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International Edition

MAY 1989
ISSUE #344
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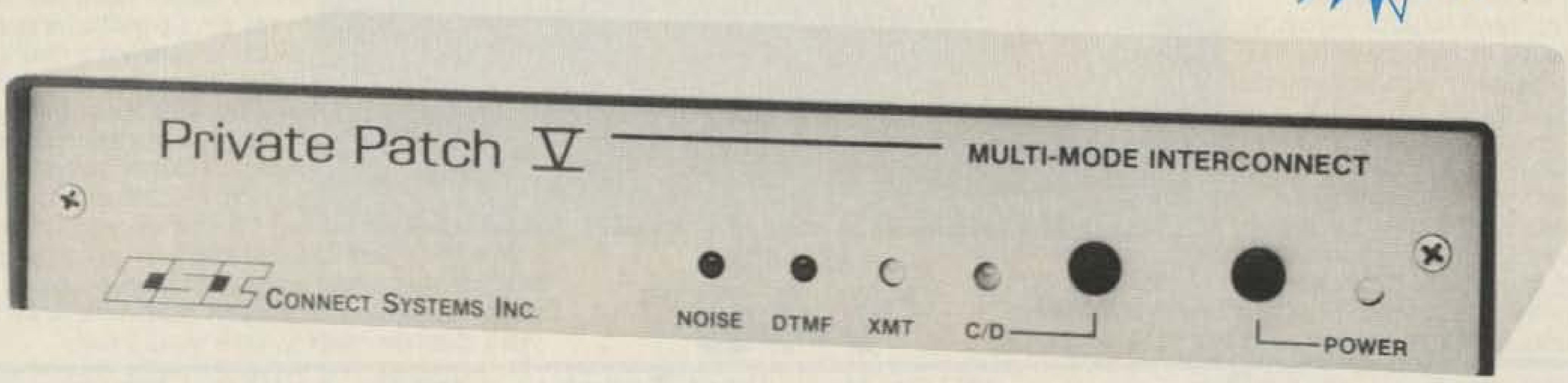

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MFJ's *Best* 300 Watt Tuner gives you minimum SWR from 1.8-30 MHz ... *plus* you get MFJ's new *peak* and average reading Cross-Needle SWR/ Wattmeter, dummy load, 4:1 balun, antenna switch and more ... $149.95

The MFJ-949D gives you more precise matches and lower SWR than **any** tuner that uses two tapped inductors. Why? Because you get two **continuously** variable capacitors that give you infinitely more positions than the **limited** number on switched coils.

This gives you the precise control you need to get your SWR down to a minimum. After all, isn't that why you need a tuner? Covers 1.8-30 MHz.

You get MFJ's **new** lighted 2-color **peak** and average reading Cross-Needle SWR/Wattmeter that shows you SWR, forward and reflected power - all at a single glance. Meter lamp uses 12 VDC or 110 VAC with MFJ-1312, $9.95.

MFJ-949D
$149.95

You get a 4:1 balun for balanced lines and a 50 ohm 300 watt dummy load for tuning your exciter.

You get a 6-position antenna switch for selecting 2 coax lines (direct or through tuner), random wire, balanced line or dummy load.

You get a beautiful black all aluminum cabinet that matches your rig. Its compact size (10x3x7 in.) fits right into your station.

With MFJ's **best** 300 watt PEP tuner you get an MFJ tuner that has earned a reputation for being able to match just about anything - one that is highly perfected and has years of **proven** reliablity. Order yours today!

2-knob *Differential-T*™ Tuner

MFJ-986
$269.95

The **new** MFJ-986 Differential-T™ 2-knob Tuner uses a differential capacitor to make tuning foolproof and easier than ever. It ends constant re-tuning with broadband coverage and gives you minimum SWR at only **one** best setting. Covers 1.8-30 MHz.

The roller inductor lets you tune your SWR down to absolute minimum. 3-digits turns counter lets you quickly return to your favorite frequency.

You get MFJ's **new** peak and average reading Cross-Needle SWR/Wattmeter with a **new** directional coupler for more accurate readings over a wider frequency range. It reads forward/reflected power in 200/50 and 2000/500 watt ranges. Meter lamp uses 12 VDC or 110 VAC with MFJ-1312, $9.95.

A **new** current balun for balanced lines reduces feedline radiation and forces equal currents into antenna halves that are not perfectly balanced for a more concentrated, stronger signal. Add $10 s/h.

MFJ's *Fastest Selling* Tuner

MFJ-941D
$109.95

The MFJ-941D is MFJ's fastest selling 300 watt PEP antenna tuner. Why? Because it has more features than tuners costing much more and it matches everything continuously from 1.8-30 MHz.

It matches dipoles, vees, verticals, mobile whips, random wires, banlanced and coax lines.

SWR/Wattmeter reads foward/reflected power in 30 and 300 watt ranges. Antenna switch selects 2 coax lines, direct or through tuner, random wire, balanced line or tuner bypass. Efficient airwound inductor gives lower losses and more watts out. Has 4:1 balun. 1000 V capacitors. 10x3x7 inches.

MFJ's *Random Wire* Tuner

MFJ-16010 **$39.95**

You can operate all bands anywhere with any transceiver when you let the MFJ-16010 turn any random wire into a transmitting antenna. Great for apartment, motel, camping operation. Install a wire anywhere! Tunes 1.8-30 MHz. 200 watts PEP. Ultra small 2x3x4 in.

MFJ's *Very Best* Tuner

MFJ-989C
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The MFJ-989C is not for everyone. ~~**However, if you do make the**~~ investment you get the finest 3 KW PEP tuner money can buy - one that takes the fear out of high power operation and one that lets you get your SWR down to absolute minimum. Covers 1.8-30 MHz.

The MFJ-989C is a compact 3 KW PEP roller inductor tuner with a new **peak** reading Cross-Needle SWR/Wattmeter with a new, more accurate directional coupler. Meter lamp uses 12 VDC or 110 VAC with MFJ-1312, $9.95. With **three continuoualy** variable components you get precise control over SWR **and** the widest matching range possible.

You get a two core balun wound with teflon wire for balanced lines a 6-position antenna switch.

10¾x4½x15 inch cabinetin your station. Dummy load, tilt stand, turns counter. Add $10 s/h.

MFJ's *Mobile* Tuner

MFJ-945C
$89.95

Don't leave home without this **mobile** tuner! Have an uninterrupted trip as the MFJ-945C **extends your antenna bandwidth** and eliminates the need to stop, go out and adjust your mobile whip.

You can **operate anywhere in a band and get low SWR.** You'll get maximum power out of your solid state or tube rig and it'll run cooler and last longer.

Small 8x2x6 inches uses little room. **SWR/ Wattmeter and convenient placement of controls make tuning fast and easy while in motion.** 300 watts PEP output, efficient airwound inductor, 1000 volt capacitors. Mobile mount, MFJ-20, $3.00.

144/220 MHz VHF Tuners

MFJ-921 **$69.95**

MFJ's new VHF tuners cover both 2 Meters and the 220 MHz bands. They handle 300 watts PEP and match a wide range of impedances for coax fed antennas. SWR/Wattmeter. 8x2½x3 in. **MFJ-920, $49.95.** No meter. 4½x2½x3 inches.

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$79.95 **MFJ-931**

You can create an artificial RF ground and eliminate RF "bites", feedback, TVI and RFI when you let the MFJ-931 resonate a random length of wire and turn it into a tuned counterpoise. The MFJ-931 also lets you electrically **place a far away RF ground directly at your rig** -- no matter how far away it is -- by tuning out the reactance of your ground connection wire.

Barefoot/1.5 KW Linear Tuner

MFJ-962C
$229.95

For a **few** extra dollars, the MFJ-962C lets you use your barefoot rig now and have the capacity to add a 1.5 KW PEP linear amplifier later. Covers 1.8-30 MHz.

You get two husky **continuously** variable capacitors for maximum power and minimum SWR. And lots of inductance gives you a wide matching range.

You get MFJ's **new** peak and average reading Cross-Needle SWR/Wattmeter with a **new** directional coupler for more accurate readings over a wider frequency range. It reads forward/reflected power in 200/50 and 2000/500 watt ranges. Meter lamp uses 12 VDC or 110 VAC with MFJ-1312, $9.95.

Has 6-position antenna switch and a teflon wound balun with ceramic feedthru insulators for balanced lines. 10¾x4½x14 7/8 inches. Add $10.00 s/h.

MFJ's *smallest* Versa Tuner

MFJ-901B
$59.95

The MFJ-901B is our smallest -- 5x2x6 inches -- (and most affordable) 200 watt PEP tuner --when both space **and** your budget is limited. Good for matching solid state rigs to linears.

It matches whips, dipoles, vees, random wires, verticals, beams, balanced and coax lines from 1.8-30 MHz. Efficient airwound inductor. 4:1 balun.

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CIRCLE 258 ON READER SERVICE CARD

Welcome, Newcomers!

You are about to embark on a journey into the fascinating hi-tech world of satellite communications. It won't cost thousands of dollars, and you don't even need a satellite TV dish. Just bring an open mind and an active curiosity.

The space age began on October 4, 1957, when Sputnik 1 achieved orbit and became the world's first artificial satellite. International tensions rose, but so did the excitement as scientists and engineers speculated on the potential of this man-made orbiting device. This was a radio in space. Hams took note.

A year and a half later, Don Stoner W6TNS mentioned a solid-state six-to-two meter repeater with solar power in his "Semiconductors" column in the April 1959 issue of *CQ Magazine*. The repeater was to be lofted by balloon over the Southwest. Don wrote, somewhat tongue-in-cheek: "Can anyone come up with a spare rocket for orbiting purposes?"

On the morning of December 12, 1961, OSCAR-1, amateur radio's first "hamsat," began transmitting from space. That was 27 years ago.

Today we have several hamsats. All have telemetry output, and many have transponders for communications. Earth stations range from shortwave to UHF and microwave systems. These stations have been built by amateur radio enthusiasts all over the world: UoSAT's from Great Britain; Fuji from Japan; RS units from the USSR; OSCARs by the U.S., West Germany, and others. They are in orbit *now*, just waiting for you to join the fun and use them.

In this special satellite issue you will find construction articles, tracking software and equipment reviews, satellite profiles, and informational topics on all facets of the amateur satellite program. Details of the program's history can be found in the ARRL Handbook and *The Satellite Experimenter's Handbook*. Our purpose is to show you how to get on the satellites today, and what to expect tomorrow.

Several new satellites are being readied for launch this year. Packet radio from space, digitized TV pictures from low-earth orbit, voice synthesizers with two meter FM downlink operation, and other modes, will make 1989 a banner year for AMSAT and its internationally affiliated organizations.

Care to know more? Read this issue! It's all here. You may find that your shack already has all the equipment needed for full-duplex amateur radio satellite activity. Join the fun in using the highest repeaters around. Make your next contact an OSCAR contact.

...de WA5ZIB

GLOSSARY

AMSAT—The Radio Amateur Satellite Corporation, whose purposes include satellite construction and education as a non-profit, membership-funded entity. For details call (301) 589-6062, or write to P.O. Box 27, Washington DC 20044.

AOS—Acquisition of Signal. When the satellite has appeared above your horizon for a pass.

A-O-10—AMSAT-OSCAR-10. The first amateur high-orbit communications satellite, launched in 1983.

A-O-13—AMSAT-OSCAR-13. Our newest and most complex amateur high-orbit communications satellite, launched in 1988.

Apogee—A satellite's position when it is furthest from the earth's surface.

Doppler Shift—The apparent frequency shift of signals as retransmitted through a satellite transponder.

Downlink—The space-to-earth signals coming from a satellite.

F-O-12—Fuji-OSCAR-12. An amateur radio satellite built by hams in Japan and launched in 1986 on a Japanese rocket.

Full Duplex—The ability to listen to your own signals as retransmitted via satellite.

Hamsat—Another name for an amateur radio satellite.

Keplerian Elements—A set of numbers used to define a satellite's orbit. Most tracking software requires input of these numbers to determine satellite availability.

LOS—Loss of Signal. When the satellite has completed its pass and has fallen below your horizon.

Mode—A letter description of a particular uplink/downlink frequency combination for a satellite transponder. For example: Mode "A" defines a two meter uplink and ten meter downlink operation.

OSCAR—Orbiting Satellite Carrying Amateur Radio.

Perigee—A satellite's position when it is closest to the Earth.

RS-10/11—The newest Soviet hamsat offering. These two devices are a part of the navigation satellite COSMOS 1861. They are a continuation of the "Radio" series begun in 1978 with RS-1 and RS-2.

Telemetry—Data transmitted by the satellite describing the health of the onboard systems. The format can be CW, RTTY, ASCII, PSK, or even synthesized voice.

Transponder—A linear "repeater" on a satellite that retransmits signals from one band to another. For example: An RS Mode "A" transponder takes a 40 kHz portion of two meters and translates it to a 40 KHz portion of 10 meters.

TVRO—TeleVision Receive Only. Television from space using microwave frequencies. Great fun to watch!

U-O-9—UoSAT-OSCAR-9. Built by hams at the University of Surrey in England, this low-orbit educational satellite transmits telemetry on many frequencies with a primary downlink on two meter FM. Launched in 1981, it is the oldest fully-functional hamsat.

U-O-11—UoSAT-OSCAR-11. The second University of Surrey hamsat was designed, built, and launched in six months. Launched in 1984, this hamsat continues the tradition of U-O-9 with several enhancements.

