly on the ground, it should fold over so that work on the beams and rotors could be done from the ground or, at most, while standing on a short stepladder.

I also felt it highly desirable that the tower be easily assembled and disassembled by two people. And the likelihood that I would want to relocate it within the foreseeable future meant that it should be readily transportable, preferably in a small pickup or van. In addition, it should be rugged, durable, and easy and inexpensive to maintain. And, of course, it should be affordable.

The Rohn No. 25 is one of the most popular towers in the amateur world. There are several sizes available from 10- to 40-foot towers. The Rohn No. 25 is the most popular of them all and is available in either a single leg or dual leg configuration. The tower is designed for easy and fast assembly with no tools required.

The tower is constructed of heavy-duty 1/4-inch diameter #16 gauge steel tubing for side rails in a 12½-inch equilateral triangular design with solid steel 3/8-inch diameter tubing for the main legs. The tower is 48 feet tall and weighs approximately 640 pounds. The base is 30 inches square and weighs approximately 300 pounds.

The tower is designed for use with most amateur antennas including horizontally polarized beam antennas, vertically polarized beam antennas, and dipole antennas. The tower can be used with any type of antenna system including beam antennas, dipole antennas, and horizontal or vertical polarization systems.

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prevent water accumulation.

It's a good idea to allow at least three days for the concrete to harden before continuing to erect the tower. An erection fixture or gin pole will make the process easier and faster, especially if you decide to add one or two additional 10-foot sections, bringing the total height to 58 or 68 feet.

If you're doing a 48-foot like mine, you place the hinged section atop the second 10-foot section making sure the shipping-tab bolt is closed and that the hinge is positioned on the correct side of the tower. Guy wires (if used) are then installed on the guyin tabs near the hinge point. The next step is to align and bolt together the two pieces of the boom (lever) section. The boom is then attached to the hinged section. Be sure the hinge bolts are loosened before you attempt to fold the tower over. If practical, a house or eave-bracket may be used at the hinge point in place of guy wires. The bracket must be placed within 2 feet of the hinge point.

The remaining sections are lifted into place and installed in the earlier manneur. The winch and cable mechanism is bolted to the leg of the lower tower section, just below the clevis on the boom. If an additional 10-foot tower section has been placed below the hinge section, an extra pulley must be installed just below the clevis on the boom. Finally, the cable must be set between several 2-1/2" diameter pipe and a wire rope thimble to the boom clevis and to the winch.

That's all there is to putting up a Rohn No. 25 Fold-Over tower. The installation instructions are quite simple and straightforward. Follow them and you'll get your tower up quickly, easily, and, most important of all, safely.

Once the hole is dug and the base assembly is installed, two people can complete the job in a morning or afternoon, including mounting a rotor and beam. Then you can sit back and enjoy operating, secure in the knowledge that if you pull routine preventative maintenance a couple of times a year and take prompt care of anything that crops up between times, you'll have a setup that should provide many years of reliable service.

While the 48-foot No. 25 Fold-Over tower proved just right for me, it may not be what you need. In that case, you should check out the other versions of the No. 25, as well as the many other models available from Rohn. For more information, write Unaro-Rohn, a Division of Unaro Industries, Inc., 6718 West Plank Road, PO Box 2000, Peoria IL 61655. Reader Service number 147.

Morgan W. Godwin W4WFL
Brattleboro VT

From page 10

windows at the higher elevations to Midland, El Paso, and Carlsbad. For the NBVM QSOs, we are carrying a GE Microcassette recorder.

All radio systems will be powered directly, without the use of a battery, from a 72-cell solar array which weighs four pounds. Limited night operations from dark to bedtime will be powered by a palm-sized nicad battery. Antennas will be half-wave sloped or quarter-wave radiators against quarter-wave counterpoises, as most of that area offers a very poor rf ground.

On-the-air operations will occur according to the following schedule, beginning as early as midday Sunday; listen for QNBVM from K5SB in NBVM, SSB, and CW.

0600 CDT/1100 UT 14,235 kHz
0700 CDT/1200 UT 7,195 kHz
0900 CDT/1400 UT 14,235 kHz
1000 CDT/1500 UT 20,855 kHz
1100 CDT/1600 UT 21,385 kHz
1230 CDT/1730 UT 7,195 kHz
1500 CDT/2000 UT 21,385 kHz
1700 CDT/2200 UT 14,260 kHz
1900 CDT/2300 UT 14,260 kHz
2000 CDT/0100 UT 21,385 kHz
2100 CDT/0200 UT 14,260 kHz

The first Texas NBVM station, Bob W5GEL (W5BT), will be on frequency to coordinate, as his time allows. We would be pleased to have QSOs with amateurs and will listen carefully for other QRP stations and DX stations.

All NBVM stations should be prepared to tape-record QSOs; send the tape with your QSL. If we can find our tape of the QSO, it will be recorded on the blank side of your tape and returned.

The signal from K5SBU will be very weak, so listen for QSB. Ten minutes after the schedule time, if we do not have a QSO, we may QSY to the QRP CW calling frequency for that band (60 Hz up from the bottom of each QSO). QSL to address below.

C. Richard Hoffman K5SBU
Box 1600
Corpus Christi TX 78403

WAYNE GREEN'S LAIR

I found this editorial, Wayne Green's Lair (VHFER, Vol. 1, No. 5, September, 1963, Comaire Electronics, Ellsworth MI) written some time ago by Doug DeMaw (Senior Technical Editor, ARRL) and thought you might be interested.

Wayne Green's Lair

The trip would not be complete without a visit to "73 Acres" in Peterborough, N.H. Not only have we been greeted with such hospitality and friendliness, but we have also been gifted with several meals, some of which were quite expensive. On one occasion, we visited New Hampshire's famous maple syrup and enjoyed all the trimmings and garnished with a vigorous discussion related to the controversial manners of the day (which are destined to affect all ham radio operators) was very invigorating.

For many months I have tried to understand this man Green's motives and his attacks on other publishers and organizations, but until I met this guy face to face, I could not properly evaluate his thoughts. I am convinced through seeing the results of his publishing house efforts, listening to his explanation of his convictions, and hearing his explanation of his hopes for the ham fraternity and its future, that he is neither vindictive nor radical. He believes in what he is doing, and is willing to fight for those who share his beliefs.

Wayne's empire includes a mountain-top location a few miles distant from his main facility, which is composed of numerous tiny houses, a farm house and a magnificent 100 foot tower supporting 96 elements on 2 meters. Along with all this, a mountain of radio gear repose in the "shack," and is presently being assembled into operating positions of one kw denomination for all bands.

All in all, we were mighty glad to meet Wayne, his charming KYL, and staff. They are truly a wonderful group. Don't miss stopping at Peterborough when you are in that area.

I have been reading your magazine since its beginning, and even went on the 73 trip to Europe. I still think you are one of the good guys.

Wm. Edwards K8DNV
Belairre MI

GUATEMALA '76

One of my favorite pastimes is handling traffic from the nets as fast as I am able. Although the messages that are handled are of the health and welfare type, there is a certain satisfaction which one gains in being able to deliver the message in the least amount of time. Until recently, the practice did not appear too important by my fellow hams on various nets, I agreed to jot down the details of the contact that took place during the Guatemala earthquake in 1976.

Without any doubt, a major part of the credit for saving lives and organizing the rescue effort during the disaster is due to that very fine group of amateurs that carried the greatest load in and around Guatemala City. Our efforts at the time were devoted to assisting wherever we could, fitting any circumstance where help was needed. For a time, the traffic was picked up from the Interstate Network on seventy-five in the evening and relayed to Gary, K3GJ, for dispatch. I think I found the first thing the following morning. Many nets were utilized to ensure the most expeditious handling of the traffic.

During this time, the very many minutes passed when there was a lack of traffic. On February 14, 1976, an amateur station in Peru, OA4CYC, called. It seems that Maria OR2NW was trying for several days to secure information on two sisters in Guatemala City and had probably monitored the traffic being passed on to the GUAM network at T9GDF, which she was unable to hear. After gaining our attention and the verification of callsigns, Maria asked for our help.

After trying for the previous three days by telephone and wire services, Maria wanted to know if it would be possible to secure health and welfare information on the two sisters who were in Guatemala City. On securing the details from Maria in Peru, the information was relayed immediately to Don T9GDF. He recognized the location where the sisters were, and would be in the city and indicated that he would try to reach that point via the local telephone system. In less than five minutes, Don had the answer for Maria. She said the sisters were not injured, were feeling fine, and were working hard.

That message was relayed to Dayton OH and then to DA4CYC in Peru within eleven minutes of the moment the message was
Frankly, I'm hoping that WARC '79 will give all our ham bands to the minority countries. It might teach the whole damned bunch of us a much-needed lesson!

William L. Harris KN3FOV
Lafayette IN

ASHAMED

This isn't really a letter to the editor, but I thought you should know that Stan Jopek K2JQT passed away on April 13, 1979. Stan was 40 years old and in excellent health, but he had a sudden fatal heart attack. He leaves his wife, Joan, and four teenage children. Stan was very active on six meters in the past, and was more active recently on 2 FM as the owner/operator of the .07/67 repeater in Fredonia, NY.

As tragic as Stan's sudden death was, subsequent events were repulsive, and they were the reason for this letter. One day after his death, while the family and friends were at the funeral home, someone broke into the .07/67 repeater site and stole the entire machine and backup systems. The total value of the loss was over $3800.

What I find most repulsive in this is that the theft had to have been done by hams. The .07/67 repeater was located in a remote area, and very few people even in amateur circles knew its exact location. It was located in a building along with several other commercial repeaters and transmitters which were much more valuable, less traceable, and much more portable. These units were not touched. The thieves were thorough. They even searched out the manuals for the 2-meter gear and took them also; they pig-tailed off the power leads, took the input tags for identification, and even taped up the leads to the standby batteries.

A four-wheel-drive vehicle was used, and at least two people carried the 6' high 19" rack over the muddy ground to the vehicle. The theft is being investigated by the Chautauqua County Sheriff's Department, and any information should be forwarded to them at (716)-672-5151. The Spectrum 1000 serial number is 0219.

I feel confident that a theft of this magnitude and perjury will be solved. I only hope that the persons responsible are apprehended by the authorities rather than members of the repeater club. This is the first time I've ever really been ashamed of being a ham.

Ron Warren WA2LPB
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K14
Ham Help

If anyone has a Heathkit HW-20 Pawnee (2m AM tunable xcvr) that is physically complete but not necessarily operating, I am interested in purchasing it. Please state whether or not the manual would be included. I will be happy to pay shipping via UPS.

Wm. C. Aycock WB5YEE
257 Belair Dr.
Pearl MS 39208

Our radio club has been given an old US Coast Guard receiver, model R-469UR, made by Hallicrafters. Can anyone help me find a schematic for it? Thanks.

Thomas Dick WA9QDZ
2851 Wayside Dr.
Evansville IN 47711

I desperately need the schematic for a Hy-Gain UHF 4-channel pocket scanner. Any help would be most appreciated.

Dennis Lemonds WB4QCD
PO Box 194
Estill Springs TN 37330

I have a 0-500-MHz frequency counter made by Northeastern Engineering, Inc., Model 14-20C. The counter is a large unit, about 75 lbs. and two feet square with tube-type design using nixie tubes for the frequency readout. I've been trying to find a manual for this gear with no success thus far. Fair Radio Sales can offer a schematic but no success. Can anyone out there help me? Any effort would be greatly appreciated. Thank you.

R. W. Bowyer KA4DTP
7335 Sunnybrook Dr.
Roanoke VA 24019

I bought a Kenwood TS-520S and have never felt like I have the tune adjustment right for best resonance of the final 6146Bs. The book furnished isn't too clear. Could anyone help me by explaining the proper procedure for adjusting this rig?

A. E. Farrell KA5DFV
4324 S.E. 16
Del City OK 73115

I would like to know what the boom length and element spacings are on a TA-33 Jr. Mosley triband: The moving company lost my boom.

Hubert J. Harlow KA5COS
1812 Arnold Palmer
El Paso TX 79935

I need a relay coil for a Central Electronics 20-A SSB exciter. Please give price.

Odel Gattin W4MEM
#1, Box 279
Killen AL 35645

I need the schematic for an old Hallicrafters receiver, model number SX77A or S-77A. Can anyone help?

P. B. Bjorklund
1075 Los Altos Ave.
Los Altos CA 94022

I need a Tempo One external vfo.

Keith H. Gilbertson WB9NXM
RT. #4, Box 29A
Detroit Lakes MN 56501

I would like to arrange a CW 15 meter QSO with a Vermont ham in order to complete my WAS.