Uplink—The earth-to-space signals sent to a satellite.

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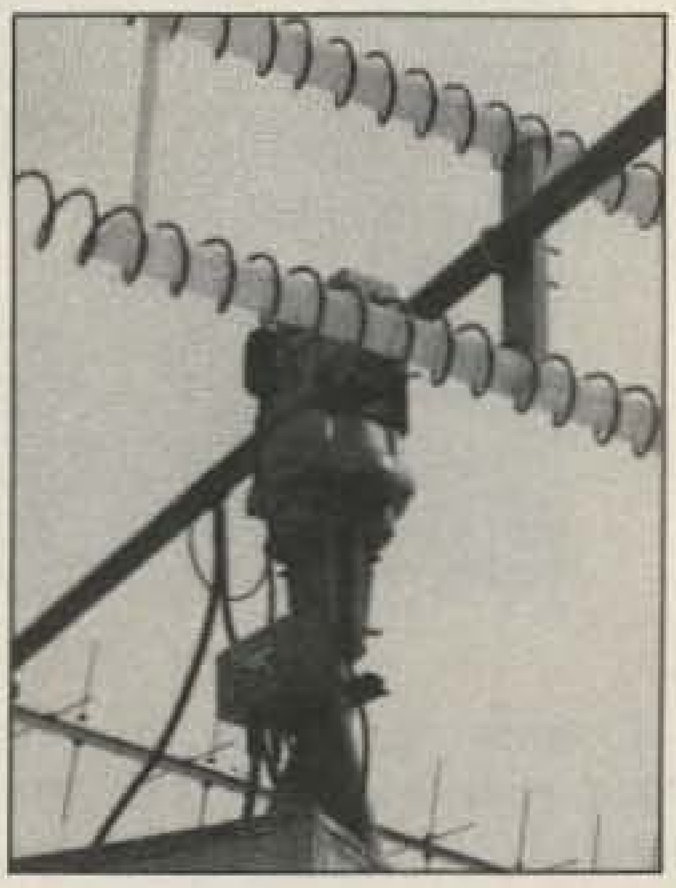
FEEDBACK... FEEDBACK!
It's like being there—right here in our offices! How? Just take advantage of our FEEDBACK card on page 17. You'll notice a feedback number at the beginning of each article and column. We'd like you to rate what you read so that we can print what types of things you like best. And then we will draw one Feedback card each month for a free subscription to *73*.



Cover Photo:
Keith Berglund WB5ZDP field testing his home-brew Mode-L dish antenna. (Photo by WB5ZDP.)

QRM

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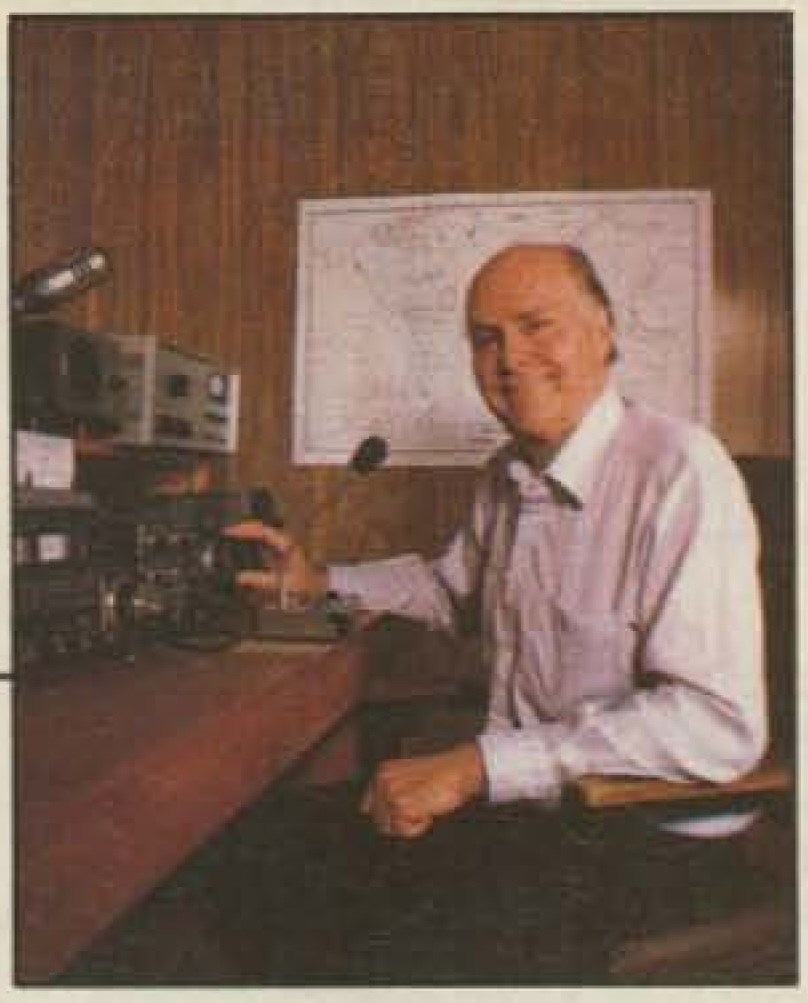

Legacy

As I look over the ominously growing Silent Keys list every month, often up to a full page these days, checking off old friends, I wonder what legacy all these hams have left to show for their existence. They've used our bands and enjoyed them, but what have they done in return?

Many that I have known well have contributed much to amateur radio. Most are like Bill Bennett W7PHO, who was commemorated at Dayton . . . after his death, naturally. Recently we lost Bill Hoisington K1CLL, who helped a whole generation of hams enjoy home building with his many articles in *73*. He took us from 160 meters up through 2,300 MHz with stuff any of us could build on our kitchen table—and with easy-to-get inexpensive parts. And that even included making the needed test equipment.

Bandel Linn (Pappy) K4PP entertained us with wonderfully creative, professionally drawn ham cartoons for over thirty years. Fortunately we had a bunch still in stock when Pappy had a stroke, so we were able to continue them in *73*.

No one who ever knew Sam Harris W1FZJ will ever forget him. In addition to being a major power behind ham moonbounce experimenting, he also developed the first parametric amplifier.

I've written about these chaps before, but I wanted you to remember them so you could think in terms of what legacy you will leave behind when you get that final mention in *QST*. Will you be remembered for anything? Or are you merely going to be one tiny increment in the number of hams who died in a particular year?

Will your going be lamented? Will you go knowing you helped amateur radio in some way—paid your dues? Or will you be remembered for your repeater jamming? The Colvins have given us hundreds of thousands of rare DX contacts over the last 30 years, while another well-known DXer lied and cheated, the epitome of the ugly American. He used fake calls, forged documents, even operated over 10,000 miles from his stated location!

Maybe being an all-time scoundrel is something—perhaps better than being a nothing. Ask any old-timers about W2OY, who was nationally known for his endless jamming and bad-mouthing of early SSB pioneers. Or Max Myers W2BIB, who jammed medical and State Department traffic from Africa. How about you? Have you ever been the president of your radio club and made it really work? How many new hams have you helped get into the hobby? How many service nets have you helped? How many times have you helped with phone patch traffic? How many articles have you contributed to the ham magazines? What pioneering have you done?

You don't even have to be an inventor or engineer to help a new technology get going. I got started in publishing when I discovered radioteletype back in 1948. Wow! I built and experimented and then built more. By 1951 I was desperate to find out what everyone else in RTTY was doing, so I started a newsletter. That quickly became a small magazine—Amateur Radio Frontiers—and that led to a RTTY column in *CQ*—which led to my becoming the editor.

I got involved with pioneering even earlier. When Jack Babkes W2GDG started experimenting with narrowband FM in 1946, I quickly built an NFM modulator into my Meissner Signal Shifter and turned off my 500 Watt modulator. At that time NFM was consigned to the top half of the 20m phone band, 14,250–14,300. Since virtually all phone was AM, the DX ops rarely ever operated in the kilowatt-packed, QRM-filled American phone band. Most of 'em operated below 14,200 and then listened from 14,200 on up for calls. Only a few ventured into the seldom-used 14,300–14,350 DX band, so DX contacts were hard to come by for us NFM pioneers.

If the receiver manufacturers had gone to the trouble of building in NFM detectors, we'd have expanded faster. You could copy the FM with an AM detector, but QRM from AM signals was serious. By 1957 the SSB handwriting was on the wall, so NFM moved up to the VHF bands, where it's the rule today.

If you're an engineer, technician, or scientist, you may be interested in working with the incredible potential of digital communications. If you're mainly a rag-chewer, you could do worse than get busy on packet radio and then get set up for satellite work.

Alas, I've known hundreds of hams who have passed on without having contributed anything whatever to amateur radio or the world. It's a pity to have such a powerful tool right there in your hands and then never think to really use it.

What have you done? Have you

QSL OF THE MONTH

To enter your QSL, mail it in an envelope to *73*, WGE Center, Forest Road, Hancock, NH 03449, Attn: QSL of the Month. Winners receive a one-year subscription (or extension) to *73*. Entries not in envelopes cannot be accepted.

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TS-711A/811A VHF/UHF all-mode base stations

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- **IF shift.**
- **"Quick-Step" tuning.** Vary the tuning characteristics from "conventional VFO feel" to a stepping action.
- **Built-in AC power supply.** Operation on 12 volts DC is also possible.
- **Semi break-in CW, with side tone.**
- **VS-1 voice synthesizer (optional)**

More TS-711A/811A information is available from authorized Kenwood dealers.

Optional accessories.

- IF-10A computer interface
- IF-232C level translator
- CD-10 call sign display
- SP-430 external speaker
- VS-1 voice synthesizer
- TU-5 CTCSS tone unit
- MB-430 mobile mount
- MC-60A, MC-80, MC-85 deluxe desk top microphones
- MC-48B 16-key DTMF, MC-43S UP/DOWN mobile hand microphones
- SW-200A/B SWR/power meters: SW-200A 1.8-150 MHz SW-200B 140-450 MHz
- SWT-1 2-m antenna tuner
- SWT-2 70-cm antenna tuner
- PG-2U DC power cable

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QRX . . .

EDITED BY BRYAN HASTINGS NS1B

Goldwater Endorses No-Code!

One of Amateur Radio's elder statesmen, Barry Goldwater K7UGA, recently came out in favor of establishing a no-code amateur radio license. "I think we can swell our ranks by at least 200,000 if we just allow young would-be amateurs to come in as licensed amateurs without having gone through the process of learning Morse Code!" Senator Goldwater made this comment among many on the subject in a videotaped interview record at his Scottsdale Arizona ranch on Saturday February 25, to newsman Roy Neal K6DUE, producer Frosty Oden N6ENV, and Newsline Radio's Bill Pasternak WA6ITF.

Look for the complete story on this announcement in an upcoming "Looking West" column.

Well Done, Andy

The staff of *73 Magazine* extends their thanks to Andy MacAllister WA5ZIB for coordinating the editorial material for this issue. Those who think this is an easy job have no idea of the vast amounts of time one spends in bookkeeping and follow-up. Even through the more drudge-filled moments, Andy never lost his cheerfulness and enthusiasm—and we dare say he was key to putting together one of the finest issues on hamsats to appear in print.

Home-brew Contest Deadline

You haven't yet gotten around to writing up your home-brew project to submit to our *Home-brew IV* contest? Now you have a reprieve—we have moved forward the deadline for article submissions for this contest by two months. Please note that the new deadline is July 1, 1989. (See announcement in box.) Ham fame and fortune still await you—but not much longer!

18 MHz/ 17 Meters

The FCC has opened the 18 MHz band for amateur operation. Stations with General, Advanced, or Extra-Class operations were allowed access to the 18 MHz band as of 0001 UTC 31 January 1989—1 minute after 7 pm EST Monday, 30 January 1989. A1A emissions are allowed in the whole band from 18.068 to 18.168 MHz. Digital emission F1B, for direct printing, telemetry, telecommand, and computer communications, is permitted below 18.110 MHz; and analog emissions, such as FAX, SSTV, and phone, may be used on 18.110 MHz and up. Maximum power limit is 1500 Watts, but amateur operations must not cause harmful interference to US Government fixed service operations. The authorization is contained in a report and order in PR Docket 88-467. Under its terms and those of WARC-79, the band goes exclusively to the Amateur Radio Service on 1 July 1989.

Suspend and Revoke

The FCC has acted in last year's Puerto Rico amateur examination fraud case by revoking the licenses of six hams and suspending the licenses of three others for six months. Losing their tickets are NP4H, KP4KB, WP4FOF, WP4FOG, NP4E, and NP4ZM. It has also been learned that WP4FOF and WP4FOG were 9 and 12 year old children when the phony exams were given. The six month suspensions went to WP4U, KP4FW, and KP4IN. Two other hams, NP4ZN and WP4GAW, returned their licenses to the FCC for cancellation to avoid getting involved in the investigation.

Canada: 220 MHz Under Siege

The entire 1-¼ meter band is now under siege in Canada. According to a bulletin from the Canadian Amateur Radio Federation, the Ontario Ministry of Government Services wants 220–225 MHz withdrawn from amateur service across Canada and reassigned for exclusive government use. This threat to the entire 1-¼ meter band is one of the biggest ever faced by Canadian amateurs.

It's not only the government, however, that's going after it. Golden West Broadcasting of Manitoba wants the band made available for stereo and monaural point-to-point broadcast remote pick-up use. The Lapp Hancock Company has filed for it to become another personal and business radio band. Radio Atlantic noted that the 220 to 225 MHz band is lightly loaded in Canada and suggests reducing it by two MHz and implementing a personal communications service. It's the stand, however, of the very powerful Canadian Electrical and Electronic Manufacturers Association that could cause the real problem for amateurs on both sides of the border. They have taken note of the re-evaluation taken by the American FCC and say that the Canadian government should consider joint implementation of any new services between 220 and 225 MHz with the United States! If this does not occur and Canada proceeds on its own, it will mean that another line-A protection zone will have to be established, one that will bar American hams in the northern tier of the United States from using the band.

Communications Canada is expected to issue a spectrum utilization study on the future use of all bands from 30 to 890 MHz during the summer.

AF Doomsday System

The Air Force quietly approved the final construction phase for a nuclear "doomsday" radio network. They concluded that the project can be ex-

$$ HOME-BREW IV $$

73 Magazine again invites all home-brewers to turn their hot solder into cold cash and prizes, and to get their name in print to boot. All projects have a chance to appear in the magazine, and we will handsomely reward the authors of the best of these.

Now for the bounty. Ramsey Electronics sweetened the pot from their line of frequency counters. First prize is $300, a 10-year subscription to *73*, and a CT-125 1.25 GHz frequency counter. Second prize is $150, a two-year sub, and a CT-90 600 MHz frequency counter. Third prize is $75, a two-year sub, and a CT-70 525 MHz frequency counter. All this is in addition to the payment every author receives for publishing in *73*.

Contest Rules

1. Entries must be received by 1 July 1989.
2. To enter, write an article describing your best home-brew construction project and submit it to *73*. If you've never written for *73*, send an SASE for a copy of our Writer's Guide, or download it from CompuServe (Hamnet forum, Library Ø., filename "73WRIT"). *Be sure to state on the submission that it is for the Home-brew IV contest.*
3. Here's the real challenge: The total cost of your project must be under $73, even if all the parts were bought new. Be sure to include a detailed parts list with prices and sources.
4. Our technical staff will evaluate each project on the basis of originality, usefulness, reproducibility, economy of design, and clarity of presentation. The decision of the judges is final.
5. All projects must be original. That is, they must not be published elsewhere. There is no limit to the number of projects you may enter.
6. All purchased articles become the property of *73 Magazine*.
8. Mail your entries to: *73 Magazine*
   WGE Center
   Forest Rd.
   Hancock NH 03449
   Attn: Home-Brew IV

QRX . . .

panded without harming the environment.

The decision to expand the so-called GWEN network of radio relay towers across the nation was made by Air Force Deputy Assistant Secretary James F. Boatright, said Kevin Gilmartin, a spokesman for the Air Force Electronic Systems Division at Hanscom Air Force Base in Massachusetts.

Approval of the final construction phase means the GWEN network ultimately will grow from 56 radio towers linking 38 terminals at military bases to 96 towers linking 49 terminals, the spokesman said.

GWEN, an acronym for Ground Wave Emergency Network, is a system of low-powered radio antennas and transmitters designed to ensure adequate communications links for US military forces following a nuclear attack. The Air Force says the network is needed to ensure that the President can give launch orders to Strategic Air Command bombers. The service aims to complete the expanded system by January 1992.

A typical GWEN station consists of a thin, 300-foot tower and three small shelters surrounded by a fence. The shelters house electronic equipment and an emergency generator and fuel. The stations normally require a 700 square foot parcel of land. The output of a GWEN station is less than 2,000 Watts.

The Air Force currently is completing construction of what it calls the "thin line" system of 56 GWEN towers. Fifty of those 56 towers are already operating, receiving, and relaying brief test messages every 20 minutes.

The initial system construction sparked public controversy, with citizens' groups in Massachusetts, Oregon, Pennsylvania, and California banding together to fight GWEN on the grounds the towers increase the likelihood of their towns becoming nuclear targets. The Air Force repeatedly dismissed those arguments, asserting that the isolated towers were not worth that type of targeting attention by the Soviet Union.

Don't Touch That Dial!

Kevin Mitnick N6NHG is back in the news. This computer-hacking ham pleaded not guilty on Friday, February 3, to an expanded indictment alleging illegal use of MCI phone codes. Kevin N6NHG of Panorama City, California, is also charged with infiltrating computer systems in the United States and England.

Mitnick remains housed at the Metropolitan Detention Center in Los Angeles, where he is forbidden to dial a telephone. Judge Pfaelzer earlier declared that Mitnick posed a very great danger to the community, and ordered him held away from direct personal telephone access and without bail shortly after his arrest.

Farscholar

The Foundation for Amateur Radio plans to award thirty-two scholarships for the 1989–1990 academic year. Licensed amateurs may compete for these awards if they plan to pursue a full time course of studies beyond high school and are enrolled in or have been accepted to enrollment in an accredited university, college or technical school. Some of the scholarships require the holding of at least an FCC General Class license or equivalent. Request additional information and an application from: The Foundation For Amateur Radio, FAR Scholarships, 6903 Rhode Island Avenue, College Park MD, 20740.

New UHF Amp

A new amplifying device can operate at much higher frequencies, and with lower noise, than traditional field-effect transistors. The High Electron Mobility Transistor (HEMT) device uses a new material system. Pioneered and developed by Hughes, the HEMT device uses indium phosphide as a substrate with gallium indium arsenide and aluminum indium arsenide grown onto it, one layer at a time, using a process known as molecular beam epitaxy.

In a HEMT device, the semiconductor material containing the impurities is separated from the region of charge-carrying electrons, allowing the electrons to move much faster. Potential uses include ultra-high frequency communication systems, high-speed radar signal processing equipment, and high-power millimeter-wave circuits.

Truly Turbo

The British are working on a neural network computer, a device whose memory is organized in much the same way as a human brain. US DARPA has estimated that the human brain contains 10^{11} neurons, each having roughly 1000 dendrites, giving the brain a storage potential of 10^{14} interconnects. Since nerves fire at 100 Hz, the human brain thus has the potential to make 10^{16} interconnects per second. This is far, far greater than the CRAY XMP1-2 supercomputer with its potential of 50×10^{6} interconnects per second. It's estimated that even a fly's brain can manage some 10^{9} interconnects per second!

Tubes 'R' Us

There are still many of us who use equipment with tubes. Radio Shack can still order nearly any common tube. And they carry a guarantee.

The recent catalog from Star-Tonics lists the following tubes available "new, most boxed" at prices from \$1.00 to \$3.00: 5Y3, 6AK5, 6AU6A, 6B8G, 6BZ7, 6BZ8, 6C6, 6CB6, 6CL6, 6CW5, 6DZ7, 6F8G, 6GU5, 6JU8A, 12AH7, 12AT7, 12AU7, 12AX7, 12BY7.

For further info, write to them at *PO Box 683, McMinnville OR 97127.*

South Africa

Radio RSA, the Voice of South Africa, has extended its amateur radio news coverage. Amateur Radio Spectrum, presented by Hans van de Gronendaal ZS6AKV, is a program dedicated to amateur radio and satellite communications. North America can hear the program, given good propagation conditions, during the week from 14:52–15:00 UTC on 26,790 MHz, and on Sunday at 02:45–02:59 UTC on 11.760 MHz, 9.615 MHz, and 9.589 MHz. Reception reports are welcome and will be confirmed by QSL card. Send reports to *Radio RSA, PO Box 4559, Johannesburg, 2000, South Africa.*

USSR DX

Victor UA1MU, who conducts a DX net for Arctic stations, Saturdays and Sundays at 0800 GMT on 14.150 MHz at 0800 GMT, invites stations worldwide to come on frequency and work some very rare DX for IOTA and various Soviet awards. KL7 stations are especially welcome.

Errata

Please take note of the following corrections in the March 1989 issue:

1) Heath HK-21 Review, p. 39, Figure 2. The black lead from the HK-21 is incorrectly shown wired to the tip of the miniature stereo plug. It should instead be wired to the plug shield (contact closest to the plug base).

2) QRX column, "Ham Radio Based Curriculum." Al Misunas' call is WB2RLO.

Thanks

To all who contributed to this month's QRX column. They are *Westlink, Indianapolis Star News, Worldradio, Modern Maturity Magazine*, ARRL, G8AUU, AMSAT-NA, Art Unwin KB9MZ, KD5RO, N6BVU, K5ZMS, G3VA, and NT2X. Keep your news items and photos rolling in to *73, Forest Rd., Hancock NH 03449, Attn: QRX*

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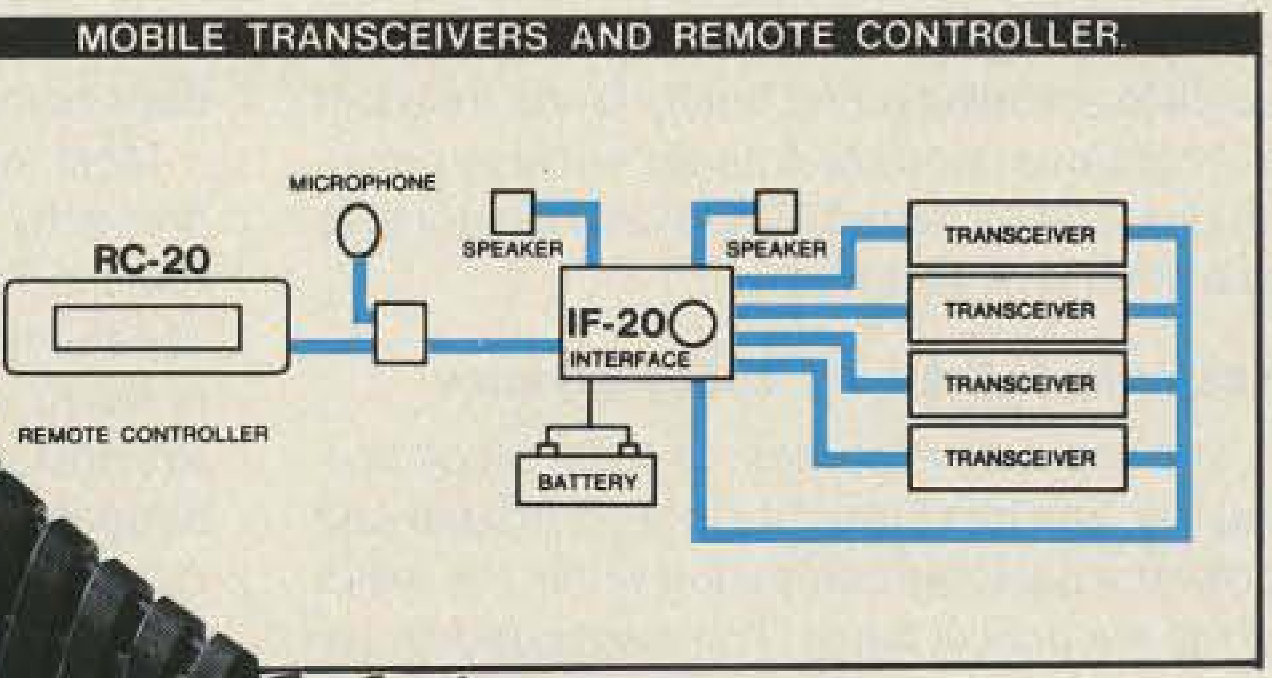
Stacked in Your Favor!

TM-231A/431A/531A

FM Mobile Transceiver

Looking for a compact transceiver for your mobile VHF and UHF operations? KENWOOD has a compact rig for each of the most popular VHF/UHF bands.

- **20 multi-function memory channels.** 20 memory channels allow storage of frequency, repeater offset, CTCSS frequency, frequency step, Tone On/Off status, CTCSS and REV.
- **High performance—high power! 50W (TM-231A), 35W (TM-431A) with a 3 position power switch (high, medium, low).**
- **Optional full-function remote controller (RC-20).** A full-function remote controller using the Kenwood bus line, model RC-20, may be easily connected to the TM-231A/431A/531A and can be mounted in any convenient location. Using the IF-20 interface the RC-20 may be connected to four mobile transceivers. (TM-231A/431A/531A or the TM-701A)
- **Multi-function DTMF mic. supplied.** Controls are provided on the microphone for CALL (Call Channel), VFO, MR (Memory Call or to change the memory channel) and a programmable function key. The programmable key can be used to control one of the following on the radio: MHz, T. ALT. TONE, REV, DRS, LOW or MONITOR.
- **Easy-to-operate illuminated keys.** A functionally designed control panel with backlit keys increases the convenience and ease of operation during night-time use.
- **Auto repeater offset on 144 and 220 MHz.**
- **Built-in digital VFO.**
  - **a) Selection of the frequency step (5, 10, 15, 20, 12.5, 25kHz)** *TM-531A: 10, 20, 12.5 25kHz
  - **b) Programmable VFO** The user friendly programmable VFO allows the operator to select and program variable tuning ranges in 1 MHz band increments.
- **Programmable call channel function.** The call channel key allows instant recall of your most commonly used frequency data.
- **Selectable CTCSS tone built-in.**
- **Tone alert system—for true "quiet monitoring"!** When activated this function will cause a distinct beeper tone to be emitted from the transceiver for approximately 10 seconds to signal the presence of an incoming signal.
- **Easy-to-operate multi-mode scanning.** Band scan, Program band scan, Memory scan plus programmable memory channel lock-out, with time operated or carrier operated stop.
- **Priority alert.**
- **DRS (Digital recording system).** The optional DRU-1 can store received and transmitted messages for up to 32 seconds, allowing the operator to quickly check or return any call using the tone alert system.
- **Automatic lock tuning function (TM-531A).**
- **Repeater reverse switch.**



Optional Accessories

- **RC-20** Full-function remote controller
- **RC-10** Multi-function remote controller
- **IF-20** Interface unit handset • **DRU-1** Digital recording unit • **MC-44** Multi-function hand mic. • **MC-44DM** Multi-function hand mic. with auto-patch • **MC-48B** 16-key DTMF hand mic. • **MC-55** 8-pin mobile mic.
- **MC-60A/80/85** Desk-top mics. • **MA-700** Dual band (2m/70cm) mobile antenna (mount not supplied) • **SP-41** Compact mobile speaker • **SP-50B** Mobile speaker • **PS-430** Power supply • **PS-50** Heavy-duty power supply • **MB-201** Mobile mount • **PG-2N** Power cable • **PG-3B** DC line noise filter
- **PG-4H** Interface connecting cable • **PG-4J** Extension cable kit • **TSU-6** CTCSS unit

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73 Review *by Gil Carman WA5NOM*

Silicon Ephemeris Tracker

Version 3.0 Satellite Tracking Program

Silicon Solutions, Inc.
P.O. Box 742546
Houston TX 77274-2546
Tel.: (713) 777-3057
Price Class: To Be Announced

Amateur radio pioneers established the Amateur Radio Satellite Corporation (AMSAT) to stimulate the development of knowledge, tools, and equipment which would bring satellite communications to the average amateur. Former AMSAT president, Tom Clark W3IWI, made perhaps the most important contribution, with his BASIC tracking program which was released in the late '70s.