Bob Cent WB7UNM
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S-100 Computer Boards

8K Static RAM Kit Goodby $135.00

16K Static RAM Kit $165.00

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1024K EPROM Kit (less PROMS) $220.00

Video Interface Kit $175.00

Motherboard $32.95 Extender Board $19.95.

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Reader Service—see page 211
Social Events

from page 130

hope to arrange special li-
censes for visiting hams who
may wish to operate from XE1-
lant during their stay. There
will be a flea market and
demonstrations at the conven-
tion hall. For more information,
contact the Radio Club Leon,
PO Box 12A, Leon, Guanajuato,
Mexico.

ESSEX MT
JUL 21-22
The International Glacier-
Waterton Hamfest will be held
on July 21-22, 1979, at the
Three Forks Campground, ten
miles east of Essex, Montana, on
US Highway 2. Registration is
2:00 am. Talk-in on .52 and
34/94. For more information,
write Glacier-Waterton Ham-
fest, PO Box 2225, Missoula MT
59806.

EUGENE OR
JUL 21-22
The 4th annual Lane County
Ham Fair will be held on July
21-22, 1979, at the Oregon Na-
tional Guard Armory, 2515 Cen-
tennial Blvd., Eugene, Oregon.
Registration is $3.00, and an
extra drawing ticket is given with
advance registration. Registration
be displays, lectures, contests,
swaps, transmitter hunt, and
entertainment. The facilities
provide plenty of free park-
ing for motor homes and trail-
er. For information and advance
reservations, phone or write
Wanda or Earl Hemenway, 2366
Madison, Eugene OR 97405 at
(503) 485-5575.

PITTSFIELD MA
JUL 21-22
The NoBarC Hamfest will be
held on July 21-22, 1979, at Cum-
nington Fairgrounds, Pittsfield,
Massachusetts. There will be
technical talks, demonstrations,
and deals. Flea market admission
is $1.00. Advance registration is
$1.00 single and $5.00 per
spouse, and $4.00/$6.00 at the
gate. Gates open at 5:00 pm on
Friday for free camping. Talk-in
on 146.31/91. For reservations,
contact Tom Hamilton WA1VPX,
206 California Ave., Pittsfield
MA 01201.

GOLDEN CO
JUL 22
The Rocky Mountain Radio
League, Inc., will hold its Field
Demonstration Day and Swap-
fest on July 22, 1979, at the
home of Karl Ramseer at
WA0HJZ, which is located on
Highway 93, Golden Gate Can-
yon Road. This is accessible by
going one mile north of the city
limits of Golden, turning west-
ward off Highway 93 onto
Golden Gate Canyon Road, pro-
ceeding for approximately 7½
miles, and making a right turn
across the cattle guards. Signs
will be posted for further direc-
tions. There will be demonstra-
tions, including slow-scan TV
and computers, door prizes, an
unlimited buffet, and live music
and ice supplied by the League.
It would be appreciated if every-
one would provide food for
helping out the League with any
spare blankets and chairs. There
will be camping facilities
available for campers, trailers,
nomad nites, etc., on Saturday
afternoon before the Fest. No
dogs, guns, or motorcycles, please.

MARSHALL MO
JUL 22
The Indian Footsteps Amateur
Radio Club will hold its 4th an-
nual hamfest on July 22, 1979,
at the Saline County Gar-
drawings, Marshall, Missouri.
Tickets are $2.00 each or 3 for
$5.00 in advance; $2.50 at the
door. Registration is at 8:00 am,
with luncheon at 11:30 pm (all
you can eat) and the drawing at
2:30 pm. Prizes include a Tempo 51,
and many more. There will be
flea markets for the OM and
XYL. There is no charge for flea
market tables this year, but
reservations are requested.
There will also be old and new
equipment displays, a 10-X
booth, and other activities for
the XYLs. Talk-in on .52, 28/88,
and 147.84/24. For information
and tickets, write Norman Gib-
bin WB8BSZ, 692 North Ted,
Marshall MO 65640.

SHEBOYGAN WI
JUL 22
The annual Lakeshore Swap-
Fest and Bratwurst Fry will be
held on Sunday, July 22, 1979.
Events include prizes, a flea
market, an auction, manufacturer's
displays. Admission is $1.00.
Talk-in on .66/06. For further
information, contact WB9NRM at
(414) 457-3203.

BELVIDERE IL
JUL 22
The Big Thunder Amateur
Club will hold its annual ham-
fest on Sunday, July 22, 1979,
at the Boone County Fairgrounds.
The fairgrounds are located one
mile north of Belvidere on IL 78.
Talk-in on .52 simplex. Dona-
tions are $2.00 at the door. Ad-
vance tickets are $1.50. For in-
formation and tickets, contact
Michael Santucci WD9JGH, 862
Ivy Oaks Rd., Caledonia IL
61011.

MACKS INN ID
JUL 27-29
WIMU (Wyoming, Idaho, Mon-
tana, and Utah) will hold its 47th
annual hamfest on July 27-29,
1979, at Mack’s Inn, Idaho.
Festivities include 2-meter
hunts, OSCAR demonstrations,
ladies' crafts, and a repeater
display. The pre-registration
prize will be a Wilson Mark II
handle, complete with
touchtone™, battery pack, and
charger. The grand prize is your
choice of an icom IC-211 or a
Kenwood TS-520. Saturday
night special events include kids' movies and an adult
dance. For further information,
call Dave Hunting WB7FGV,
Box 662, Kemmerer WY 83101, or
call (307) 877-9440.

MOOSE JAW SASKATCHEWAN CAN
JUL 27-29
The Moose Jaw Amateur
Radio Club will hold its 1979
Hamfest (Particicfest 79) on July
27-29, 1979, at the Saskatchewan
Technical Institute, 600
Saskatchewan St. W., Moose
Jaw, Saskatchewan, Canada.
Registration will be held on Fri-
day evening with a full day of
teaching on Saturday culmi-
nating in a banquet and dance.
Most of the meetings and work-
shops will be held on Sunday.
There will also be a busy schedule for the XYLs.

OKLAHOMA CITY OK
JUL 27-29
The Central Oklahoma Radio
Amateurs will sponsor the Okla-
ahoma State ARRL Conven-
tion and "Ham Holiday" on July
27-29, 1979, at Lincoln Plaza,
4445 Limestone Blvd., Oklahoma
City, Oklahoma. The program
will include an ARRL forum and
technical talks on 1-GHz
radio techniques, fast-scan TV
for radio amateurs, WFM, and
other subjects of current in-
terest. In addition, a full pro-
gram is scheduled for the ladies.
Pre-registration will be
$4.00 if received before July 20.
After that date, it will be $5.00.
A synthesized 800-channel
VHF transceiver will be award-
ed to encourage pre-regis-
tration. The main award will be a
TS-120V with power supply.
Adequate rooms are available for
commercial exhibitors and
swappers. Mail your registra-
tion to CORA, PO Box 14424,
Oklahoma City OK 73113.

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vance tickets are $1.50. For in-
formation and tickets, contact
Michael Santucci WD9JGH, 862
Ivy Oaks Rd., Caledonia IL
61011.

OLIVER BC CAN
JUL 28-29
The Okanagan International
Hamfest will be held on July
28-29, 1979, at Gallagher Lake
KOA Campsite, 8 miles north of
Oliver, B.C., Canada. Registration
starts at 9:00 am Saturday.
Activities start at 1:00 pm
Saturday and continue until
2:00 pm Sunday. Ladies may
bring their hobbies and items
for a white-elephant sale.
Featured will be prizes, a flea
market, bunny hunts, entertainment,
and more. A potluck lunch will
be served Sunday at noon. Call
on 3800, .34/94, and .76 single
frequency. For information, write
John Juul-Andersen VE7DTX,
8802 Lakeview Dr., Vernon,
B.C., Canada V1B 1W3, or Lota
Harvey VE7DKL, 584 Heather
Rd., Penticon, B.C., Canada
V2A 1W8.

BOWLING GREEN OH
JUL 29
The Wood County Amateur
Radio Club will hold its 15th an-
nual Wood County Ham-a-Rama
on July 21-22, 1979, at the Bowling
Green Fairgrounds, Bowling
Green, Ohio. Gates will open at
10:00 am, with free admission
and parking. Dealer tables and
space are available. Trunk sale
space and food will also be
available. Tickets are $1.50 in
advance and $2.00 at the door.
Prizes will be awarded. Talk-in
on .52 K8T1H. For information,
write Wood County ARC, clo
Eric Wittman, 1411 Bishop Road,
Bowling Green OH 43402.

NASHVILLE TN
JUL 29
The Radio Amateur Trans-
mitting Society (R.A.T.S.) of
Nashville Tennessee will sponsor
the Nashville Hamfest on Sunday,
July 29, 1979, at the National
Guard Armory on Sid-
cro Drive, in Nashville, Ten-
nessee. Tables, bargains, and
refreshments are available, as
well as prizes. Admission is
$3.00. Talk-in on .90/30. For
more information, contact
Richard Wagner KA4MZE, 1015
Haber Drive, Brentwood TN
37027, or phone (615)-794-5356.

BALTIMORE MD
JUL 29
The Baltimore Radio Amateur
Television Society (BRATS) will
be holding the ARRL BRATS
Maryland Hamfest on Sunday,
July 29, 1979, at the Howard
County Fairgrounds, Rtes. 32
and I-70, 15 miles west of
Baltimore, Maryland. The event,
beginning at 8:00 am rain or
shine, includes a giant flea
market, indoor and outdoor ex-
hibits area, top prizes, and plen-
ty of good food and refresh-
ments. For information, write:
Tailing is $2.00, and tables are
$4.00 in advance, $5.00 at the
Continued on page 204
INTRODUCTORY
PRICE

$369.00

ALSO - NEW FM 6016A
FOR 6 METERS

SHOWN WITH OPTIONAL µP-800 MICRO-PROGRAMMER * $99.95

FREQUENCY RANGE - Receive and Transmit 144.00 to 148.995 MHz, 5 KHz steps (1000 channels) + MARS-CAP and MULTIPLE OFFSET BUILT IN.

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- Extra DC Power Cord & Plug 4.00
- Extra Mounting Bracket 6.00

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COMPARE!! Nothing Else Does!

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- SUPER 100 LB. M.P.H. BLACK MAGNETIC MOUNT
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Complete with 17 COAX AND CONNECTOR

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2

Larsen Kulrod
Antennas which need no ground plane!

OMNI MODELS

For easy mounting on fiberglass or where mounting material thickness prohibits usual mounts.
Mounting flange and base loading coil housing is a single, sealed, waterproof unit. Handles a full 150 watts. Models available for High Band and UHF.

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Base loaded 1/2 wave antenna. Delivers unity gain without a ground plane. Delivers 2 to 2.5 db gain over 1/4 wave whip with ground plane of 1/2 wave or more radius. For 144-148 MHz.

OM-440-K
Collinear antenna with phasing coil. Delivers 2 db gain without a ground plane. Delivers 4 db gain over 1/4 wave whip with ground plane of 24" or more radius. For 440-450 MHz.

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Larsen Antennas

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VANCOUVER, WA 98663
PHONE: (206) 572-2722

IN CANADA: Unit 101, 283 E 11th Avenue
VANCOUVER, B.C. V5T 2C4
PHONE: (604) 872-8517

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CONTROLLED, and provides frequency stability in extreme environments. Designed for use in high performance aircraft and ground based beacon applications, this device can also be used as an up-converter pump for microwave communications relay.

Frequency Range: 6.0 to 6.3 GHz

Power Output: 1 Watt Min. 3 Watts Max.

Frequency Stability: + - 1 x 10^-6

Spurious Harmonics: - 30dB

Input Voltage: 24 to 32 Volts DC

ONLY $69.95

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Model 519 Oscilloscope DC to 1GHz $899.00
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TRW BROADBAND AMPLIFIER MODEL CA165B
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| MC1563R | 12.40 | MC1568L | 10.00 |
| MC1558R | 5.31 | MC1568L | 5.00 |
| MC1569R | 8.15 | MC1569G | 6.50 |
| MC3424P | 3.82 | MG5800G | 9.95 |
| MB820P | 6.95 | MG6821P | 12.00 |
| 2513 | 6.95 | 1116-200NS | 10.37 |
| BD50A | 3.95 | TMS4060 | 9.95 |
| 270A | 8.96 | TMS4024 | 13.90 |
| 271A | 29.95 | 1702A | 4.95 |

MC1573R | 12.00

TYCO

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Alfred Model 632D
Sweep signal generator
2-4 GHz $399.00

Polorad Model 1206
1.95 to 4.20 GHz signal source $400.00
Model 1107 3.8 to 8.20 GHz signal generator $550.00

TUNNEL DIODES

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FETs
3N128 1.00
40673 1.39
MPF102 1.45
MPF121 1.45
MPF131 1.00

CRYS TALS (Cont’d)

FAIRCHILD VHF AND UHF PRESCALER CHIPS

| 9590DC | $8.95 |
| 95980DC | 350 MHz Preselector Divide by 1011 |
| 350 MHz Preselector Divide by 1010 |

CRYSTAL FILTERS: Type 001-1988 same as 2194F

TCXO Crystal Oscillator
1 MHz $19.95

S O N A L E R T Model SL628P
6-28 volts DC
3-14 ma
$5.95

MZH ELECTRONICS KITS:

Kit #1
Motorola MC14410CP CMOS Tone Generator
CMOS Tone Generator uses 1MHz crystal to produce standard dual frequency dial signal. Directly compatible with 12 key Chomeric Touch Tone Pads. Kit includes the following:
1 Motorola MC14410CP Chip
1 PC Board
And all other parts for assembly.
NOW ONLY $15.70

Kit #2
Fairchild 89090DC Prescaler 350MHz
9590DC Prescaler divides by 10 to 350 MHz. This kit will take any 35MHZ Counter to 350 MHz. Kit includes the following:
1 Fairchild 9590DC Chip
1 2N5179 Transistor
2 UG 88U BNC Connectors
1 PC Board
And all other parts for assembly.
NOW ONLY $19.95

CRYS TALS (Cont’d)

C R Y S T A L S ( C o n ’ t )

N O W O N L Y $5.95

| 2E26 | $5.00 |
| 3-500Z | 4C350A |
| 3-1000Z | 4C1500B |
| 3828 | 7628 |
| 4.85A | 5.40 |
| 4.125A | 6.87 |
| 4.250A | 8.00 |
| 4.400A | 11.1684 |
| 4-1000A | 5.25 |
| 4XC505F | 38.50 |
| 4XC505Q | 53.50 |
| 4XC512Q | 53.50 |
| 4XC520Q | 72.00 |
| 4XC525Q | 18950 |

SONALERT Model SL628P
6-28 volts DC
3-14 ma
$5.95

Prices Subject to Change

BANK AMERICAN/VIISA/MASTERCHARGE

Exp. Date

Your Signature:

(602) 242-3037

2111 W. Camelback
Phoenix, Arizona 85015

187
The CT-50 is a versatile and precision frequency counter which will measure frequencies to 600 MHz and up to 600 MHz with the CT-600 option. Large Scale Integrity (LSI) circuitry and solid state technology have enabled this counter to match performance found in units selling for over three times as much. Low power consumption (typical 400-400 mA) makes the CT-50 ideal for portable battery operation. Following accessories are included in the kit: 50 MHz LED display, fully shielded metal case, easy pushbutton operation, automatic decramp point, fully socketed IC's and input protection to 50 volts to insure against accidental burnout or overload. And, the best feature of all is the easy assembly. Clear, step by step instructions guide you to a finished unit, you can rely on.

**Order your today!**

- **CT-50:** 60 MHz counter kit
- **CT-50T:** 60 MHz counter and tested
- **CT-600:** 600 MHz tester option, add $89.95

**OP-AMP SPECIAL**

- 741 mini dip: $12.50
- 1-BET mini dip: 741 type: $10.25

**VIDEO TERMINAL**

A completely self-contained, stand alone video terminal. Requires only pushbutton keyboard and TV set to become a complete terminal unit. Two units available, common features are single 5v supply, XTL controlled sync and beats (rate 8600). Complete computer and keyboard control of inter. Pairly error corrected and display. Accepts and generates serial ASCII plus parallel keyboard input. The 3216 is 32 chart by 16 lines, 2 pages with memory dump feature. The 6146 is 64 by 16, lines, with 32 columns (2 options) and has RS-232 and 20ma loop interfaces on board. Kit includes sockets and complete documentation.

- RE 3216 terminal card: $194.95
- RE 6146 terminal card: $194.95
- Lower Case option: $194.61
- Power Supply Kit: $14.95
- Video/RF Modulator, Y1: $6.95
- Assmbled: tested units, add: $60.00

**CALENDAR ALARM CLOCK**

The clock that's got it all: 6-5" LED, 12 hour, snooze & 24 hour alarm, 5 year calendar battery backup, and lots more. The super 7001 chip is used. Size 5x4x2 inches. Complete kit, less case (not available).

- DC:9 $34.95

**30 Watt 2 mtr PWR AMP**

Simple Class C power amp features 8 times power gain. 1 W in for 8 out, 2 in and 4 W in for 32 out. Max output of 35 W, incredible value, complete with all parts, less 10k TR relay.

- PA:1, 30 W in amp kit: $22.95
- TR:1, RF scanned TR relay kit: $6.95

**Super SLEUTH**

A super sensitive am phillter which will pick up a pin drop at 15 feet. Great for monitoring baby's room or as a general purpose whisper filter. Full 2 W micro output runs on 6 to 15 volts, uses 6.45 ohm speaker.

- Complete kit, EN-9 $5.95

**POWER SUPPLY KIT**

Complete regule regulated power supply provides variable 6-18 v to 1200mA. Excellent load regulator good for 20mA, and 5¥ voltage changes. Transforms, requires 6 V DC 1 A to 12 A.

- Complete kit: PS-3LT $5.95

**SIREN KIT**

Produces upward and downward warning characteristics of a police siren. Use both audio and visual outputs runs on 3¥ volt. Uses 3¥40ohm speaker.

- Complete kit: SM-3 $2.95

---

**FREQUENCY COUNTER KIT**

Outstanding Performance $89.95

**SPECIFICATIONS:**

- Frequency range: 6 MHz to 55 MHz, 600 MHz with CT-600.
- Resolution: 10 Hz, 0.1 sec gate.
- High: 0.1 sec gate.
- Resolution: 50%, 0.6% high LED, peak readout in mHz. Accuracy adjustable to 0.5 ppm.
- Statically: 2.0 ppm over 10° to 40° C. temperature compensated.
- Input: 1 mV 30 microamp direct, 50 ohm with CT-600.
- Overload: 50 VAC Maximum, 9000 VDC.
- Sensitivity: less than 25 microv to 65 MHz, 50-150 V to 600 MHz.
- Power: 110 VAC 5 Watts or 12 VDC 600 mA.
- Size: 6" x 4" x 2". High quality aluminum case, 2 lbs.

---

**CLOCK KITS**

Our Best Seller Your Best Deal

Try your hand at building the finest looking clock on the market. The satin finish anodized aluminum case looks great anywhere. While the 4 LED digits provide a highly readable display. This is a complete kit, no extra needed, and it only takes 2-1/2 hours to assemble. Your choice of case colors: silver, gold, bronze, black, blue.

- Clock kit 12-24 hour: DC-5 $122.95
- Clock with 10 mm timer: DC-12 $27.95
- Alarm clock: DC-12 hour only: DC-8 $24.95
- 12 V car clock: DC-7 $27.95

For wired and tested clocks add $1.00 to kit price

---

**Ramsay's famous MINI-KITS**

**FM WIRELESS MIKE KIT**

Transmits up to 300 to any FM broadcast radio, uses any type of mike. Runs on 3-9 V. Type FM-2 has added sensitivity make it a super.
These Low Cost SSB TRANSMITTING CONVERTERS
Let you use inexpensive recycled 10 or 11 meter SSB exciters on VHF!

- Linear Converter for SSB, CW, FM, etc.
- A fraction of the price of other units
- 2W p.e.p. output with 1 mA drive
- Use low power tap on exciter or attenuator pad
- Easy to align with built-in test points
- Link with VHF RX converter for transceive

KIT ONLY $69.95

<table>
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<tr>
<th>MODEL</th>
<th>INPUT (MHz)</th>
<th>OUTPUT (MHz)</th>
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<tbody>
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<td>50-52</td>
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<td>XV2-2</td>
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<tr>
<td>XV2-8</td>
<td>144-146</td>
<td>220-222</td>
</tr>
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</table>

FAMOUS HAMTRONICS PREAMPS
Let you hear the weak ones too! Great for OSCAR, SSB, FM, ATV. Over 14,000 in use throughout the world on all types of receivers.

P9 Kit $12.95
P14 Wired $24.95

Specify band when ordering

- Deluxe vhf model for applications where space permits 1 1/2" x 3" Models available to cover any 4 MHz band in the 26 to 230 MHz range 12 Vdc
- 2 stages Ideal for OSCAR 20 dB gain

P8 Kit $10.95
Specify band when ordering

- Miniature vhf model for tight spaces size only 2 1/2 x 2 Models available to cover any 2 MHz band in the range 20 to 230 MHz 20 db gain 12 Vdc

P15 Kit $18.95
P35 Wired $34.95

- Covers any 6 MHz band in UHF range of 380 to 520 MHz 20 dB gain 2 stages 12 Vdc

Easy to Build FET RECEIVING CONVERTERS
Let you receive OSCAR and other exciting VHF and UHF signals on your present HF or 2M receiver

VHF KIT STILL ONLY $34.95

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<th>MODEL</th>
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<td>C110-ELT</td>
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<td>CB Channel 9 (17)</td>
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Professional Quality VHF/UHF FM/CW EXCITERS

- Fully shielded designs
- Double tuned circuits for spurious suppression
- Easy to align with built-in test aids

See our Complete Line of VHF & UHF Linear PA's

- Use as linear or class C PA
- For use with SSB Kmitg Converters, FM Exciters, etc
- LPA 2-15 VHF PA, 2W in/15-20W out. Solid-state U/F switching. Kit only $50.95
- LPA 2-45 VHF PA, 2W in/40-45W out. Can also be used with 8-10W drive. Kit price $109.95
- LPA 4-10 UHF PA, 200-500W in/6-10W out. Kit price $579.95

New R75 One Channel VHF FM RECEIVER
Offers Unprecedented Range of Selectivity Options!

- New generation
- More sensitive
- More selective
- Uses crystal filters
- Smaller
- Easy to align

R75A Kit for monitor or weather satellite service -60dB at ±30 KHz $69.95
R75B Kit for normal nfm service -60dB at ±17 KHz -90dB at ±25 KHz $74.95
R75C Kit for repeater service -60dB at ±14 KHz -80dB at ±22 KHz $54.95
R75D Kit for split channel operation. Uses 8 pole crystal filter -60dB at ±9 KHz, -100dB at ±15 KHz $99.95

Specify band: 10M, 6M, 2M, or 220 MHz. May also be used on adjacent commercial bands. Use 2M version for 137MHz WX satellite.

HAMTRONICS SIX CHANNEL VHF & UHF FM RECEIVERS
In use by the hundreds throughout the world. Unlimited applications.

- Commercial grade design
- Easy to build & align
- 70 or 100dB selectivity options
- Low system cost
- Compartmentalized shielding

- Use in multiple-site applications
- Hardwired or remote

P35 Kit $18.95
P35 Wired $34.95

- Covers any 6 MHz band in UHF range of 380 to 520 MHz 20 dB gain 2 stages 12 Vdc

Call or Write to Get FREE 1979 CATALOG With Complete Details
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hamtronics, inc.
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READER SERVICE — see page 211

DEALER INQUIRIES INVITED
NEW!

CAR CLOCK MODULE - #MA6008

Originally used by HYGAIN to indicate time and channel on an expensive C.B. Mini size, self contained module. Not a Kit. Four digits plus flashing indicator for seconds. Includes MM5369 and 3.58 MHZ crystal for super accurate time base. With hookup data.

MFGR’s CLOSEOUT
LIMITED QTY.

$6.99 each
SPECIAL OFFER: Two for $13

INCLUDES CRYSTAL TIMEBASE!
WORKS ON 12 VDC!

NATIONAL SEMICONDUCTOR
CAR CLOCK MODULE - #MA6008

50% OFF SALE!

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PERFECT FOR USE WITH A TIMEBASE.

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JUMBO CLOCK MODULE

$4.95
REG. $9.95
ADD $1.95 FOR AC XFMR

MILITARY TIME FORMAT!

MA1003D
BRAND NEW!

FEATURES:
- FOUR JUMBO ½ INCH LED DISPLAYS
- 24 HR REAL TIME FORMAT
- 24 HR ALARM SIGNAL OUTPUT
- 50 OR 60 Hz OPERATION
- LED BRIGHTNESS CONTROL
- POWER FAILURE INDICATOR
- SLEEP & SNOOZE Timers
- DIRECT LED DRIVE (LOW RFI)
- COMES WITH FULL DATA

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JUMBO CLOCK MODULE

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SIX DIGIT ALARM CLOCK CHIP

24 Pin Dip. Super easy to use
FEATURES:
- 12 HOUR DISPLAY * 24 HOUR ALARM
- 4 OR 6 DIGITS * ALARM TONE OUTPUT
- SNOOZE ALARM * EASY LED INTERFACE
- POWER FAIL IND.
- BRIGHTNESS CONTROL
- AM/PM INDICATION * SINGLE POWER SUPPLY
- FAST AND SLOW SET * LOW POWER

HOUSE #
WE SUPPLY FULL DATA, specs.
MM5375AA

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JUMBO CLOCK MODULE

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3 FOR $5.95
HUGE SPECIAL PURCHASE!