This program used a very modest formulation. It included only the most significant factors which govern a satellite's orbital motion, and it produced results quite adequate for amateur use. Its universal design and minimum size made it easily adaptable to most of the small computers available in the newly emerging PC market. The amateur satellite enthusiast had finally found freedom from tedious pencil and paper tracking calculations, and he retired his OSCAR locator aids to a bottom desk drawer.

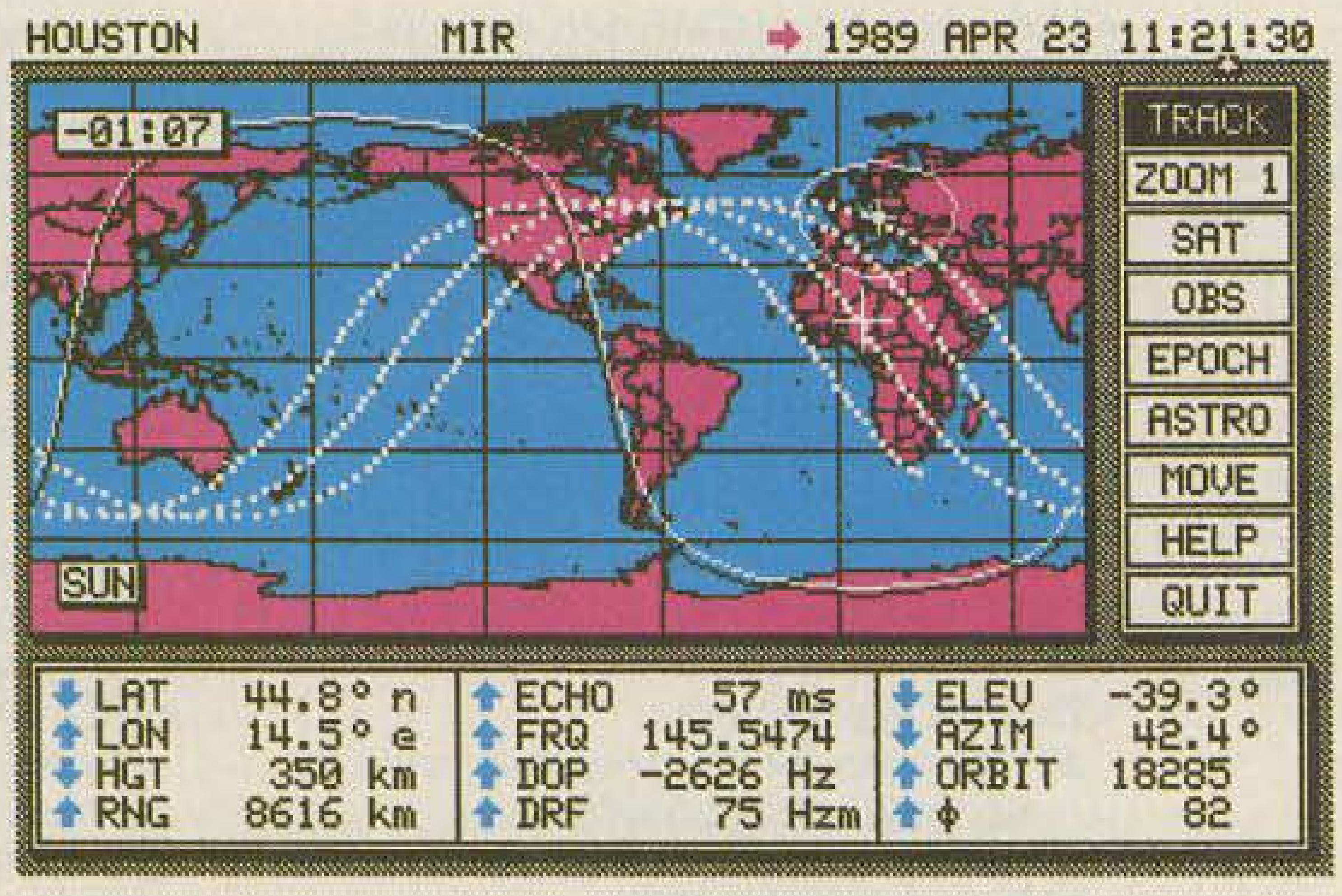

Figure 1. The world map with the satellite's current position and access area, or zero elevation contour.

Yesterday's Frills are Today's Basics

The rapid development in technology during the '80s has brought more affordable and powerful personal computing within the reach of the majority of hams. The most popular use of computers in the ham shack has long been satellite tracking; today, that distinction is perhaps being challenged by packet radio.

Most of the tracking software programs presently available from AMSAT have their roots in Tom Clark's original formulation, with variations in input and output features, depending on the capabilities of the operating systems and the hardware for which they are adapted. But the computer literate ham of modern times is no longer impressed by the slow and cumbersome software of past years. Color graphics, speed, and user friendly interfaces are now considered basic requirements.

Among the numerous offerings of tracking software available today, there is one which has been consistently considered by most amateur and commercial satellite users to be top of the line in abundance of features and ease of use. It is the GrafTrak II/Silicon Ephemeris package created by Joe Bijou WB5CCJ and Richard Allen W5SXD of Silicon Solutions, Inc.

Version 1.0 was first introduced in August 1985, following several years of development and verification. It is the first of a new generation of tracking software which uses the modern and powerful C programming language, and is not related to the IWI family. The version 2.0 upgrade in April 1987 added antenna and receiver control, as well as groundtrack plotting and automatic switching modes. It was difficult to imagine any additional tracking needs which version 2.0 would not fill, but the recently released version 3.0 offers many valuable enhancements to this already mature software.

System Requirements

GrafTrak II is the graphics-oriented program and Silicon Ephemeris is its tabular out-

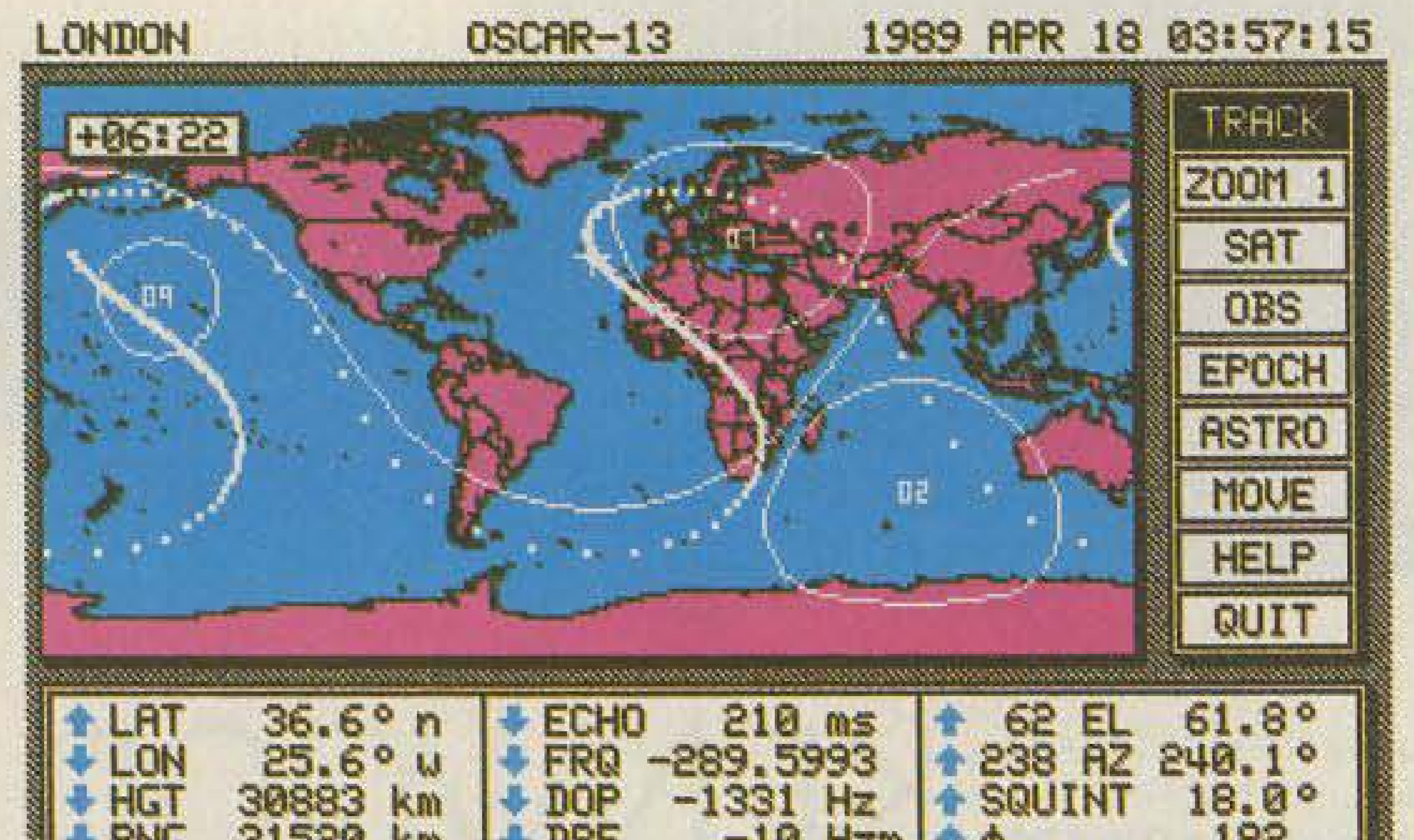

Figure 2. If latitude and longitude inputs define the satellite's orientation, the orbit number will be replaced with the antenna off-pointing (squint) angle with respect to the observer. The arrows to the left of each parameter indicate whether its value is increasing or decreasing.

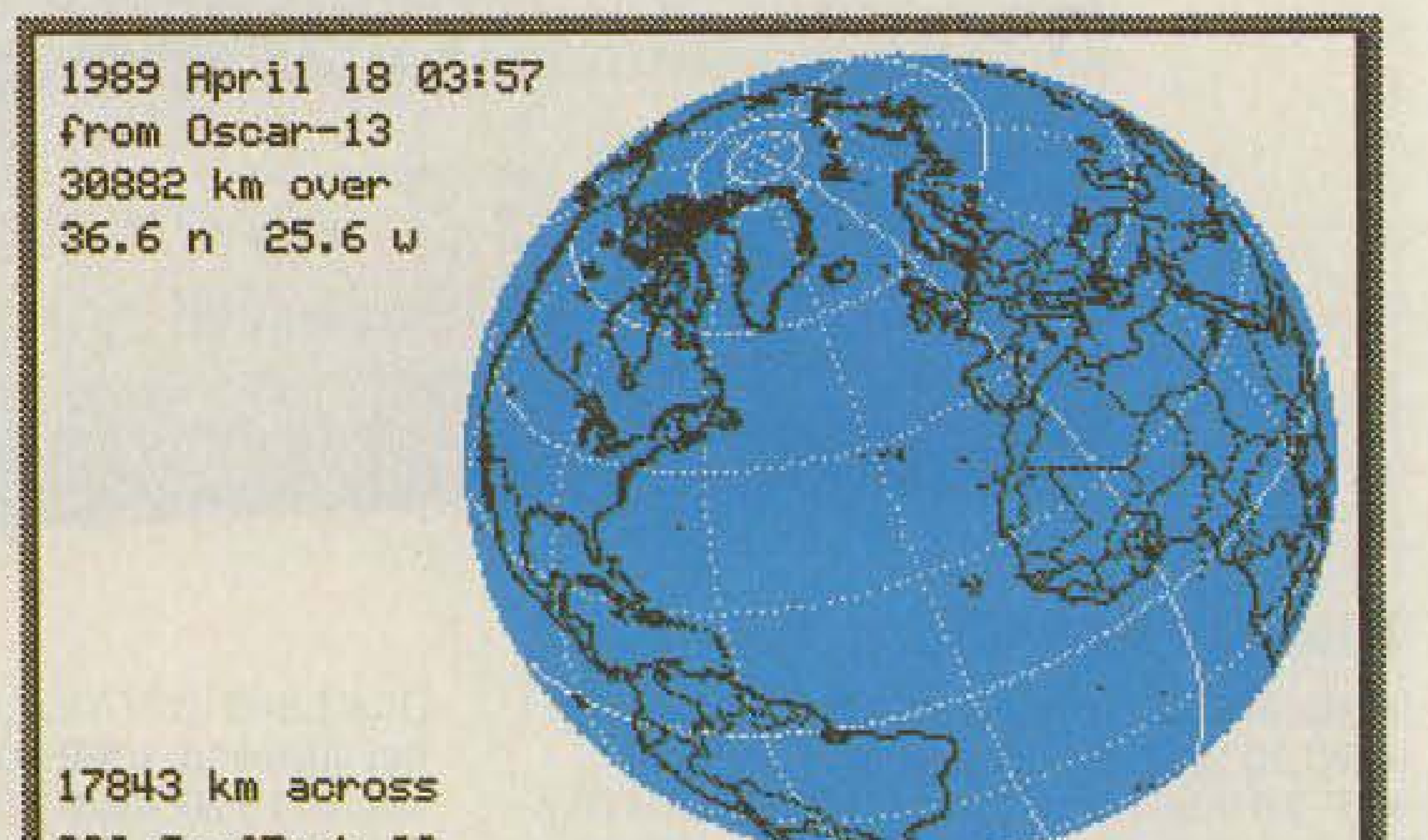

Figure 3. Press the "3" key to replace the track mode display with a three-dimensional perspective of the Earth as seen from the primary satellite.

put companion. The programs operate on the IBM PC, XT, AT, PS/2, and compatibles. The 8087/80287 math co-processor was required for previous versions, but now it is optional. Version 3.0 software will use the co-processor, if available, for improved performance, but it will run (significantly slower) without it. Systems based on the 80386 processor will provide a reasonable execution speed without the substantial investment in the 80387; however, I recommend the co-processor for the XT and AT compatibles unless you are blessed with extreme patience.