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FAIRCHILD PN5

SUPER TRANSISTOR
2N4402 TO-92 Plastic Silicon PNP
Driver High Current VCEO-40HFE
50 to 150 at 150 MA FT-150 MHZ A
super "BEFED-UP" Version of the
2N3906
8 FOR $1

6 FOR $5

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MK50390 - 4 Digit - Direct Drive on Readouts Like FCM 7010
$1.99

MK50250 - 6 Digital with Alarm! For multiplexed Led DIO
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all items

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P.O. BOX 401247  GARLAND, TEXAS  (214)271-2461

020
Thousands of personal and business systems around the world use this board with complete satisfaction. Puts 16K of software on line at ALL TIMES! Kit features a top quality soldermask and silk-screened PC board and first run parts and sockets. All parts (except 2708's) are included. Any number of EPROM locations may be disabled to avoid any memory conflicts. Fully buffered and has WAIT STATE capabilities.

**$59.95**

**OUR BEST SELLING KIT!**

USES 2708's!

**ASSEMBLED AND FULLY TESTED**

**ADD $5 FOR 250NS!**

**OUR 45NS 2708'S ARE $8.95 EA. WITH PURCHASE OF KIT**

- **16K STATIC RAM KIT-S 100 BUSS**
  - **$295 KIT**
  - **FULLY STATIC AT DYNAMIC PRICES**

**8K LOW POWER RAM KIT-S 100 BUSS**

**250 NS SALE!**

**ADD $5 FOR 250NS!**

**$129 KIT (450 NS RAMS)**

Thousands of computer systems rely on this rugged, work horse, RAM board. Designed for error-free, NO HASSLE, systems use.

**KIT FEATURES:**

1. Doubled sided PC Board with solder mask and silk screen layout Gold plated contact fingers
2. All sockets included
3. Fully buffered on all address and data lines.
4. Phantom is jumper selectable to pin 67
5. FOUR 7805 regulators are provided on card

**COMPLEMENTARY POWER TRANSISTORS**

**SILICON NPN AND PNP TO-220 CASE**

**VCEO - 40V PD - 30 WATTS FOR AUDIO POWER AMPS, ETC.**

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**TIP30 - PNP**

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- **8 FOR $89.95**

**450 NS!**

**2708 EPROMS**

Now fast speed! Prime new units from a major U.S. Mfg. 450 N.S. Access time. 1K x 8. Equiv. to 4-1702 A's in one package.

**$15.75 ea.**

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**4 FOR $50.00 PRICE CUT**

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  - 16K x 1 Bit. 16 Pin Package Same as Mostek 4116-4 250 NS access 40 NS cycle time. Our best price yet for this state of the art RAM 32K and 64K RAM boards using this chip are readily available. These are new, fully guaranteed devices by a major mfg.

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**CAR CLOCK MODULE - #MA6008**

**$6.99 each**

- **NEW!**
  - **INCLUDED CRYSTAL TIMEBASE**
  - **WORKS ON 12 VDC!**

**EXPERIMENTER'S HEATING PLATE**

Large Manufacturers Surplus. 5½x10½ in. Made of 3/8 in. tempered glass with heating element laminated on back. Works off 120 VAC. Protected by thermostat and two thermal fuses. Rated 120 Watts. Use for any heating applications. Perfect for heating ferric chloride to increase PC Board etching efficiency. Units are brand new, non-submersible. **WHILE THEY LAST—$2.99 each**

**MALLORY COMPUTER GRADE CAPACITOR**

30,000 MFD 15 WDC Small 3 x 2 inches. **$1.99 ea. 3 FOR $4.99**

**NEW! REAL TIME**

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**“THE COLOSSUS” FAIRCHILD SUPER JUMBO LED READOUT**

A full 80 inch character. The biggest readout we have ever sold. Super efficient. Compare at up to $2.95 each from others! **OUR CHOICE**

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**16K PROGRAMMING MANUAL**

By MOSTEK, or ZILOG. The most detailed explanation ever on the working of the Z-80 CPU CHIPS. At least one full page on each of the 158 Z-80 instructions. A MUST reference manual for any user of the Z-80 300 pages. Just off the press **$12.95**

**GENERAL INSTRUMENT FULL WAVE BRIDGE**

4 AMP 600 PIV **75¢ 3 FOR $2**

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**TIP30 - PNP**

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30,000 MFD 15 WDC Small 3 x 2 inches. **$1.99 ea. 3 FOR $4.99**

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Digital Research Corporation

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TEMPERATURE CONTROLLED HEATING PLATE

$2.99

5½ x 10½ In. 120 VAC, 120 WATTS. Made of 1/4 In. tempered plate glass with Ni-Chrome heating element laminated to back. Element size is 4½ x 9¼ Inches. Double protected by TI KLIXON Thermostat and two thermal fuses. Each also has neon ready light.

Besides the obvious use as a bun warmer, food warmer, coffee warmer, glue warmer, etc., our tests show this plate to be an excellent warmer for ferric chloride solution used in etching PC Boards by hobbyists. Typically increases etching efficiency by 300% over room temperature. Non-Submersible.

CMOS PARTS BONANZA

99¢ EACH

Complete Module: 2 x 1½ In.
Contains: MC14553 3 DIGIT BCD COUNTER, MC14511 BCD to 7 segment decoder latch, CD4060 OSCILLATOR and RIPPLE COUNTER, CD4011 NAND gate. Also was square N.O. push button, 9V battery clip, SPDT Sub-Mini slide switch. Plus misc. resistor, caps, transistor. All parts easily removed. Reg. Dist. List on MC14553 alone is over $4 each!

FIBER POINT PENS

Writes on almost anything. Water Soluble ink. Designed to write on plastic etc. Black. Fine Tip. 49¢ Value.
SPECIAL: 6/$1 100/$14

PUSH BUTTON SWITCH

N.O. SPst. P.C. Mount. Same as used on CMOS Parts Bonanza at left.

5 FOR $1

4 BIT MICROPROCESSOR MODULE

75¢ (MODULE ONLY) 3 FOR $2

Originally custom designed for a large US Consumer Mfg. These were used as part of a weight loss program. Unit counts up to 25 bites with 24 flashes between bites to indicate chewing rate. Has 2 Digit LED readouts, adjustable on board oscillator. 4 Bit Microprocessor with PROM. Our experimentation shows this module has many applications for timing, pacing, etc. Also there are on board signals that can produce various beeping, warble and exotic tones. Some application data included.

Complete units in case, as above: $2.49 each.

74C903 CMOS:

National Semiconductor. New CMOS Part. Hex Inverting Buffer. Use for interface from PMOS to TTL or CMOS. Can Drive LED’s. 6/$1

ORDER FROM EITHER COMPANY: SEE TERMS OF SALE ON OUR RESPECTIVE ADS

Digital Research Corporation
(OF TEXAS)
P.O. BOX 401247 • GARLAND, TEXAS 75040 • (214)271-2461

BULLET ELECTRONICS
P.O. BOX 401244E • GARLAND, TEXAS 75040
(214)278-3553
BULLET ELECTRONICS
P.O. BOX 401244E
GARLAND, TX 75040
(214) 278-3553

WE APOLOGIZE!
JUST WHEN IT LOOKED LIKE ALL THE HOOPLA ABOUT OUR LOW COST HIGH CURRENT REGULATED PS-14 POWER SUPPLY KIT WAS FADING AWAY AND OUR COMPETITORS COULD BREATHE A LITTLE EASIER, WE GO AND DO SOMETHING LIKE THIS!

**PS-15 POWER SUPPLY KIT**

**12V 30 AMPS**

<table>
<thead>
<tr>
<th>SPECs:</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTINUOUS CURRENT</td>
</tr>
<tr>
<td>30 AMPS</td>
</tr>
<tr>
<td>REGULATION</td>
</tr>
<tr>
<td>200 MV LOAD AND LINE</td>
</tr>
<tr>
<td>RIPPLE</td>
</tr>
<tr>
<td>LESS THAN 300MV @ 30A</td>
</tr>
<tr>
<td>CURRENT LIMIT</td>
</tr>
<tr>
<td>ADJUSTABLE FOLDBACK TYPE</td>
</tr>
<tr>
<td>VOLTAGE OUTPUT</td>
</tr>
<tr>
<td>ADJUSTABLE 11.5 TO 14 VDC</td>
</tr>
<tr>
<td>SAFETY FEATURES</td>
</tr>
<tr>
<td>SHORT CIRCUIT PROTECTION; THERMAL SHUTDOWN; RF BY-PASSED</td>
</tr>
</tbody>
</table>

PRICE DOES NOT INCLUDE CHASSIS, METERS OR JACKS

**PS-14 Power Supply Kit.**

Same features as above but 20 AMP max current. SHIPPING PAID. 45.00

**OVP-2 OVERVOLTAGE PROTECTOR**

Protect your expensive gear from overvoltage from transients or power supply malfunctions. Use with any fused power supply. Compatible with PS-14 or PS-15. Adjustable 10-20 VDC

**SE-01 SOUND EFFECTS KIT**

<table>
<thead>
<tr>
<th>MATCHED METER SET</th>
</tr>
</thead>
<tbody>
<tr>
<td>A quality pair of American Made 3½” rectangular panel meters. 5% Accuracy. Modern styling.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7 WATT AUDIO AMP KIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMALL. SINGLE HYBRID IC AND COMPONENTS FIT ON A 2” x 3” PC BOARD (INCLUDED). RUNS ON 12 VDC. GREAT FOR ANY PROJECT THAT NEEDS AN INEXPENSIVE AMP. LESS THAN 3% THD @ 5 WATTS. COMPATIBLE WITH SE-01 SOUND KIT.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6 DIGIT AUTO/VAN CLOCK</th>
</tr>
</thead>
<tbody>
<tr>
<td>LARGE ¼” CHARACTERS (LED)</td>
</tr>
<tr>
<td>QUARTZ XTAL TIMEBASE</td>
</tr>
<tr>
<td>ALARM &amp; SNOOZE OPTIONS</td>
</tr>
<tr>
<td>NOISE FILTERING</td>
</tr>
<tr>
<td>EASY TO ASSEMBLE</td>
</tr>
<tr>
<td>$16.95 LESS SPEAKER &amp; BATTERY</td>
</tr>
<tr>
<td>$16.95 CHIPS</td>
</tr>
<tr>
<td>76477 CHIP IS INCLUDED, EXTRA CHIPS $2.95 EACH</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ULTRASONIC RELAY KIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>INVISIBLE BEAM WORKS LIKE A PHOTO ELECTRIC EYE. USE UP TO 25 FT. APART. COMPLETE KIT. ALL PARTS &amp; PC BOARDS.</td>
</tr>
</tbody>
</table>

**REGULATOR CARD & COMPONENTS: 14.95**

**SPECIAL PACKAGE: PS-15, OVP-2 AND METERS**

59.95

<table>
<thead>
<tr>
<th>LEAD’S</th>
</tr>
</thead>
<tbody>
<tr>
<td>JUMBO GREEN</td>
</tr>
<tr>
<td>JUMBO RED</td>
</tr>
<tr>
<td>MEDIUM RED (½”)</td>
</tr>
<tr>
<td>MEDIUM ORANGE</td>
</tr>
</tbody>
</table>

| OTHERS WILL SELL YOU THE CHIP, BUT ONLY BULLET CAN FURNISH YOU A COMPLETE KIT OF ALL THE PARTS YOU NEED TO PUT THE T.J. 76477 SOUND CHIP THROUGH ITS PACES! WE INCLUDE SPECS AND PROGRAMMING CHARTS YOU WILL BE AMAZED AT THE THOUSANDS OF SOUND EFFECTS YOU CAN PRODUCE WITH OUR KIT MAKE PHASOR GUN, STEAM TRAIN, GUNSHOT AND OTHER SOUNDS. BOARD HAS AUXILIARY PULSE GENERATOR, COMPARATOR AND MULTIPLEX OSC FOR EVEN MORE VERSATILITY. |

<table>
<thead>
<tr>
<th>NEW!</th>
</tr>
</thead>
<tbody>
<tr>
<td>$5.95</td>
</tr>
</tbody>
</table>

| OTHERS WILL SELL YOU THE CHIP, BUT ONLY BULLET CAN FURNISH YOU A COMPLETE KIT OF ALL THE PARTS YOU NEED TO PUT THE T.J. 76477 SOUND CHIP THROUGH ITS PACES! WE INCLUDE SPECS AND PROGRAMMING CHARTS YOU WILL BE AMAZED AT THE THOUSANDS OF SOUND EFFECTS YOU CAN PRODUCE WITH OUR KIT MAKE PHASOR GUN, STEAM TRAIN, GUNSHOT AND OTHER SOUNDS. BOARD HAS AUXILIARY PULSE GENERATOR, COMPARATOR AND MULTIPLEX OSC FOR EVEN MORE VERSATILITY. |

**YOU GET:**

- HUGE 40 AMP TRANSFORMER
- 3 LARGE HEAT SINKS
- DRILLED & PLATED PC BOARD
- LARGE COMPUTER GRADE CAP
- ALL ELECTRONIC PARTS
- FUSES, FUSE HOLDERS, LINE CORD WIRE, MICA INSULATORS
- COMPLETE STEP-BY-STEP INSTRUCTIONS
- COMPLETE WARRANTY AND REPAIR SERVICE
- WE PAY SHIPPING™

© Canadian Orders add $10.00 for Shipping and Insurance

**SPECIAL PACKAGE: PS-15, OVP-2 AND METERS**

59.95

**PARTS**

| 301 DP AMP & LEAD CAN | 3/1.00 |
| 725 VOLT REG. 10 LEAD CAN | 50 |
| '13741 PET INPUT 741 MINI DIP | 3/1.10 |
| 30000 @ 15V COMPUTER GRADE | 2.10 |
| 2N4400 NPN GEN. PURPOSE | 8/1.00 |
| 2N4402 PNP COMPLEMENT | 8/1.00 |
| 2N6028 P.T.W./SPECS | 50 |
| LM380 2W AUDIO IC W/SPECS | 1.00 |
| LM377 DUAL LM380 W/SPECS | 2.50 |
| L7815 VOLT REG. 1A 15V | 65 |
| L725 LOW NOISE OP AMP | 99 |
| IL-1 OPTO ISOLATOR MINI DIP | 60 |
| "MEM 631" DUAL GATE MOSFET | 1.00 |
| DIODE PROTECTED SIMILAR TO 4067x | 50 |
| 40624 VANCAP DIODE 10 PDO | 40 |
| IC4002 1A 20V DIODE | 15/1.00 |
| 730B TAB PNP POWER | 3/1.00 |
| *MC1353P FM IF DISC IC | 50 |

*INDICATES ITEM IS "HOUSE NUMBERED"

**LED’S**

| JUMBO GREEN | 4/89 |
| JUMBO RED | 5/89 |
| MEDIUM RED (½”) | 1/16 |
| MEDIUM ORANGE | 11/16 |

| OTHERS WILL SELL YOU THE CHIP, BUT ONLY BULLET CAN FURNISH YOU A COMPLETE KIT OF ALL THE PARTS YOU NEED TO PUT THE T.J. 76477 SOUND CHIP THROUGH ITS PACES! WE INCLUDE SPECS AND PROGRAMMING CHARTS YOU WILL BE AMAZED AT THE THOUSANDS OF SOUND EFFECTS YOU CAN PRODUCE WITH OUR KIT MAKE PHASOR GUN, STEAM TRAIN, GUNSHOT AND OTHER SOUNDS. BOARD HAS AUXILIARY PULSE GENERATOR, COMPARATOR AND MULTIPLEX OSC FOR EVEN MORE VERSATILITY. |

© Reader Service—see page 211
MA1003 CLOCK/CASE COMBINATION $19.95

Easy to build — just add 12V DC and time setting switches. Since the MA1003 is car battery compatible and includes a built-in, precision crystal timebase, it’s the easiest clock we’ve seen to get up and running in mobile applications. Unlike LED displays, the 4 blue/green fluorescent digits won’t wash out in sunlight . . . and for something like a van clock, they look really beautiful. The matching case includes an optical filter that brings out the best of the readouts, as well as a mounting hardware. Why pay the high prices of built-in car or van clocks? Do it yourself, and save lots of bucks.

The MA1003 clock module is available separately for $16.50, while the case is available separately for $5.95 . . . but we recommend the $19.95 combination price for maximum savings.

NEW FROM MULLEN COMPUTER PRODUCTS: H8 EXTENDER BOARD KIT

Mullen Computer Products has come up with another winner to go along with their S-100 Extender Board Kit (which is also available from us, and also costs $38). The H8 Extender Board Kit really takes the trouble out of testing or repairing H8 boards; it includes, among other things, jumper links in the power supply lines for insertion of fuses, Ammeters, current limiters, and the like, and a heavy-duty board that stands up to constant usage.

$39

12V, 8A POWER SUPPLY KIT $44.50

This is our longest-running kit, and the specs tell you why. Handles 8 Amps continuous, or 12A with a 50% duty cycle. Includes foldback current limiting, crowbar overvoltage protection, RF suppression, adjustable output 11-14V, more. Ideal for powering mobile transceivers, tape equipment, or TVs at home; also powers disc drives and makes a great lab bench supply. Easy to assemble — except for transformer, diodes, and filter caps, all parts mount on heavy-duty circuit board. Does not include case.

16K MEMORY EXPANSION CHIP SET $109 (3/$320)

For Radio Shack-80, Exidy Sorcerer, and Apple machines. Compare our features with similar chip sets: 250 ns access time, low power parts used exclusively, DIP shunts included, 1 year limited warranty, and easy-to-follow instructions that make memory expansion a snap — even for beginners!

BIPOLAR, REGULATED, VIRTUALLY BLOW-OUT PROOF, 1/4 AMP PER SIDE POWER SUPPLY KIT: ONLY $15!

These power supplies are great for fixed voltage applications. Available in +5V, +6V, +8V, +9V, +12V, and ±15V — specify project #13-XX, where the XX stands for the desired output voltage. Compact, simple assembly; does not include case.

TERMS: Add $1 handling to orders under $15. Allow up to 5% shipping, more for power supplies (excess refunded). Give street address for UPS delivery. Prices good through cover month of magazine. VSPA “Mastercharge” call our 24 hour order desk at (415) 562-0636. CODs OK with street address. Call our sales tax. Thanks for your business!
CALL US WITH YOUR REQUIREMENTS

AMERICA'S NO. 1 Real Amateur Radio Store

Associated Wants to TRADE - BUY - SELL
GOT YOUR BEST DEAL? THEN CALL US AT
913-381-5900 - NO TRADE? ASK FOR EXT. 12

NOTE: SEND $1.00 FOR OUR CURRENT CATALOG
OF NEW AND RECONDITIONED EQUIPMENT.

* ALSO WE PERIODICALLY PUBLISH A LIST OF
UNSERVICED EQUIPMENT AT GREAT SAVINGS.
A BONANZA FOR THE EXPERIENCED OPERATOR.
TO OBTAIN THE NEXT UNSERVICED BARGAIN LIST,
SEND A SELF ADDRESSED STAMPED ENVELOPE.
CUSTOMERS THE WORLD OVER ARE CLAMORING FOR OUR GIANT "ONE CENTERS"

SALE
A PENNY MORE GETS YOU TWO

**Spectrol**

**"SKINNY-TRIMS" POTENTIOMETERS**

<table>
<thead>
<tr>
<th>Single Turn</th>
<th>Pot Type</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>3237</td>
<td>1500</td>
<td>90°</td>
</tr>
<tr>
<td>2368</td>
<td>2500</td>
<td>100%</td>
</tr>
<tr>
<td>1510</td>
<td>4000</td>
<td>100%</td>
</tr>
<tr>
<td>2532</td>
<td>5000</td>
<td>100%</td>
</tr>
<tr>
<td>3249</td>
<td>10000</td>
<td>100%</td>
</tr>
</tbody>
</table>

ORDER BY CAT. NO. AND VALUE

**25 AMP BRIDGE RECTIFIERS**

<table>
<thead>
<tr>
<th>Value</th>
<th>Qty</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>120 V</td>
<td>2 for</td>
<td>$1.29</td>
</tr>
<tr>
<td>250 V</td>
<td>1 for</td>
<td>$2.49</td>
</tr>
</tbody>
</table>

**"CRIMP-ON" PL-259 COAX PLUG**

Quick Easy plug wiring. No soldering. Interchangeable with RG-58, RG-59, RG-62, RG-8U.

**"THE FAT" MALLORY 1A4 MERCURY BATTERY**

**$1.49**

**1N4000 Epoxy Rectifiers**

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Qty</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2377</td>
<td>10</td>
<td>0.10</td>
</tr>
<tr>
<td>2378</td>
<td>10</td>
<td>0.15</td>
</tr>
<tr>
<td>2379</td>
<td>10</td>
<td>0.20</td>
</tr>
<tr>
<td>2380</td>
<td>10</td>
<td>0.25</td>
</tr>
<tr>
<td>2381</td>
<td>10</td>
<td>0.30</td>
</tr>
<tr>
<td>2382</td>
<td>10</td>
<td>0.35</td>
</tr>
<tr>
<td>2383</td>
<td>10</td>
<td>0.40</td>
</tr>
<tr>
<td>2384</td>
<td>10</td>
<td>0.45</td>
</tr>
<tr>
<td>2385</td>
<td>10</td>
<td>0.50</td>
</tr>
</tbody>
</table>

**LEDS:**

YOUR CHOICE $1.29 + Post.

<table>
<thead>
<tr>
<th>Color</th>
<th>Qty</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>RED</td>
<td>1000</td>
<td>0.10</td>
</tr>
<tr>
<td>GREEN</td>
<td>1000</td>
<td>0.12</td>
</tr>
<tr>
<td>WHITE</td>
<td>1000</td>
<td>0.15</td>
</tr>
<tr>
<td>ROYAL BLUE</td>
<td>1000</td>
<td>0.17</td>
</tr>
<tr>
<td>JADE GREEN</td>
<td>1000</td>
<td>0.20</td>
</tr>
<tr>
<td>JADE GREEN BIRD</td>
<td>1000</td>
<td>0.25</td>
</tr>
</tbody>
</table>

**3 ELEMENT 120 VAC HOTPLATE**

$6.88 2 for $6.89

**1 AMP 1000 VOLT MINI RECTIFIERS**

<table>
<thead>
<tr>
<th>Cat. No.</th>
<th>Qty</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2357</td>
<td>10</td>
<td>$2.49</td>
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</tbody>
</table>

**"ONE PENNY MORE GETS YOU TWO" MINI ELECTROS**

**Plastic**

<table>
<thead>
<tr>
<th>Qty</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>MFD, VOLS, 25µF, 50V, Axial</td>
</tr>
<tr>
<td>15</td>
<td>10µF, 450V, Axial</td>
</tr>
<tr>
<td>15</td>
<td>10µF, 630V, Axial</td>
</tr>
<tr>
<td>10</td>
<td>25µF, 630V, Axial</td>
</tr>
<tr>
<td>10</td>
<td>10µF, 1000V, Axial</td>
</tr>
</tbody>
</table>

**10 AMP RECTIFIERS**

<table>
<thead>
<tr>
<th>Qty</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>SILICON, 10AMP, 1400V, Axial</td>
</tr>
<tr>
<td>1</td>
<td>SILICON, 25AMP, Axial</td>
</tr>
</tbody>
</table>

**MOTOROLA STYLE "SANDY DISC"**

**10 AMP**

<table>
<thead>
<tr>
<th>Qty</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Rectifiers, 10AMP, Axial</td>
</tr>
</tbody>
</table>

**"BEEM-O" LIGHT DIODES**

<table>
<thead>
<tr>
<th>Qty</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3-WATT, 1500V, Axial</td>
</tr>
</tbody>
</table>

**120 LED WATCH GUTS**

<table>
<thead>
<tr>
<th>Qty</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>For $1.50</td>
</tr>
</tbody>
</table>

How to Order:

- Add Penney's Stock No. and Price to this page.
- Insert order with this page in your Mailing Carton.
- Mail to Penney's, 101 W. 23rd St., New York 11, N.Y.