The minimum RAM requirement is 384K bytes, but you need 640K to make use of all available features. The graphics output is IBM 320 X 200 medium resolution with all CGA or EGA video adapters. EGA provides a much larger color spectrum to choose from. A single high density drive or two 360K floppy drives are minimum requirements to run GrafTrak; however, a hard disk is faster and more convenient. Initial program loading time has been significantly reduced in Version 3.0. It takes nine seconds on my IBM XT compatible, compared to 45 seconds for Version 2.0.

An excellent commercial quality illustrated manual is provided with the programs. It describes in detail all modes of operation and shows sample output. However, after a few minutes of initial setup and familiarization, you will find most of the commands to be intuitive single keystrokes, and with the help menu instantly available with a press of the "H" key, you seldom need to refer to the manual.

Display Features

After the GrafTrak program and data have been loaded, the display will show the world map with the satellite's current position and access area, or zero elevation contour (see Figure 1). This contour represents the Earth's horizon as seen from the satellite, and all observers within it will have line of sight access. In Version 3.0, this contour is not limited to zero elevation, but may be set for larger values if low-grazing passes are not of interest.

For satellites with downward (nadir) pointing, high-gain antennas, this coverage circle may be chosen instead to show a region within a nadir angle field of view as seen from the satellite. For weather and mapping satellites with downward pointing cameras, a swath-angle field of view may be defined, which will show a great circle arc normal to the groundtrack, indicating image width. Latitude and longitude grid lines may be included on the map display, if desired.

The first satellite and observer in the data base is initially selected by default if they have not been designated with command line tokens. These tokens may be included after the data base file name, in the same manner as batch file parameters, to set up all modes and options for the desired configuration at start up. To avoid the DOS command line limit of 128 characters, or just for editing ease, these tokens may be read from an ASCII text file. The selected primary observer and satellite are indicated at the top of the display. The current date and time are shown in UTC, as determined by the DOS clock. If you keep your DOS clock in local time, you must define the number of hours to add in the file OFFSET.GMT.

The numerical information at the bottom shows all pertinent tracking parameters, including satellite latitude and longitude, height, range to the observer, echo time delay between an observer's uplink signal and the returned downlink, Doppler shift, drift rate, the Doppler corrected beacon frequency, elevation and azimuth as seen from the observer, orbit number, and phase angle (mean anomaly count). If the data base includes bahn latitude and longitude inputs defining the satellite's orientation, the orbit number will be replaced with the antenna off-pointing (squint) angle with respect to the observer (see Figure 2). An arrow to the left of each parameter indicates if its value is increasing or decreasing.

```
Silicon Ephemeris          V3.00       Copyright (C) Silicon Solutions, Inc.

      Mode  0 = exit to Operating System

      Mode  1 = one observer to all satellites
      Mode  2 = all observers to one satellite
      Mode  3 = schedule for one observer to one satellite
      Mode  4 = window between two observers and one satellite
      Mode  5 = rise and set times for one satellite
      Mode  6 = time ordered alerts for all satellites
      Mode  7 = one observer to all satellites (astro)
      Mode  8 = all observers to one satellite (astro)
      Mode  9 = schedule for one observer to one satellite (astro)

      Mode 10 = detailed ephemeris for Sun/Moon
      Mode 11 = all observers to Sun/Moon
      Mode 12 = schedule for one observer to Moon
      Mode 13 = window between two observers and Moon
      Mode 15 = schedule for one observer to Sun
      Mode 18 = Sun/Satellite visibility

      Mode 20 = select a new database file

                              Enter mode (       1 ) : ___________
```

Table 1. Silicon Ephemeris main processing modes.

```
Silicon Ephemeris          V3.00       Copyright (C) Silicon Solutions, Inc.
observer(s): Houston                                        object(s): all

             Amateur Radio passes for Houston, April 23
```

date	object	beacon	rise	tca	set	elev	az
Sun 23Apr89	FO-12	435.7950	00:14:26	00:26:12	00:37	49	128
Sun 23Apr89	Oscar-9	145.8250	02:00:44	02:05:00	02:09	16	72
Sun 23Apr89	Oscar-11	145.8250	02:07:10	02:12:15	02:17	10	66
Sun 23Apr89	FO-12	435.7950	02:16:06	02:28:02	02:39	49	325
Sun 23Apr89	Oscar-9	145.8250	03:32:58	03:37:25	03:41	16	264
Sun 23Apr89	Oscar-11	145.8250	03:42:16	03:49:04	03:55	59	260
Sun 23Apr89	FO-12	435.7950	04:21:18	04:32:04	04:42	22	348
Sun 23Apr89	Oscar-11	145.8250	05:25:05	05:27:04	05:29	1	271
Sun 23Apr89	FO-12	435.7950	06:26:20	06:37:16	06:48	24	16
Sun 23Apr89	FO-12	435.7950	08:28:53	08:40:59	08:53	57	38
Sun 23Apr89	RS-10/11	29.4070	09:48:15	09:55:55	10:03	21	86
Sun 23Apr89	FO-12	435.7950	10:31:03	10:42:34	10:54	40	234
Sun 23Apr89	RS-10/11	29.4070	11:32:36	11:41:13	11:49	44	279
Sun 23Apr89	FO-12	435.7950	12:38:13	12:42:55	12:47	2	244
Sun 23Apr89	RS-10/11	29.4070	13:26:15	13:28:22	13:30	1	295
Sun 23Apr89	Oscar-9	145.8250	14:58:56	15:03:53	15:08	36	99
Sun 23Apr89	Oscar-11	145.8250	15:45:04	15:51:51	15:58	53	99
Sun 23Apr89	Oscar-9	145.8250	16:32:27	16:36:02	16:39	7	291
Sun 23Apr89	Oscar-11	145.8250	17:23:29	17:28:44	17:33	11	293
Sun 23Apr89	RS-10/11	29.4070	20:53:01	21:00:10	21:07	14	73
Sun 23Apr89	RS-10/11	29.4070	22:37:30	22:46:19	22:55	66	268
Sun 23Apr89	FO-12	435.7950	23:21:23	23:32:26	23:43	30	124

```
Sun 23Apr89 passes =  22
```

Table 2. Result of using Mode 6 selection from Table 1. The tracked birds are all LEOs (Low Earth Orbiters).

The initial display is in the real time track mode, with the map and numerical information updating once per second. The satellite's position is normally shown at the center of the screen with the world map scrolling in the background. The map may also be set to remain centered on a selected longitude, if desired, with the satellite moving instead (Figure 1). The display may be stepped forward or backward in time by simply using the cursor keys to move an arrow indicator to the date or time item to be changed, then bumping it up or down with the + or − keys, respectively. An Epoch mode is provided to allow faster selection of a specific date and time, with the map display inhibited until return to the track mode. You may freeze the display at any time or activate the automatic fast forward mode. You will see an arrow to the left of the date to remind you when the display is not at current time. The escape key will restore the current date and time.

Many Functions

You have a large number of commands for performing special functions, such as finding rise and set times, drawing groundtracks, displaying the daylight/darkness sun line, or switching to a new satellite or observer. You select most of these functions with a single key stroke. By pressing the "H" key, you can display the multi-page help menu of all commands. Three different zoom magnifications are available which you may select manually or invoke with the auto zoom mode. This mode will automatically choose the largest map magnification that will show both the satellite and observer locations on the screen at the same time.

The auto-switch mode will determine which satellite has the nearest upcoming acquisition time, and select it as the primary object. While in the auto-switch mode, an audio alarm will sound every minute, starting at five minutes before the expected rise time of the selected satellite. A long warble sound announces the rise and set. This alarm feature helps prevent a pass from occurring unnoticed, and you may also activate it while tracking a single satellite. It will continue to track the selected satellite until the satellite sets. Then it will search for the next available satellite. Time from the current satellite's rising is also shown on the display during auto-switch mode.

Press the "3" key to replace the track mode display with a three-dimensional perspective of the Earth as seen from the primary satellite or celestial object being tracked (see Figure 3). This view may also be generated for any extraterrestrial observation point by specifying its latitude, longitude, and altitude relative to Earth.

Perhaps the most significant new enhancement in Version 3.0 is the alternate satellite display capability. Since the auto-switch selection of a high altitude satellite like OSCAR-13 can last for several hours, opportunities for others like FO-12 might go unnoticed if it were not for this feature. You may include coverage circles in the display for as many additional satellites as you desire, with each identified by its menu number (see Figure 2). This capability also greatly simplifies the rather complex task of determining multi-satellite crosslink opportunities. Two satellites are within mutual

Continued from page 14

line of sight when their horizon circles are overlapping.

Data Base Management

With GrafTrak II's editor, you can create and edit the data files. Each file contains information for as many as 16 satellites and 16 observer locations. The working data file is specified on the command line when the program is loaded, and you may change it later. You can create as many data files as you need. Using the editor, you may write out or read in individual satellites or observers to rearrange their order or to transfer data between files.

The input satellite orbital parameters are the standard NORAD mean Keplerian elements, which you may either enter manually or read in from an ASCII text file in the two-line format of the NASA prediction bulletins. You may load the editor and run it as a DOS gateway function from GrafTrak if you have at least 640 K of memory. GrafTrak will remain loaded during editing and retain all previously set modes.

Accurate Orbital Information

Accurate orbital information is the most important key to successful satellite tracking. Regularly updated elements are available from several dial-in bulletin boards and packet radio services. You may obtain data for the amateur radio and weather satellites from the weekly AMSAT bulletins at the WDØGML BBS in St. Louis at (314) 447-3003. Silicon Solutions is developing a processor which will automatically update the GrafTrak data files from the AMSAT bulletin format. The Celestial RCP/M BBS operated by Tom Kelso in Fairborn, Ohio, (513) 427-0674, maintains up-to-date two-line elements for about 60 of the most commonly requested satellites.

I use a batch process of my own design which, with the press of a single menu key, automatically dials the bulletin board, downloads the current file of two-line elements, hangs up, extracts the satellites I use, and reads them into the GrafTrak data file by preloading the keyboard buffer with the required editor keystrokes. Those who have not yet joined the world of digital communications may obtain the NASA prediction bulletins by mail, free of charge, from *The NASA Goddard Space Flight Center, Code 513, Greenbelt MD 20771.*

In addition to the Keplerian elements, a beacon frequency may also be specified for each satellite. The tracking display will output the Doppler shift and drift rate resulting from the satellite's motion relative to the observer. For two-way operation through satellites that have inverting transponders, like OSCAR-13, I prefer to input the beacon frequency as the downlink minus the uplink frequency at the passband center. The Doppler output will then be the correction which you add to the nominal transponder sum.

For example, if you wish to zero beat a station, and the Doppler shows 2.1 kHz, simply transmit 2.1 kHz above the normal uplink frequency. This will put you very near zero beat without the typical "VFO sweeping" to find your downlink. This method will result in a meaningless frequency display (Figure 2), but I have found the two-way Doppler information more useful. If you want only the one-way Doppler, input the nominal beacon frequency and the display will show the Doppler-corrected downlink.

Automated Rotor and Receiver Control

One of the best features is the antenna rotor control, or auto-tracking capability, which provides serial port output of azimuth and elevation pointing commands to an external ARRL compatible interface unit (*QST*, September 1986, p. 40). Automatic receiver frequency control for downlink Doppler drift compensation is also included for external Yaesu FRG-9600 compatible units. These modes provide hands-off computer antenna pointing, greatly easing the operating task, especially for low-altitude satellites like FO-12.