**Reader Service—see page 211**
<table>
<thead>
<tr>
<th><strong>E. F. Johnson Desk Top Microphone</strong></th>
<th><strong>CB Special</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceramic Element/High Imp</td>
<td>Brand new printed circuit board assembly. Used in all HyGain 40 channel CB transceivers. Fits many other manufacturers' units also. Squelch pot/volume control/channel selector switch not included.</td>
</tr>
<tr>
<td>was <strong>$28.95</strong> now <strong>$15.00</strong></td>
<td>1. 9—7.50 ea. Board Dimensions</td>
</tr>
<tr>
<td><strong>While They Last</strong></td>
<td>10-49—6.50 ea. 6&quot; x 5&quot;</td>
</tr>
<tr>
<td>Desk Top Style</td>
<td>100-up—5.50 ea.</td>
</tr>
<tr>
<td><strong>$19.95 ea.</strong></td>
<td><strong>NEW Hy-Gain Remote 40ch CB Less Case, Speaker &amp; Control Mic</strong> (as-is) <strong>$14.95 ea.</strong></td>
</tr>
<tr>
<td></td>
<td><strong>New 40 CH CB Boards</strong> w/40 ch SW</td>
</tr>
<tr>
<td></td>
<td>1-9 $10.50 ea. 50-99 $9.00 ea.</td>
</tr>
<tr>
<td></td>
<td>10-49 $9.50 ea. 100-up $8.50 ea.</td>
</tr>
<tr>
<td><strong>Serviceman Special</strong></td>
<td><strong>NEW Hy-Gain 40ch CB Less Case, Speaker &amp; Knobs (as-is)</strong> <strong>$14.95 ea.</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Polyfoam Coax—50 OHM</strong> Equal to RG174 <strong>$6.00 ea.</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Low Loss</strong> Polyfoam Coax Cable <strong>$1.00 ea.</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>MINI TOGGLE SW &amp;H</strong></th>
<th><strong>12 Vdc RELAY</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SPDT</strong></td>
<td>SPST Open Frame</td>
</tr>
<tr>
<td><strong>$1.00 ea.</strong></td>
<td>5 Amp Contacts</td>
</tr>
<tr>
<td></td>
<td>Mfg-Magnecraft</td>
</tr>
<tr>
<td></td>
<td><strong>$1.50 ea.</strong></td>
</tr>
<tr>
<td></td>
<td><strong>4/$5.00</strong></td>
</tr>
<tr>
<td><strong>E. F. Johnson</strong></td>
<td><strong>FCC 2 sided</strong></td>
</tr>
<tr>
<td><strong>40ch Selector</strong></td>
<td>.020 Copper Clad Board</td>
</tr>
<tr>
<td><strong>Switch</strong></td>
<td><strong>$2.00 ea.</strong></td>
</tr>
<tr>
<td><strong>$3.50 ea.</strong></td>
<td><strong>25% off</strong></td>
</tr>
<tr>
<td></td>
<td><strong>$3.00 ea.</strong></td>
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</table>

<table>
<thead>
<tr>
<th><strong>12 Vdc RELAY</strong></th>
<th><strong>CRYSTAL FILTERS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SPST 35 Amp Contacts</strong></td>
<td>10.7/3/Lead Can Type</td>
</tr>
<tr>
<td><strong>Open Frame</strong></td>
<td><strong>$3.00 ea.</strong></td>
</tr>
<tr>
<td><strong>Rugged, great for mobile use</strong></td>
<td><strong>$5/20.00</strong></td>
</tr>
<tr>
<td><strong>$4.50 ea.</strong></td>
<td><strong>$7.50 ea.</strong></td>
</tr>
<tr>
<td><strong>$5.00 ea.</strong></td>
<td><strong>2 for $1.25</strong></td>
</tr>
<tr>
<td><strong>$3.00 ea.</strong></td>
<td><strong>5 for $3.00</strong></td>
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<table>
<thead>
<tr>
<th><strong>12 Vdc RELAY</strong></th>
<th><strong>CAPS</strong></th>
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</thead>
<tbody>
<tr>
<td><strong>SPST Open Frame</strong></td>
<td>2200 UF @ 16V</td>
</tr>
<tr>
<td><strong>5 Amp Contacts</strong></td>
<td>Radial Leads</td>
</tr>
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<td><strong>Mfg-Magnecraft</strong></td>
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<tr>
<td><strong>$1.50 ea.</strong></td>
<td><strong>$7.50 ea.</strong></td>
</tr>
<tr>
<td><strong>4/$5.00</strong></td>
<td><strong>$2.25 ea.</strong></td>
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<thead>
<tr>
<th><strong>CRIMMERS CAPS</strong></th>
<th><strong>MUFFIN FANS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Small enough to fit in your watch—</td>
<td>3 Blades, 110 Vac, 4 7/8&quot; sq.</td>
</tr>
<tr>
<td>3.5 to 20 pF</td>
<td>Removed from equipment—</td>
</tr>
<tr>
<td>5 to 30 pF</td>
<td>Excellent condition— <strong>$4.95 ea.</strong></td>
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<tr>
<th><strong>CRYS TAL FILTERS</strong></th>
<th><strong>RECEIVER FRONT ENDS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>10.7/3/Lead Can Type</td>
<td>Made by EFJ</td>
</tr>
<tr>
<td><strong>$3.00 ea.</strong></td>
<td><strong>$12.00 ea.</strong></td>
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<tr>
<th><strong>GOLD PLATED CARD EDGE CONNECTORS</strong></th>
<th><strong>12VDC RELAY</strong></th>
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<tr>
<td><strong>Double Row/Wire Wrap .100</strong></td>
<td><strong>SPST 35 Amp Contacts</strong></td>
</tr>
<tr>
<td>25 pins</td>
<td><strong>Open Frame</strong></td>
</tr>
<tr>
<td><strong>$3.49 ea.</strong></td>
<td><strong>Rugged, great for mobile use</strong></td>
</tr>
<tr>
<td>10/$30.00</td>
<td><strong>$4.50 ea.</strong></td>
</tr>
</tbody>
</table>

| **Double Row/Solder Eyelet .156**   |
|-------------------------------------|-----------------|
| 6 pins                              | **$1.10 ea.**   |
| 10/$9.00                           | **$1.00 ea.**   |
| 15 pins                             | **$1.55 ea.**   |
| 10/$12.50                          | **$1.40 ea.**   |
| 22 pins                             | **$2.08 ea.**   |
| 10/$17.00                          | **$1.95 ea.**   |
| 43 pins                             | **$3.66 ea.**   |
| 10/$30.00                          | **$3.50 ea.**   |

| **22 pins/Dual Row/Dipped Solder**  |
|-------------------------------------|-----------------|
| .156                                | **$2.06 ea.**   |
| 10/$17.00                          | **$1.50 ea.**   |
|                                    | **$1.42 ea.**   |

| **IC SOCKETS**                     |
|------------------------------------|-----------------|
| **Cambio**                         | **Gold Plated Wire Wrap** |
| **14 pin**                         | **$0.35 ea.**   |
| 10/$3.00                           | **16 pin**      |
| **$0.38 ea.**                      | **10/$3.30**    |

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<tr>
<th><strong>MODEM CABLE</strong></th>
<th><strong>EFJ CRYSTAL OVENS</strong></th>
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<tr>
<td><strong>50'</strong></td>
<td>6V/12V 75°</td>
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<td><strong>$5.00 ea.</strong></td>
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<th><strong>MOTOROLA SRF 574</strong></th>
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<td><strong>house marked</strong></td>
<td>3 Blades, 110 Vac, 4 7/8&quot; sq.</td>
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<td><strong>9W 175 MHz Amp.</strong></td>
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<td><strong>$5.00 ea.</strong></td>
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<th><strong>TRIMMER CAPS</strong></th>
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<tr>
<td><strong>$12.00 ea.</strong></td>
<td>3.5 to 20 pF</td>
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<td><strong>$1.00 ea.</strong></td>
</tr>
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<td><strong>$3.00 ea.</strong></td>
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<td><strong>2 for $1.25</strong></td>
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<th><strong>WHITE PORCELAIN EGG INSULATORS</strong></th>
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<td>1 1/4&quot; x 11&quot; 50 ea.</td>
</tr>
<tr>
<td>3 for $1.25</td>
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| **EQUIPMENT / COMPONENTS / WIRE & CABLE / ACCESSORIES** |

**TERMS:**

All material guaranteed. If for any reason you are not satisfied, our products may be returned within 10 days for a full refund (less shipping). Please add $3.00 for shipping and handling on all orders. Additional 5% charge for shipping any item over $5 lbs. COD's accepted for orders totaling $50.00 or more. All orders shipped UPS unless otherwise specified. Florida residents please add 4% sales tax. Minimum order $15.00.

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TWX: 810-848-6085
WHOLESALE - RETAIL

**S. W. J.  ELECTRONICS CORP.**

7294 N.W. 54 STREET
MIAMI, FLORIDA 33166
<table>
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<tr>
<th>R.F. CONNECTORS</th>
<th>R.F. TRANSISTORS</th>
<th>F.E.T.'s</th>
<th>SEMTECH MINISTIC</th>
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<tr>
<td>UG-1095A/U</td>
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<td>UG-58/U</td>
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<td>40673 $1.39 or 10/10.00</td>
<td>1500PIV 1.5 AMPS</td>
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<td>PL-259</td>
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<td>3N128 $1.35 or 10/10.00</td>
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<td>UG-447/U</td>
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<td>SPDT 25 Amps $5.95</td>
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<td>BRIDGES 24 AMPS</td>
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<tr>
<td>UG-701/U</td>
<td>3.00</td>
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<td>and CHIMNEYS NEW</td>
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<tr>
<td>UG-212C/U</td>
<td>3.00</td>
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<td>$14.95 per set (1 socket, 1 chimney)</td>
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| TUBES | MICROWAVE DIODES | B&W COILS |
|-------|-----------------|----------|----------|
| 3-500Z | $90.00 | 1206T | $3.99 |
| 572B/160L | 34.00 | 2006T | $7.99 |
| 614F | 5.09 | FAIRCHILD REGULA | $6.99 each |
| 614A | 5.99 | TOR | |
| 614W | 7.95 | TUBES | |
| 81 | 12.95 | 6146B | $6.50 |
| 81 | 9.95 | MINIMUM ORDER $5.00 | |
| 4CX250B | 29.95 | Maximum Shipping $1. Insurance 35¢ per $100. COD | |
| 4CX250R | 32.95 | charges 85¢ to street address only! We prefer street address as we ship UPS and P.O. | |
| 6KD6 | 4.99 | Box #’s take up to 50% longer to deliver. We accept VISA or Mastercharge. Please list complete card number and expiration date. Allow 10% | |
| 6LF6 | 4.99 | extra for shipping of heavy items. We reserve the right to change prices without notice. All items listed are subject to prior sale. Some items listed | |
| 6LQ6/6E6 | 6.25 | are in small quantities. | |
| 8950 | 6.65 | | |
| 2E26 | 6.00 | TRIMMERS 5-80pf | 45¢ each or 10/3.50 or 100/25.00 |
| 3B28 | 5.00 | | |
| 4X150A | 15.00 | TRIMMER CAPS small enough to fit in your watch | 3.5-11pf 75¢ each or 10/$6.00 |
| 6360A | 7.95 | | |
| 6939 | 5.95 | PISTON CAPS 1.2-10pf | 75¢ each or 10/$5.50 |
| 7289/2C39 | 4.95 | | |
| 8072 | 45.00 | | |

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<tr>
<th>FERRITE BEADS</th>
<th>CHOKES (U252)</th>
<th>ADDITIONAL R.F. TRANSISTORS</th>
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<td>MRF454/568BLYCF 17.10</td>
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<td>T-37-6</td>
<td>6/1.00</td>
<td>TRIMMERS 5-80pf</td>
<td>45¢ each or 10/3.50 or 100/25.00</td>
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<td>25/4.00,</td>
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<td>CHOKES (U252)</td>
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<td>1N914/1N4148</td>
<td>30/$1.00 or 120/$3.00</td>
<td>TRIMMER CAPS small enough to fit in your watch</td>
<td>3.5-11pf 75¢ each or 10/$6.00</td>
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<td></td>
<td>PISTON CAPS 1.2-10pf</td>
<td>75¢ each or 10/$5.50</td>
<td></td>
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</tbody>
</table>

Prices subject to change without notice.
**ALDELCO ELECTRONIC CENTER**

OVERVOLT 12
Crow Bar circuit protects Transceivers & Tape Decks from runaway power supply voltage that can zap expensive components. OV 12 causes fuse in Power Supply to blow if voltage exceeds preset level (approx. 16 to 18 volts). Rated at 25 Amperes $7.95
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Includes a reprint of six-page construction article from Dec. 1978 73 Magazine
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**DUAL DIGITAL 12/24 HOUR CLOCK KIT NOW WITH A NEW WALNUT GRAIN WOOD CABINET**
Features:
- BIG . 5 0 L E D S
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- ea $4.95
- Woodgrain or black leather
- ea $4.95

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**Blinkly Flasher Kit**
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- Holds 8 HC25U