When the antenna control is active, the elevation and azimuth displays are modified to show both the desired pointing angles and the current rotor positions as read from the interface (Figure 2).

Antenna and receiver controls were first available in version 2.0, but some enhancements have been made in version 3.0, such as a FLIP option to avoid azimuth rotor hard-stop reversals during a pass. This uses the inverse tracking technique (when required) of pointing the azimuth directly opposite the satellite's direction and redefining the horizon at an elevation of 180 degrees. Of course, your elevation rotor and interface unit must be capable of 180 degrees of rotation to use this feature. Antenna pointing is normally disabled when the display is not at current time because the satellite will not be there, but you may activate it for testing.

An optional software driver is available for the Kenpro KR-010 interface, and assembly source code is provided for a memory resident station control program which may be customized to meet your own interface needs. In addition to the kit offering from A&A Engineering, which you will find in the *QST* article, compatible units are also available from *Mirage Communications Equipment, Inc., PO Box 1000, Morgan Hill CA 95037* and *L.L. Grace Communications Products, 41 Acadia Drive, Voorhees NJ 08043.*

Astronomical Tracking Modes

The tracking calculations are not limited to manmade Earth orbiting satellites. By selecting the astronomical mode, tracking information will be displayed for either the Sun, Moon, or a Star. There is no built-in menu of stars or planets to choose from, but you may input the inertial right ascension and declination of a celestial object. All satellite functions, such as groundtrack plotting, rise and set searches, three-dimensional Earth views, and even antenna pointing for EME operations are available in the astronomical mode.

The position and pointing calculations in astronomical mode are accurate to better than one arc minute for any epoch within 2000 years of the current date. The time-keeping functions are performed in true Julian date, eliminating the need for annual sidereal time updates and leap year difficulties which have plagued other tracking software.

If you have an interest in visual sightings of satellites, the GrafTrak/Silicon Ephemeris combination is definitely the software for you. You can make a fast check for visual opportunities by selecting one hour after sunset (or, for morning passes, before sunrise) and stepping the time forward in one-day increments until the groundtrack "walks" its way over to your location. The Sun/Satellite visibility mode of Silicon Ephemeris provides detailed pointing and lighting tables for all periods when the satellite is in sunlight above your horizon, with the Sun elevation below the desired value.

The passes with best visibility usually occur when the sun is about 12 degrees below the horizon; however, the brighter satellites, like *Mir* and the space shuttle, can be seen in twilight under favorable conditions.

You can save the screen images on disk as picture files and recall them later. A utility program called SHOW can load several of these files into RAM and display them consecutively in a repeating animation sequence. You may set the speed of this animation as desired. It's especially effective in creating demonstrations, such as a "satellite's-eye view" of the Earth in orbit, a perpetually spinning Earth as seen from the moon, or the annual figure eight analemma of the Earth's motion as seen from the sun.

Tracking Table Printouts

Silicon Ephemeris is the tabular output companion to GrafTrak. It includes 18 different modes of tracking data calculations which will satisfy the most demanding satellite enthusiast or EME operator. See Table 1 which shows the main menu of processing modes. The multi-satellite and multi-observer modes are very useful as real-time screen displays of mutual access geometry, but they may also be used to search for an event or verify an event at a desired date or time. The schedule and window modes fill the need for long-range predictions when printed output is required for planning future operating times.

Use Modes 4 or 13 for communication opportunities, when two observers will have simultaneous access to a satellite, or for EME (moonbounce) operation. I have used Mode 6 most often, since acquisition times for all low-altitude satellites in the data base file are output in the order in which they occur (see Table 2), eliminating the need to cross reference several printouts. This way you can be sure not to miss an opportunity. However, as a result of its fast analytical formulation, this mode will not include the high elliptical orbit satellites, like OSCARs 10 and 13. You may obtain tabular tracking data for Phase 3 orbits, which may have unusual groundtrack geometry, with Modes 3 and 5. These are slower, recursive search modes.

You're not likely to find a more complete satellite tracking system anywhere! 73

FEEDBACK

In our continuing effort to present the best in amateur radio features and columns, we recognize the need to go directly to the source—you, the reader. Articles and columns are assigned feedback numbers, which appear on each article/column and are also listed here. These numbers correspond to those on the feedback card opposite this page. On the card, please check the box which honestly represents your opinion of each article or column.

Do we really read the feedback cards? You bet! The results are tabulated each month, and the editors take a good, hard look at what you do and don't like. To show our appreciation, we draw one feedback card each month and award the lucky winner a free one-year subscription (or extension) to *73*.

To save on postage, why not fill out the Product Report card and the Feedback card and put them in an envelope? Toss in a damning or praising letter to the editor while you're at it. You can also enter your QSL in our QSL of the Month contest. All for the low, low price of 25 cents!

Inexpensive Mode-L Dish Antenna

Pay little and gain much.

by Keith Berglund WB5ZDP

With Mode-L now a reality on AMSAT OSCAR-13, my thoughts turn towards which antenna I should use. There are a few commercially available, but none of them are circularly polarized, and all are more expensive than I would have liked. A $125 price tag is not expensive to some hams but, on the other hand, if you have access to a drill press, a hacksaw, and $30, you can walk into your local hardware store and end up with a 23.5 dBi gain antenna that will give you a bodacious signal through the bird.

How Big?

In theory, a parabolic dish is pretty simple. Merely take a low gain feed antenna at the focal point, point it at the parabolic reflector, and Blammo! The RF energy is focused into a tight, high gain beam. This antenna is no exception, so the project can be divided into two parts: the dish and the feed antenna.

You must first determine how much gain you would like out of your antenna. As you would expect, gain equals size. The bigger the dish, the bigger the gain. A simple formula that relates these factors is: $G(dBi) = 7.5 + 20 \text{ Log } d + 20 \text{ Log } F$, where d = the diameter of the dish in feet, and F = the frequency in GHz. So, for example, the gain of a five foot dish at 1269 MHz would be $7.5 + 13.98 + 2.07 = 23.55$ dBi.

Next, you must determine the shape of the dish. A graph of the dish can be determined by using the formula: $Y = X^2/(4*f)$, where Y = the Y coordinate, X = the X coordinate, and f = the focal length in inches (distance from dish origin to the feed antenna).

I used a simple hand calculator to plot X as a function of Y for X values from zero to 30 inches in one-inch increments. Thus, 30 inches corresponds to half of the parabolic shape of a 60-inch (5-foot) dish. I chose an "f" of 24 inches, which corresponds to a focal-length-to-diameter ratio of 0.4 (60/24). The 0.4 ratio is a good choice for the feed system that I selected (more on that later) and is easy to construct.

Construction

Enough about theory. How do you build it cheaply?

The first thing to do is to take the points calculated above and turn them into something tangible. Get a piece of old 4'x 2' ½-inch plywood (or equivalent), and mark the full-scale X and Y coordinates on it with a black marker pen. At zero, and then at increments of one inch, drive nails into the curve. After 30 points, and 30 nails, you will have a rugged template to work with.

Go to your local hardware store and get some ½-inch electrical conduit. It's cheap, available, and bendable. A 10-foot piece costs less than three dollars. You will need three of these pieces to make the "spokes" of the dish. Use an ordinary hacksaw to cut eight 32-inch spokes. Then, using a bench vise as a conduit bender, carefully bend the pieces to conform to the wooden template, generating eight spokes. If you have access to a real conduit bender, by all means use it. Be careful not to bend the conduit too much as it will permanently kink. At this point, drill two ¼-inch holes completely through the conduit at 1 inch and 2 inches from zero to accommodate mounting.

The center hub that everything attaches to consists of two pieces of ⅛-inch aluminum sheet cut into an octagon shape and drilled as shown in Figure 1. Every 45 degrees, drill two holes for each "spoke". This hole pattern also allows for a 1-inch plumbing floor flange to be mounted to the bottom of the bottom plate, and a ¾-inch floor flange to be mounted to the top of the top plate. The 1-inch flange may have to be redrilled to accommodate the hole pattern of the hub, but this is can be done easily using a drill press. These flanges are designed to accommodate a piece of 1-inch pipe to act as a mounting pole for the dish, and a ¾-inch piece of pipe to accommodate the feed antenna (more on this later).

After assembling the hub and spokes as shown in Figure 2, you'll have a five-foot, eight-legged spider!

Adding The Screen Wire

While you're at the hardware store, buy 20 feet of ordinary metal screen. Before the screen wire can be added, it must have something to attach to. Drill a ⅛-inch hole through the end of each spoke so that a piece of 16 AWG wire can be strung around the outer perimeter of the dish. The two ends of the wire are held together and tightened by a small screen door turnbuckle (see Figure 3). Next, on the inside of the dish, starting about ¼ inch in from the outer perimeter, drill a ⅛-inch hole every four inches along each leg.

Continued on page 91

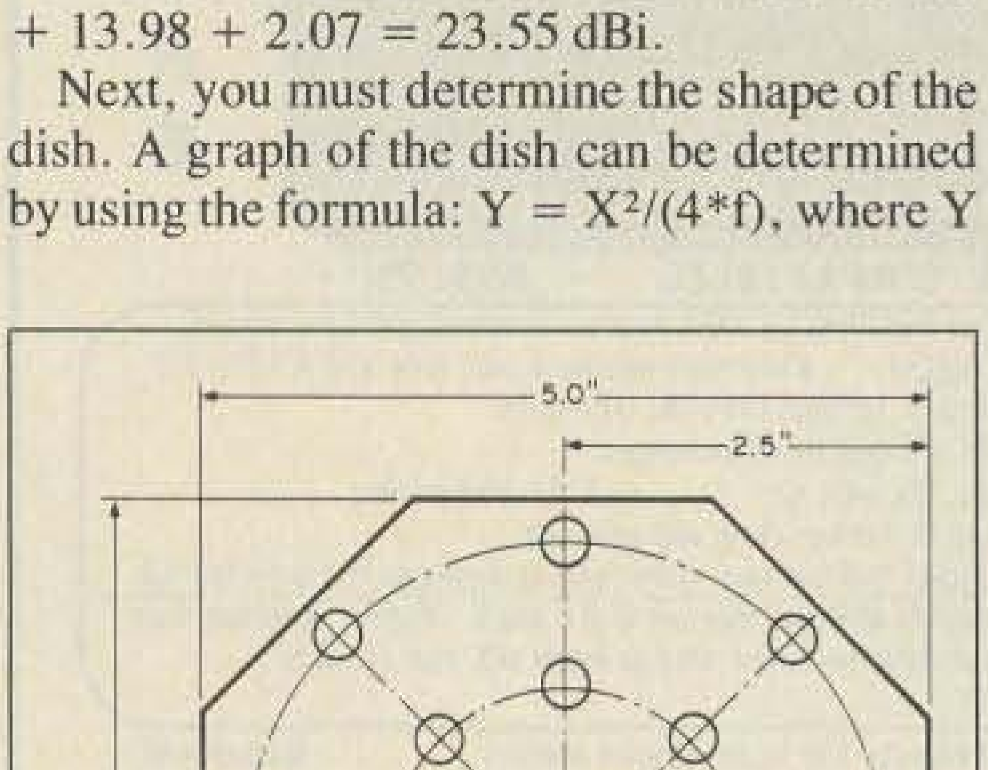

Figure 1. Center hub of the Mode-L antenna. It consists of two pieces of ⅛-inch aluminum sheet cut into an octagon shape and drilled.

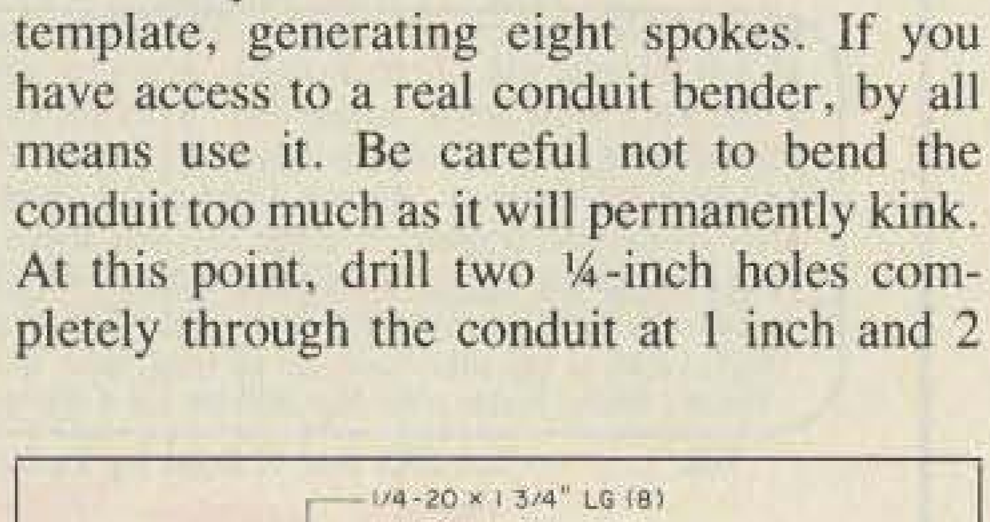

Figure 2. Assembling the spokes on the antenna hub.