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Tunable 420 MHz Fast Scan TV Converter
Receive Fast Scan Amateur TV in the 420 to 450 MHz Band with any TV set. Low noise, high gain rf Amp with Varactor tuned input and outputs. Built in AC supply. Comes in two tone walnut & beige cabinet measuring 17 1/2” x 4 1/4” x 4 1/8”
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- 12-20 Volts 500ma $6.95

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**RF TRANSISTORS**
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- SD1047 50W 11dB 30MHz 500-4LFL 21.15
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- SD1098 25W 6 450 500-4LFL 23.25
- SD1098 40W 5 450 500-4LFL 27.15
- SD1158 10W 5 200 MT22 10.95
- SD1272 35W 6 220 MT22 12.95
- SD1276 20W 10 50 MT22 16.30
- SD1416 70W 6.7 175 500-4LFL 26.80
- SD1428 40W 6.5 175 500-4LFL 22.65
- SD1433 15W 7 450 MT90 9.50
- SD1434 50W 5 450 500-4LFL 34.00
- SD1451 50 14 50 500-4LFL 18.10
- SD1477 100W 6 175 500-4LFL 52.85
- 2N5846 10W 6 450 MT90 10.75

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- 2N2876 16W 200 MHz TO60 $12.35
- 2N3975 3.0W 400 MHz TO60 5.80
- 2N3953 2.5W 175 MHz TO39 1.40
- 2N3866 1.0W 400 MHz TO39 1.25
- 2N3268 7.0W 175 MHz TO50 6.30
- 2N4427 1.0W 175 MHz TO39 1.35
- 2N5850 3.0W 175 MHz MT72 4.75
- 2N5910 1.25W 175 MHz MT72 7.80
- 2N6914 1.75W 175 MHz MT72 10.25
- 2N6813 1.25W 175 MHz MT72 7.00
- 2N6817 4.5W 175 MHz MT72 8.45
- 2N6802 25W 175 MHz MT72 10.95
- 2N6823 10W 175 MHz MT72 12.30
- 2N6804 4.0W 175 MHz X106 PNP 16.30
- 2N6805 15W 175 MHz X106 PNP 8.50
- 2N6906 3.0W 175 MHz X106 PNP 10.35
- 2N6907 40W 175 MHz X106 PNP 20.00

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- Provision for Attachment of Memory for DX or Contest Work

Revised version of the Accukeye featured in the ARRL Handbook. Has more logical IC Layout and ON Board sidetone Oscillator. Includes PC Board, TTL ICs, 555 Timer, IC Sockets, Switch, Speaker, Transistors, capacitors and resistors. Requirements: VDC

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- Four chips will total 4224 BITS
- LED indicator for Programming
- Adaptable to other keys

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Includes PC Board and Parts
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Still only $19.95

- Requires 5 volts DC

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(714) 278-4394 California Residents 1-800-542-6239

### QTY.

| DIO/ZEINES | 100v | 10mA | .06 
|------------|------|------|------
| 1N4006     | 600v | 1A   | .09 
| 1N4007     | 1000v| 1A   | .15 
| 1N4148     | 75v  | 1mA  | .25 
| 1N4733     | 5.1v | 1W   | .25 
| 1N4742     | 24v  | 1W   | .25 
| 1N533A     | 6.2v | 500mA| .25 
| 1N758A     | 10v  | .25 
| 1N759A     | 12v  | .25 
| IN5243      | 13v  | .25 
| IN5244      | 14v  | .25 
| IN5245      | 16v  | .25 
| IN5349      | 12v  | 3W   | .25 

### QTY.

| Sockets/Bridges | 8-pin pcb | .16 | 0.35 
|-----------------|-----------|----|------
| 14-pin pcb     | 20 | .40 
| 16-pin pcb     | 25 | .45 
| 18-pin pcb     | 30 | .95 
| 20-pin pcb     | 35 | 1.05 
| 22-pin pcb     | 40 | 1.15 
| 24-pin pcb     | 45 | 1.25 
| 28-pin pcb     | 50 | 1.35 
| 40-pin pcb     | 55 | 1.45 
| Molex pins .01 To-3 Sockets | 35 
| 2 Amp Bridge | 100 | 0.95 
| 25 Amp Bridge | 200 | 1.50 

### QTY.

| TRANSISTORS, LEDs, etc. | .25 
|-------------------------|-----
| 2N2222M (2N2222 Plastic) | 15 
| 2N2222 | 15 
| 2N2907A | 19 
| 2N3006 | 19 
| 2N3004 | 19 
| 2N3006 | 19 
| 2N3006 | 19 
| TIP36 \ PNP Darlington | 1.95 
| LED Green, Red, Clear, Yellow | 1.9 
| D74L | 2.25 
| MAN72 | 2.76 
| MAN7301 | 2.76 
| MAN7302 | 2.76 
| MAN74 | 4.26 
| FND359 | 6.00 

### QTY.

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### Special Discounts

- **Total Order Deduct**
  - $35-$99: 10%
  - $100-$300: 15%
  - $301-$1000: 20%

**INTEGRATED CIRCUITS UNLIMITED**

8789 Clairemont Mesa Blvd, San Diego, California 92111

Out of State 1-800-854-2211 Cable Address:ICUSD Telex: 697-827

(714) 278-4394 California Residents 1-800-542-6239

**NAME**

**STREET ADDRESS**

**CITY**

**STATE**

**ZIP**

**PHONE**

**CHARGE CARD #**

**AE Visa**

**EXP. DATE**

**C.D.O.**

**WILL CALL**

**UPS POST**

**NET 10th of the MONTH**

**PO #**

ALL ORDERS SHIPPED PREPAID - NO MINIMUM - COD ORDERS ACCEPTED - ALL ORDERS SHIPPED SAME DAY

OPEN ACCOUNTS INVITED - California Residents add 6% Sales Tax. PRICES SUBJECT TO CHANGE WITHOUT NOTICE.

24 Hour Phone Service - We accept American Express / Visa / BankAmericard / Master Charge

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**SPECIAL DISCOUNTS**

- **Total Order Deduct**
  - $35-$99: 10%
  - $100-$300: 15%
  - $301-$1000: 20%
VARIABLE POWER SUPPLY KIT $1195

- Continuously Variable from 2V to over 15V
- Short-Circuit Proof
- Typical Regulation of 0.1%
- Electronic Current Limiting at 300mA
- Very Low Output Ripple
- Fiberglass PC Board Mounts All Components
- Assorted in about One Hour
- Makes a Great Bench or Lab Power Supply
- Includes All Components except Case and Meters

ADD $1.25 FOR POSTAGE/HANDLING

SPECIALS - THIS MONTH ONLY

1036C Continuum 2V-15V
10370 Samantha 200V 20mA
10510 Adjustable Voltage Regulator
10520 2 Watt Audio Power Amplifier
10522 Photo Limiter Loop
10532 Precision Voltage Regulator
10531 Dual 741 Compressed Op Amp
10530 100 Bin Stack 4f FET IC's
11040-HF FET/Transistor 100kHz-1MHz
10011 Dual High Gain Op Amp
10042 Dual Hi-Slew Rate Op Amp
10054 Dual Hi-Speed Op Amp
10051 LF-18 Logic Probe m-TTL, CMOS, etc.

SEND FOR ADVAS NEW 1979 CATALOG
NEARLY 1000 SEMICONDUCTORS, KITS, CAPACITORS, ETC. SEND 25¢ STAMP.

OTHER ADVA KITS:

LOGIC PROBE KIT--Use with CMOS, TTL, DTL, RTL, HTL, and more MOS IC's. Much in protection against random overshoot and undershoot. Drawn only a few bits from circuit under test. Dual LED readout. Complete kit includes probe and test lead. ONLY $28 for FREE RETURNED POWER SUPPLY KIT--Write for details and price. No excuse for zapping yourself or פני וספוכל את המואזנים של המונח במודך. drawouts only a few bits from circuit under test. Dual LED readout. Complete kit includes probe and test lead. ONLY $28 for FREE RETURNED POWER SUPPLY KIT--Write for details and price. No excuse for zapping yourself or.

FREE IC or FET'S WITH $5 & $10 ORDERS.
DATA SHEETS WITH MANY ITEMS.

SUPER SPECIALS:

1084 Germanium Diode 20V 100mA $1.85
1084A Germanium Diode 20V 100mA $1.85
1084B Germanium Diode 20V 100mA $1.85
1084C Germanium Diode 20V 100mA $1.85
1084D Germanium Diode 20V 100mA $1.85
1084E Germanium Diode 20V 100mA $1.85
1084F Germanium Diode 20V 100mA $1.85
1084G Germanium Diode 20V 100mA $1.85
1084H Germanium Diode 20V 100mA $1.85
1084I Germanium Diode 20V 100mA $1.85
1084J Germanium Diode 20V 100mA $1.85
1084K Germanium Diode 20V 100mA $1.85
1084L Germanium Diode 20V 100mA $1.85
1084M Germanium Diode 20V 100mA $1.85
1084N Germanium Diode 20V 100mA $1.85
1084O Germanium Diode 20V 100mA $1.85
1084P Germanium Diode 20V 100mA $1.85
1084Q Germanium Diode 20V 100mA $1.85
1084R Germanium Diode 20V 100mA $1.85
1084S Germanium Diode 20V 100mA $1.85
1084T Germanium Diode 20V 100mA $1.85
1084U Germanium Diode 20V 100mA $1.85
1084V Germanium Diode 20V 100mA $1.85
1084W Germanium Diode 20V 100mA $1.85
1084X Germanium Diode 20V 100mA $1.85
1084Y Germanium Diode 20V 100mA $1.85
1084Z Germanium Diode 20V 100mA $1.85

SEND FOR ADVAS NEW 1979 CATALOG
NEARLY 1000 SEMICONDUCTORS, KITS, CAPACITORS, ETC. SEND 25¢ STAMP.

NEW SPECIALS

LM318CN High Speed Op Amp 50V/μs mOIP $0.94
LM318D High Speed Op Amp 50V/μs mOIP .90
LM339N Quad Comparator Single or Dual Supply .79
LM380N ½W Audio Power Amplifier 8-22V .90
NE567V Tone Decoder (PLL) 0.01Hz to 500kHz .99
XR567CP Tone Decoder (PLL) 0.01Hz to 500kHz .99
LM723CN Precision Voltage Regulator -2.37V DIP 3/$1
LM74CN Dual 741 Compensated Op Amp 2/$1
SA1024 Dual 512 Stage (1024) Audio Delay Line $18.95
XR2206CP Function Generator with digital data...
XR2242CP Long-Range Precision Timer μs to days 3.00
1 YEAR TIMER Kit-2 XR2242s and Applic. Note...
LM5201N Quad Comparator +5V or 2 to 36VDC $1.20
CA3018A 4-Transistor Array/Darlington .99
CA3028A RF/IF Amplifier DC to 120MHz 1.25
CR4558 Dual High Gain Op Amp mOIP 3/$1
SPACER Kit - 4 of 5 assorted sizes $1.00 ±15 VOLT Regulated Power Supply Kit-Easy assembly, 5m regulation, 100mA, fully protected. Includes all components and hardware, no PCB or case—Add $1.50 for shipping $13.95

11270 Germanium Diode 80V 200mA 4/$1
11283 Temp Comp Reference 6.2V±% 0.005%/°C $0.60
11914 Silicon Diode 100V 10mA 25/$1
113040 100V Zener Better than an OB3 .75
113045 110V Zener 1W-Better than an OB2/OC3 .75
113071 200V 100mA Switching Diode 40s .30
2N2915 NPN Dual Transistor 2mV Match ±100 $1.95
2N3819NM N-Channel RF FET 100MHz $0.35
2N4020 PNP Dual Transistor 5mV Match ±250 $5.00
2N4445 N-Channel FET 5c Switch 3.50
2N5394E Ultra-Low Noise J-FET Audio Amp $1.25
2N5912 Dual J-FET RF OI Amplifier to 800MHz 2.90
2N6028 Programmable Unijunction Transistor $4.45
2N6449 300 Volt N-Channel J-FET/Ampl $2.00
CP640 Broadband FET RF Amplifier 140dB Dyn Range $4.50
E304 N-Channel RF FET 3.8dB NF @ 400MHz .50
MPSA12 NPN Darlington Transistor ±2000 .75
TIS88 N-Channel 400MHz RF FET $0.60
RESISTOR Kit-150 pcs 4W, 20 most common values, individually packaged, 5 to 20 pcs each .4.95
PC BOARD Mounting Kit-9 ea screw, spacer, nut and washer-32 pcs total .1.00

SEND FOR ADVAS NEW 1979 CATALOG
NEARLY 1000 SEMICONDUCTORS, KITS, CAPACITORS, ETC. SEND 25¢ STAMP.