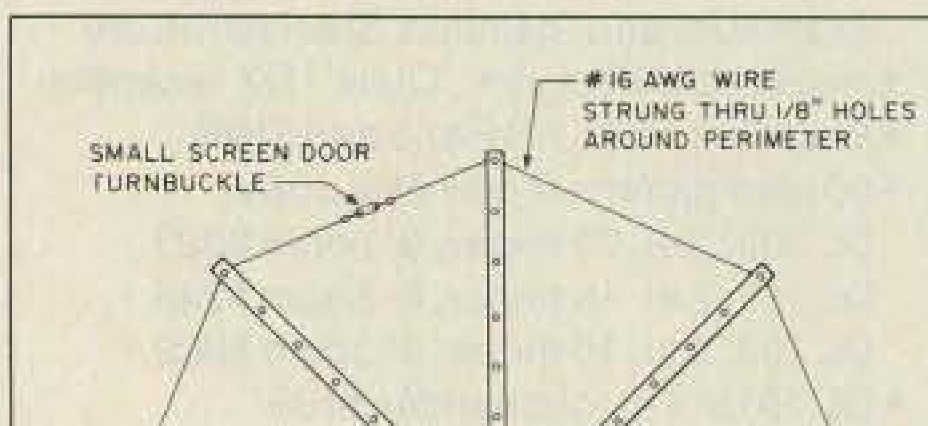

Figure 3. Frame of the Mode-L antenna.

Decoding OSCAR Telemetry—Part I

Learn all about the state of the birds.

by James R. Miller G3RUH

Tune to 145.8-146.0 MHz SSB at some hour any day, and chances are you'll hear the familiar sound of hams enjoying an OSCAR-13 contact. But search around on 145.812 MHz SSB, and you'll hear something different—a rhythmic purring sound. That's OSCAR telemetry, the satellite's signals telling us just how things are up there.

All satellites broadcast telemetry. Some do nothing else. There are four sending data now, and at least four more in the pipeline. This telemetry data is available for anyone to enjoy—now! All you need is a little electronics, a decoder to turn that whirring noise into digital form, and a terminal, as with packet radio, to display it.

And that's when the fun begins. You can read the mail, download the bulletins, keep up-to-date on OSCAR-13 operations, decode the numerical data and learn about the space environment, study a spacecraft's health, or like me, do all of these!

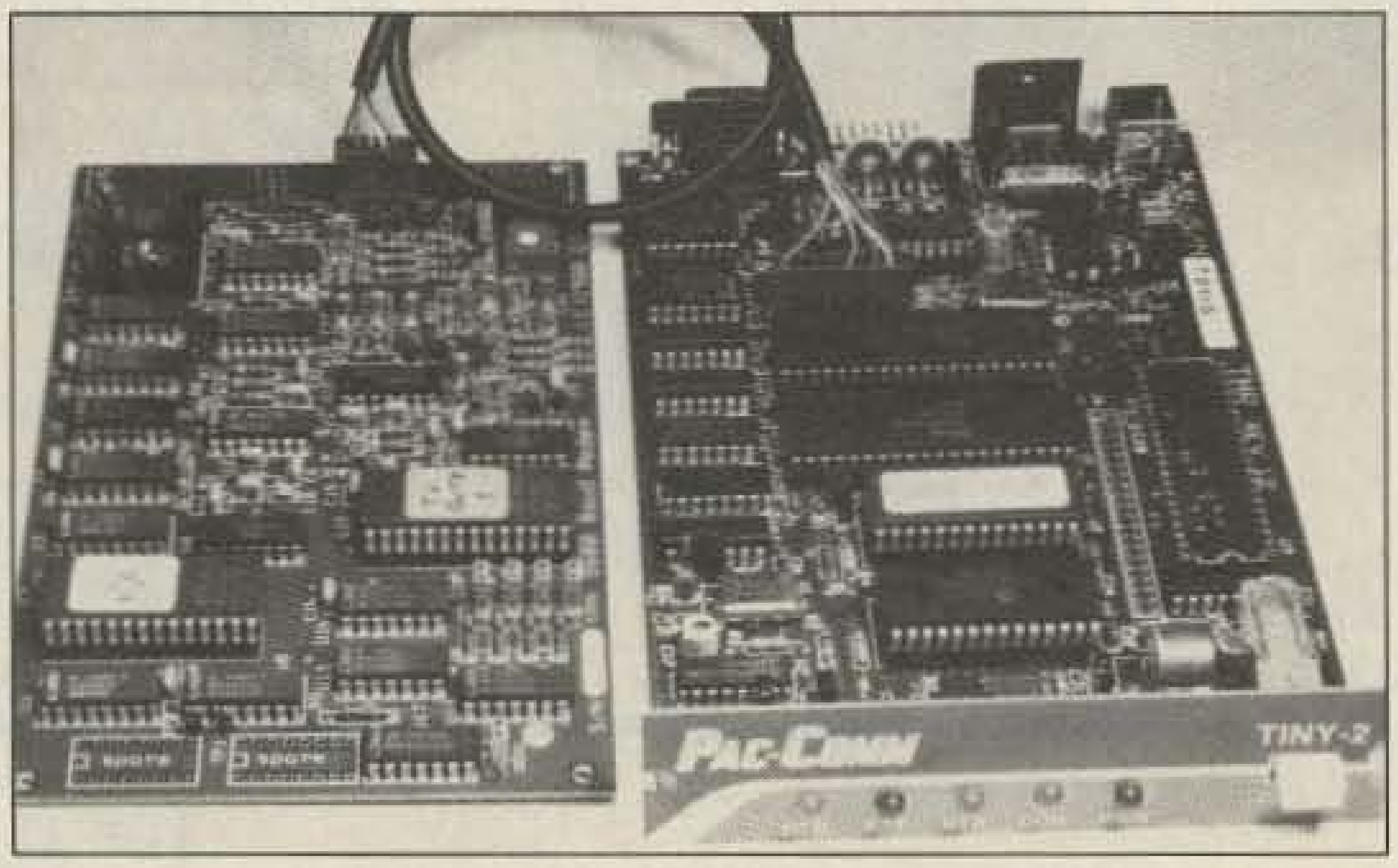

Photo A. 9600 baud modem for packet radio and UoSAT-D linked to the modem disconnect header of Pac-Comm's Tiny-2 TNC. One EPROM contains data for a "finite impulse response" digital filter that precisely shapes the transmitted audio waveform for minimum bandwidth. The other is part of a high resolution digital phase-locked loop for clock recovery. EPROMS are supplied with the PCB.

In the last few years I've supplied over 2000 decoder PCBs to hams to help them unlock the secrets of OSCAR telemetry. Maybe you'll be next!

In Part I, I focus on three satellites: OSCAR-9 (UoSAT-1), OSCAR-11 (UoSAT-2), and OSCAR-13 (P3C). Look for telemetry info, Fuji-OSCAR-12 (UoSAT-D), and the four microsats in Part II, to appear in the June '89 issue of *73*.

The Telemetry Decoder

Surprisingly, you can decode some telemetry with very simple equipment. UoSAT sends very strong signals you can receive on a regular FM HT several times a day at 145.825 MHz. To turn the audio you hear into an RS-232 digital stream, all you need is a simple decoder circuit consisting of two one-shot monostables and a flip-flop. The display system might be a 1200 baud printer or 1200 baud computer terminal (VDU).

But simple decoders only work properly on noise-free signals, and it wouldn't be long before you'd want to improve your decoder. A proper error-resilient UoSAT decoder would be a natural upgrade, as would a gain antenna for stronger signals.

Once you start acquiring telemetry data, you're soon faced with the fascinating problem of what to do with it all. The computer comes into its own as a means of storage, retrieval, processing, and presentation. An audio cassette recorder is invaluable when you want to re-examine raw audio signal after the satellite has passed.

Satellite Overview

Because the cost per Watt of spacecraft power is enormous, satellites usually transmit with only just enough power for the job. They expect ground stations to provide good "ears" and smart demodulators.

Such is the case with OSCAR-13. To acquire and decode its telemetry, you need an SSB receiver (2 meter or 70 cm) and a rotatable beam antenna, preferably with elevation control. If the coax feeder is long and loses more than about 3 dB of signal, you'll need a masthead preamplifier. A specific "AO-13 Data Demodulator" extracts the digital data. Some of this can be dumped to a printer or VDU, but in practice, the computer will need to read, process, and display it first. Hardware and software is readily available for several machines. For the basic user, OSCAR-13 also sends two short Morse code bulletins and ten minutes of 50 baud RTTY every hour.

Fuji-OSCAR-12 carried the first spaceborne packet radio mailbox for general use. It sends telemetry in AX.25 packet format. You will need a 70 cm SSB receiver, gain antenna with steering, an AX.25 packet radio TNC, and an FO-12 PSK modem. This will let you read down-coming mail and telemetry values. The data rate is 1200 baud. To access the mailbox, you need an FM transmitter on 2 meters. The modem does the uplink digital-to-audio conversion. When not in mailbox mode, FO-12 sends its telemetry in CW.

Two of the new MicroSats, which AMSAT North America is preparing for a late 1989 launch, will carry AX.25 packet radio mailbox facilities. The uplink and downlink formats are identical to those of FO-12. Strong received signals on 70 cm are planned. An omni-directional antenna may be satisfactory. A third MicroSat will carry a TV camera and transmit its images digitally in AX.25 packet format.

UoSAT-D will be launched with the MicroSats, making up a six-satellite mission for the Ariane rocket. UoSAT-D will carry a Packet Communication Experiment (PCE) for general use, and transmit its packet traffic and telemetry in AX.25 protocol frames on 70 cm FM. The UoSAT-D data rate is 9.6K bits/s. You would need a 9600 baud modem with the TNC.

UoSAT

General: There are two UoSATs, UoSAT-1/OSCAR-9 and UoSAT-2/OSCAR-11. They are in similar orbits, with periods of 93.6 and 98.5 minutes. Due to their orbits, the satellites conveniently appear around the same time each day. For example, UoSAT-2 goes overhead southbound at about 1000 local time each day, and Northbound at about 2100 ($\pm$ 45 minutes). A typical pass lasts about 12 minutes. Ideal for schools, for example, or for anyone who wants an organized life!

Both transmit very strong signals on 145.825 MHz FM, and sometimes on 435.025 MHz FM. You can hear them on a 2 meter HT.

Data Transmitted: UoSAT-2's data transmission follows a regular weekly pattern and consists of plain-text bulletins of interest to all satellite users, telemetry data, and information related to the special packet radio "data communications experiment" (DCE). The telemetry is of two kinds; either 70 quantities sent repeatedly every 5 seconds, or dwell telemetry. That's one or two specific quantities gathered up over a whole orbit and sent in one long burst.

Figure 1 shows an example of a plain-text bulletin drawn at random from my log disc. These bulletins are typically several pages long. The news is gathered from all over the world, and it's the most up-to-date source of amateur satellite information available anywhere.

Now see Figure 2. The first line shows the date: 1989 Jan 26, Thursday, at 1028:08 UTC. Then follow 70 data groups are in the format CCddd, where CC is the channel number, 00 to 69, and ddd is the value. For example, "37431" means channel 37 has value 431. You can now look up the meaning of channel 37 from the published table (see "Reading" at the end of this article), and find that it's the 145 MHz Beacon Temperature, and converts as Temp = 0.2 x (480 - N). Simply plug in N = 431 to discover that the temperature is 9.8 degrees C.

Of course, you wouldn't want to go through that exercise too often, but I think you'd agree that a computer program to dissect the table and do the calculations is quite straightforward, fun, and an ideal project for hams and college students alike!

Telemetry Format: UoSAT-2 sends data in normal 11- or 12-bit serial ASCII code; one start bit, seven data, even parity, and two or three stop bits. It signals bits by using two tones, or exactly two cycles of 2400 Hz for a data "1" (stop/idle), and exactly one cycle of 1200 Hz for a data "0" (start). The sine wave tones zero-crossings are synchronized with the data transitions. The tones are transmitted as FM on the 145.825 MHz carrier. (UoSAT-1 has the tones reversed).

Telemetry Demodulation: The simple signaling scheme suggests that a decoder based on timing zero-crossings would be easy to implement, and I have seen at least six designs. While they would get you going, they are very prone to errors caused by noise spikes. A much better method is to exploit the information carried by two synchronous tones in a device called a "matched filter decoder."

The G3RUH UoSAT Decoder has been available since 1983, and about 800 are in use by hams, schools, colleges, and at the UoSAT Spacecraft Control Station itself at the University of Surrey, Guildford, England.

Essentially, the decoder compares incoming audio with locally generated 1200 and 2400 Hz replica tones. The best similarity determines whether the bit is a "1" or a "0." Resilience to noise comes about because noise is completely unlike the tones, or "unmatched."

The decoder then outputs ASCII data at RS-232 voltage levels that any terminal device or program can read.

Decoder Specifications:

Input—Typically 50 mV to 5V RMS audio from an FM receiver.

Output—The 1200 baud serial data stream is output in three formats: 1) RS-232c level, 2) regenerated two-tone audio for tape recording, 3) 12V CMOS level plus 1200 Hz clock.

Controls—Input invert switch; UoSAT-½ switch; lock meter.

Set-up—Two preset pots: PLL frequency and ½ voltage supply.

Power/PCB—12V @ 15 mA. Single-sided PCB, 160 x 100 mm. Eight CMOS chips, one op amp. 19 resistors, 12 capacitors.

Availability—You may obtain PCB from G3RUH, AMSAT-UK (12 pounds airmail), and AMSAT-VK, or order it via Project OSCAR. AMSAT-NA stocks no satellite products, though this should change soon. Phone and check. All addresses and phone numbers are at the end of this article.