ADVA ELECTRONICS
BOX 4181 GB
WOODSIDE, CA 94062
Tel. (415) 328-1500

202
LINE PRINTER HAMMER DRIVER BOARD
Each board contains approx. 130 each #MJE300 (Silicon Darlington NPN hfe 750, 1.5A). About $130.00. Includes over 100 1N4001 diodes, plus support chips. The whole package is yours for only $14.95.

HURRY. WE DON'T EXPECT THESE TO LAST VERY LONG!

SOLID DIPPED TANTALUM CAPACITORS
1.35 VOLT .15 35 .23 19
.22 35 .23 19
.33 35 .23 19
.47 35 .23 19
.68 35 .23 19
1.0 35 .25 20
1.5 35 .29 23
2.2 35 .31 25
3.3 35 .36 29
4.7 35 .38 30
6.8 35 .50 40
10.0 35 .65 48
15.0 35 .79 63
22.0 35 1.38 1.12
33.0 35 2.06 1.49
47.0 35 2.65 2.12

VALUES AND QUANTITY MAY BE ASSORTED TO ATTAIN QUANT.

NYLON TIE WRAPS
3" 65000 10/4.30
4" 65002 10/5.00
5" 65003 10/5.50
6" 65004 10/6.90
8" 65005 10/1.58
10" 65006 10/1.94
14" 65007 10/2.96

SCREW MOUNT
1.5" 65054 4/1.25
2.0" 65052 1.007.89
2.4" 65051 1.007.89
3.1" 65024 1.59

REPEAT OF A SELL-OUT
A complete 12 hour digital clock. Some are manufacturer's unique range lists, some are returns, and some are just scratch & dent. Features hours, minutes, alarm, snooze alarm. Parts value alone would equal $20.00, you pay only $6.00.

GALLIUM PHOSPHIDE L.E.D.'s
Provide greater light output, brighter colors, greater uniformity and less current drain than conventional L.E.D.'s.
110 DIAMETER
P/N 724H
Red Diffused 4/1.00
724Y
Yellow Diffused 4/1.49
220 DIAMETER
714H
Red Diffused 5/1.19
714G
Green Diffused 4/1.49
714Y
Yellow Diffused 4/1.59
220 DIAMETER (low dome)
704R
Red Diffused 4/1.59
704G
Green Diffused 4/1.65
704Y
Yellow Diffused 4/1.84
704O
Orange Diffused 4/1.84
101R-Dual (Red and Green)
2/5.00

MOUNTING HARDWARE
-.220 Diameter #7M4H 12/1.00

% WATT 5% DEPOSITED CARBON FILM RESISTOR ASSORTMENT
ASST. A 10 ea. 1 OHM, 1.5 OHM, 2 OHM, 2.7 OHM, 3.3 OHM, 3.9 MH, 4.7 OHM, 5.6 OHM, 6.8 OHM, 8.2 OHM
100 pcs $4.20

ASST. B 10 ea. 10 OHM, 12 OHM, 15 OHM, 18 OHM, 22 OHM, 27 OHM
100 pcs $4.20

ASST. C 10 ea. 68 OHM, 82 OHM, 100 OHM, 120 OHM, 150 OHM
100 pcs $4.20

ASST. D 10 ea. 470 OHM, 560 OHM, 660 OHM, 820 OHM, 1.1K, 1.2K, 1.5K, 1.8K, 2.2K, 2.7K
100 pcs $2.40

ASST. E 10 ea. 3K, 3.3K, 4.7K, 5.6K, 6.8K, 8.2K, 10K
100 pcs $2.40

ASST. F 10 ea. 22K, 33K, 39K, 47K, 56K, 68K, 82K, 100K, 120K
100 pcs $2.40

100 pcs $2.40

ASST. H 10 ea. 1M, 1.2M, 1.5M, 1.8M, 2.2M, 2.7M, 3.3M, 3.9M, 4.7M, 5.6M
100 pcs $2.40

ASST. A-H INCLUDES ALL RESISTOR ASSORTMENTS (800 pcs)
100 pcs $4.20

DEFECTIVE CALCULATORS
Well, some are and some are not. We can't afford the time to test them. $2.50 ea. Batteries not included, 2/$4.00.
door. Talk-in on 16.76, 63/03, 52.52, and 52.525. For information, contact BRATS, PO Box 5915, Baltimore MD 21208.

IRVING TX  AUG 3-5
Encounter '79, the Texas VHF-FM Society's 1979 Summer Convention, will be held August 3-5, 1979, at the Villa Inn, Irving, Texas. Activities include a transmitter hunt, flea market, FCC exams, manufacturers' exhibits, hospitality room, and several programs and forums. Talk-in on 146.52 and repeaters in the area. Pre-registration is $5.00 until July 1. Registration at the door is $6.00. For information, write Encounter '79, PO Box 3608, Arlington TX 76101.

FLAGSTAFF AZ  AUG 3-5
The Amateur Radio Council of Arizona will hold its annual Ft. Tuthill Hamfest on August 3-5, 1979, at Flagstaff, Arizona. Prizes include TS-520 transceivers, a microwave oven, a Wilson Mark II HT, a Wilson System III triband antenna, and more. Featured will be a western barbecue, tech sessions, and exhibits. Camping facilities are also available. For further details or information, write Ft. Tuthill Hamfest, c/o 8520 E. Edwards Ave., Scottsdale AZ 85253.

LITTLE ROCK AR  AUG 4-5
The Central Arkansas Radio Emergency Net (CAREN) Amateur Radio Club will hold its second annual Ham-a-Rama on Saturday and Sunday, August 4-5, 1979, at the Arkansas State Fairgrounds, Little Rock, Arkansas. There will be two main prizes given, as well as door prizes. Featured will be forums, dealers' exhibits, a Saturday night party, and a large flea market. Talk-in on 146.34/94. For details, send an SASE to Morris Middleton ADSM, 19 Elmherst Drive, Little Rock AR 72209.

REND LAKE IL  AUG 5
The Shawnee Amateur Radio Association Hamfest will be held on August 5, 1979, at Rend Lake in southern Illinois. Complete camping and recreational facilities will be available, so plan to spend the weekend at the lake and attend the hamfest. Family activities are planned. Hourly door prizes will be awarded. There will be no charge to vendors. For information, contact WB9ELP or WB9SWG.

PIPPSTON PA  AUG 5
The South Hills Brass Pounders and Modulators will hold its 42nd annual Pittsburgh Hamfest on August 5, 1979, from 9:00 until dusk at Allegheny County Community College south campus on Rte. 885, 2 miles south of the Allegheny County Airport and approximately 15 miles southeast of Pittsburgh, Pennsylvania. Advance registration is $1.50; $2.00 at the door. There will be a large indoor air-conditioned area for vendors and the flea market, and a large paved surface for the outdoor flea market. There will also be prizes and food. Talk-in on 146.13/73 and 52.52. For information and pre-registration, write Bruce Banister, 5954 Leprechaun Dr., Bethel Park PA 15102.

MT SINAi L N Y  AUG 5
The Radio Central Amateur Radio Club will hold its "Ham-Central" on Sunday, August 5, 1979 (rain date is August 12, 1979), at the Mt. Sinai Elementary School, Rte. 25A, Mt. Sinai, Long Island, New York. Admission for sellers is $3.00 per table and $1.50 for buyers, with XYLs and children under 12 free. Many areas are to be used for Radio Central and the St. Charles Hospital Repeater. Doors will open at 7:00 am for sellers and 9:00 for others. They will close at 4:00 pm. Featured will be an antenna advice with Art and Madeline Greenberg, a Novice table, great food, a CW contest, an ARRL table, a special event of a fly-in by the Suffolk County Police Dept. helicopter, and a Radio Central Club table. Talk-in on 146.52 WA2UEC and 144.71/145.31 KZVL. For information, call Jack Longtin at (516) 594-8538 or Robin Goodman at (516) 744-6260, or write Radio Central, "Ham-Central," PO Box 680, Miller Place NY 11764.

JACKSONVILLE FL  AUG 4-5
The Jacksonville Hamfest Association is pleased to announce the 1979 Jacksonville Hamfest and ARRL North Florida Section Convention to be held on August 4-5, 1979, at the Jacksonville Beach Municipal Auditorium, Jacksonville, Florida. The location is just one block from the beach, where U.S. 90 meets the sea. Advanced registrations are available at $3.00 per person from J. I. Guthrie WA4/303 10th St., Atlantic Beach, Florida 32233. Price at the door will be $3.50.

A large indoor swap area will be featured, with advance table reservations available for $15.00 per table per day from Robbie Roberts KH4FMB/W4, 10557 Atlantic Blvd., #31, Jacksonville, Florida 32211. Information on exhibitors' booths and space are available from the same address.

Other features and programs include statewide organization meetings on such topics as traffic nets and MARS, a microprocessor seminar, a solar power demonstration, a DX "pilup" contest, a hidden transmitter hunt, an OSCAR forum, ARRL forums, emergency preparedness forums, demonstrations, presentations, antenna and technical seminars, and much more.

More general information may be obtained from JHA, 911 Rio St. John's Dr., Jacksonville FL 32211.

SALEM OH  AUG 5
The second annual Salem Area Hamfest will be held on August 5, 1979, from 9:00 am to 3:00 pm at the Kent State University campus, Salem, Ohio. Tickets are $1.50 in advance and $2.00 at the door. Inside tables are $5.00 with space for your own table at $2.00. Flea market space is $1.00. There will be air-conditioning, a wheelchair ramp, free parking, refreshments, and prizes, consisting of an Atlas RX-110, TX-110, and a PS-110. Talk-in on 146.52. For details, write Harry Milhoan WABFSB, 1128 West State, Salem OH 44460.

AMARILLO TX  AUG 10-12
The Panhandle Amateur Radio Club will hold its sixth annual Golden Spread Hamfest and Convention on Friday, Saturday, and Sunday, August 10-12, 1979, at The Inn of Amarillo, 601 Amarillo Blvd. West, Amarillo, Texas. The format consists of two full days of exhibits and trading, six technical sessions, programs for the ladies, valuable door prizes, Army and Navy MARS meetings, ARES meeting, an ARRL forum, and plenty of free parking. Displays may be set up any time after 1:00 pm on Friday, August 10th, at a fee of $20.00 per table. For information, write Hamfest, PO Box 10221, Amarillo TX 79106, or phone Jay Ledbetter W5USBM at (806) 376-6042 (nights and weekends) or Chuck Passmore W5BRC at (806) 372-1631.
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SYNTHESIZED HANDIE

The Yaesu FT-207R Synthesized Handie
has all the features you could want in a very compact package

- 144-148 MHz Range
- 10 KHz Steos
- 3 Watts Output
- 4 Memories plus Programmable Offset
- Priority Channel
- Memory and Band Auto Scan
- Optional Equipment:
  - Keyboard Encoded Frequency Entry
  - 2 Tone (Touchtone®) Input from Keyboard
  - Keyboard Lock guards against accidental frequency change
  - Odd Splits Can Be Programmed from Keyboard
  - Automatic Battery Saver Feature for LED Display
  - Rubber Flex Antenna
  - Tone Squelch, Speaker/Mike, Nicads, Battery Charger

Price And Specifications Subject To Change Without Notice Or Obligation

YAESU ELECTRONICS CORP., 15954 Downey Ave., Paramount, CA 90723 • (213) 633-4067
YAESU ELECTRONICS Eastern Service Ctr., 9812 Princeton-Glendale Rd., Cincinnati OH 45246

679X
Looks the same as the TR-7625, but offers 10 watts RF output (switchable to 1 watt low power). Also uses RM-76 Microprocessor Control Unit. Offers one built-in memory.

Featuring 25 watts RF output (switchable to 5 watts low power), the TR-7625 is a high-performance 2-meter FM transceiver with built-in memory, and is designed to permit multi-channel (800-channel) operation. Compact and perfect for mobile or ham shack use. When used with optional RM-76 Microprocessor Control Unit, the TR-7625 offers a whole new dimension in channel memory and scanning capability.

RM-76
Optional Microprocessor Control Unit. Combines with either the TR-7600 or TR-7625. Stores frequencies in six memories (simplex/repeater), and it scans.

Here's an outstanding 2-meter ALL-MODE TRANSCEIVER that provides an extra dimension of versatility over the entire 2-meter band. Feature-packed and equipped for SSB, FM, CW and AM. Complete with built-in digital frequency readout, receiver preamplifier, VOX, sidetone, and microphone.

See your Authorized Kenwood Dealer for more details.

TRIO-KENWOOD COMMUNICATIONS INC.
1111 WEST WALNUT/COMPTON, CA 90220

See Kenwood’s "TECH TALK" in this issue for information on the TS-120S.