Associated Equipment: You can use any 2 meter FM radio to receive UoSAT on 145.825 MHz. You can take audio direct from the external speaker socket. Some receivers will have a separate AF O/P socket on the rear panel that bypasses the volume control. The antenna can range from the "rubber duckie" to a fully steerable beam; results will be in direct proportion to signal strength. With a beam antenna without elevation control, you can follow passes that don't rise more than about 30 degrees. A "turnstile" (crossed dipole) is a very effective, simple, fixed omnidirectional antenna, especially for overhead passes. You can display the data on any 1200 baud serial device, such as a VDU, printer, or computer terminal. If you operate packet radio, you already have a suitable terminal.

"All satellites broadcast telemetry."

Reading: Probably more has been written about UoSAT than any other amateur spacecraft, and the list below is just a selection. The UoSAT booklet will appeal to Novices and old-timers alike, and has the full telemetry specifications. N5AHD's article shows what you can do when you're really hooked! The UoSAT program papers by Martin Sweeting and his team of engineers range from the very general (no math) to the highly scientific, and I highly recommend them for a full understanding of the practical realities of every aspect of spacecraft design and operations.

Miller J.R., G3RUH, "Data Decoder for UoSAT," *Wireless World*, (UK), May 1983, pp. 28-33.

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Diersing R.J., N5AHD, "Processing UoSat Whole-Orbit Telemetry Data," *Proceedings of the 4th Annual AMSAT Space Symposium*, pp. 55-76. ARRL 1986.

Sweeting M.N., G3YJO, et. al., "UoSAT—A Cost Effective Spacecraft Engineering Programme," *J. Inst. Electronic and Radio Engineers*, (UK), Supplement to Vol. 57 No. 5, Sept/Oct 1987, 120 pages, 14 articles. ISSN 0267-1689. (Obtain from AMSAT-UK, 10 pounds airmail).

OSCAR-13

General: OSCAR-13 is the latest voice/CW transponding satellite for hams, launched by Ariane rocket on 15 June, 1988. Its period is just under 12 hours, and its orbit is elliptical. Most of the time its distance from the Earth exceeds 35,000 km (22,000 miles), which means nearly half the Earth is in view for hours at a time, every day.

OSCAR-13 carries three transponders: Mode B (70 cm up, 2 meters down), Mode L (23 cm up, 70 cm down), and Mode S (70 cm up, 13 cm down).

Telemetry transmissions are associated with each mode. On 2 meters this is at 145.812 MHz, while on 70 cm it is 435.653 MHz. Occasionally these are changed to 145.985 or 435.677 MHz for a few minutes. Transmissions are continuous. On the hour and half hour, there are short CW bulletins; on the quarter hours, five minutes of 50 baud RTTY. The rest of the time, OSCAR-13 broadcasts telemetry data.

Data Transmitted: OSCAR-13 alternately sends two kinds of information: plain-text message bulletins and spacecraft numerical telemetry. It transmits data in 512 byte blocks, each block preceded by four synchronization bytes and followed by a two-byte check sum. Idle bytes space out the blocks. Plain-text uses ASCII codes.

A byte, comprised of eight bits, is transmitted serially at a rate of 400 bits/s. A block lasts 10.24 seconds. Blocks are separated by about 13.5 seconds. This rhythm is clearly discernible in the audio.

Figure 3 shows two typical message blocks. Note that the first letter of a block is a unique block identifier. Five text blocks use K, L, M, N, and Y, while telemetry data uses the letter Q.

Telemetry data (Q) blocks are hybrid. The first 256 bytes are plain-text, and identify the satellite. They also show the time, date, and certain command status flags. The second 256 bytes contain 128 bytes of data about the spacecraft's present operation, and 128 bytes of historic "snapshot" data. These data bytes sent voltages, currents, temperatures, navigation sensor, status flags, counters, timers, and so on. You can decode them with reference to the published calibration information. The computer's job is to present the data in real time.

Telemetry Format: I described the block format above. Now I'll recast the bits in a form familiar to packet radio users, NRZI. This means that a "1" is represented by a change in the bit stream (01 or 10), and a "0" by no change (00 or 11). Next, each bit is exclusive-ORed with the 400 Hz bit rate lock (Manchester coding). Finally, the transmitter carrier is modulated the same way as SSB is produced. Because the signal is binary, the net result is a 180 degree reversal of the carrier phase known as phase-shift keying (PSK).

Yes, it's complicated because it has to make maximum use of the precious spacecraft power. Only one Watt is transmitted, yet a 400 bits/s data rate at 40,000 km is

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UoSAT-OSCAR-11    Bulletin-060    23 Oct. 1986
***************   *************   *************
         UoSAT Spacecraft Control Centre,
          University of Surrey, England.

* Particle Wave Surveys Continue *
 The UO-11 particle/wave experiment and the Digital Store and Readout
system have seen daily use during that last week.

** AMSAT PHASE-IV STUDY LAUNCHED **
 AMSAT-NA Engineering Vice President Jan King (W3GEY) recently completed
a "Phase 4 Technical Study Plan", outlining the technical and operational
choices that must be made as Amateur Satellite community looks for more
advances satellite communications facilities.  The document addresses all
of the engineering choices that effect selection between Molniya or
geostationary orbits, and proposes that AMSAT Phase-IV devote itself to
geostationary spacecraft.  Members of the technical study team have been
looking at solutions to the problems that would be faced during the design
and operation of a low-cost geostationary satellite.
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Figure 1. A plain-text bulletin drawn at random from the G3RUH log disc.

```
UOSAT-2          8901264102808
00510 01517 02188 03408 04052 05039 06026 07051 08045 09033
10403 11336 12000 13064 14148 15458 16241 17588 18646 19565
20124 21207 22660 23635 24001 25239 26192 27524 28469 29512
30519 31090 32291 33576 34000 35271 36320 37431 38473 39500
40765 41120 42633 43054 44167 45000 46000 47491 48491 49472
50607 51119 52682 53290 54892 55000 56000 57497 58492 59497
60828 615FD 6201F 63F24 64440 651C0 66601 67700 68000 69000
```

Figure 2. An example of an actual telemetry frame as a printer or VDU would show it.

```
M de DB2OS & G3RUH                              Update 1989 Jan 30
 ***    AO-13 TRANSPONDER SCHEDULE     (valid until March)   ***
   Mode-B   from  MA   3  until  MA 100    Attitude ALON / ALAT
   Mode-JL  from  MA 100  until  MA 150     Jan 30  178.8/ -1.4
   Mode-B   from  MA 150  until  MA 240     Feb 06  178.9/ -2.1
   OFF      from  MA 240  until  MA   3     Feb 13  179.0/ -2.8
         Attitude gives best pointing angle around apogee.
      Rate of change in ALON: 0.016 deg/day, ALAT: -0.1 deg/day.

N de VK5AGR 07Jan89 0030 utc QST: The OSCAR-13 Operations and
Technical Handbook produced by AMSAT-UK in collaboration with
AMSAT-DL is NOW available - Contact AMSAT-UK, Project OSCAR or
AMSAT-Australia for details.                     73  Graham

Peter DB2OS - Jan 30: Can you  please send tape of software to
check out IHU with 32K memory board - works OK with AO10
recovery software but not IPS-C2??  73 Graham.
```

Figure 3. Two typical message blocks. The first letter of a block is a unique block identifier. Five text blocks use K, L, M, N, and Y, while telemetry data uses the letter Q.

possible, error-free. Compare that with terrestrial RTTY or packet radio.

Telemetry Demodulation: Recovering the digital data from received audio is also complicated, similar to the encoding process just described, but in reverse. First the audio carrier (about 1500 Hz) is acquired and removed. Then the 400 Hz clock is acquired and removed. Next, the bits are detected in a "matched filter." Now the NRZI is unscrambled back to regular data.

A circuit searches for the synchronizing bytes, and when it finds them, 512 bytes are clocked out to a parallel port. They are also loaded into a serializer which operates at 1200 baud and provides a start/stop serial stream to an RS-232 port. The G3RUH OSCAR-10/13 PSK Data Demodulator provides all of the above functions and has been available since 1984. About 500 are in use at present.

Decoder Specifications:

Input—Typically 50 mV to 5V RMS audio from an SSB receiver.

Outputs—Three formats: 1) RS-232 level 1200 baud, 2) eight-bit parallel, 3) 400 bits/s raw data.

Controls—Tune Carrier, Tuning/Lock meter, Meter select.

Set-up—Three preset pots; two PLL frequency and ½ voltage supply.

Power/PCB—12V @ 30 mA. Double sided PCB plated through, 200 x 160 mm. 24 CMOS chips, one op amp. 23 resistors, 22 capacitors.

Availability—The PCB is available from AMSAT-UK (19 pounds airmail). You can also order it from AMSAT-VK and Project OSCAR. RadioKit sells PCB plus full kit of parts. AMSAT-NA stocks no satellite products, though this may change. Phone and check. All addresses and numbers are at the end of this article.

Associated Equipment: You must use a 2 meter or 70 cm SSB radio to receive OSCAR-13 on 145.812 or 435.653 MHz. Tuning rate should be 100 Hz/step or better. You can take audio direct from the external speaker socket. Some receivers will have a separate AF output socket on the rear panel that bypasses the volume control.

Receiving antennas must have at least 10 dB of gain, with little coaxial feeder loss unless there is a masthead preamplifier. Steering in azimuth is essential, and elevation is highly desirable if you wish to observe all passes.

It is possible to display the plain-text information on a VDU or 1200 baud terminal device. Problems arise with the data telemetry, though, because all codes from 0 to 255 will occur. These will invariably cause comic effects on the screen, such as clearing, inverse video, beeps, backspacing, foreign symbols, and in the case of printers, ejection of large amounts of blank paper.

Software: The only practical way to handle the telemetry data is with a computer, and the RS-232 decoder output ensures that most can be used. Software is available for several machines, notably the IBM PC, Commodore C-64, Acorn/BBC, Atari 800XL, Tandy TRS-80, Sinclair Spectrum, and possibly others. These programs are not at all complicated; most of their job is cosmetic, i.e., creating a tidy display! You can obtain IBM-PC and CBM-64 display programs from AMSAT-UK, AMSAT-VK, and Project OSCAR.

Reading: The *OSCAR-13 Handbook* contains a wealth of facts, figures, tips, and descriptions of the satellite systems. It explains the telemetry in fullest detail. Worldwide contributors. A G3RUH PSK Decoder article is supplied with the PCB.

OSCAR-13 Operations and Technical Handbook, AMSAT-UK, London E12 5EQ, England. 52 pages. (From AMSAT-UK 6 pounds airmail, AMSAT-VK, or Project OSCAR).

Miller J.R., G3RUH, "A PSK Telemetry Demodulator for OSCAR-10," *Ham Radio*, (USA), April 1985, pp. 50-62. Also published in *Wireless World* (UK), Oct/Nov 1984, *Radio Rivista*, (Italy) May/Jun 1984. 73

Look for Part II in the June '89 issue of *73*.

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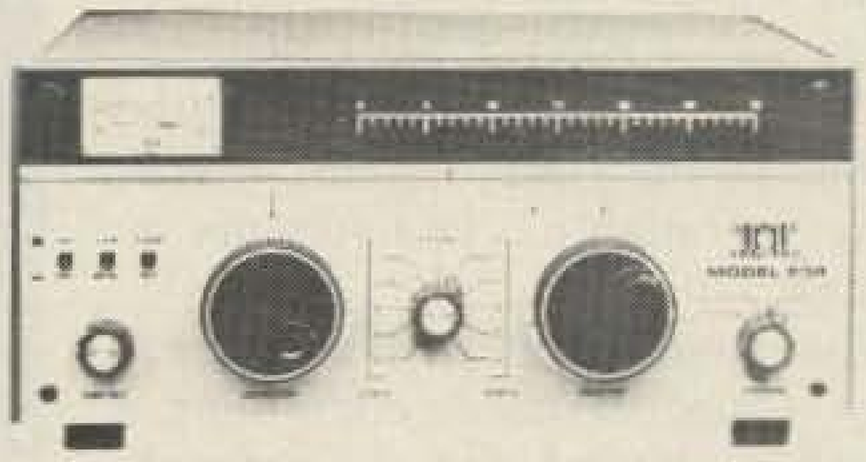

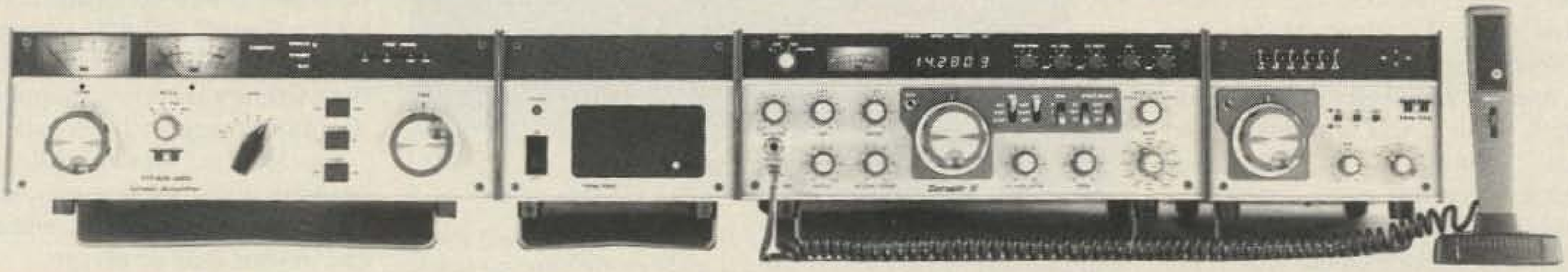

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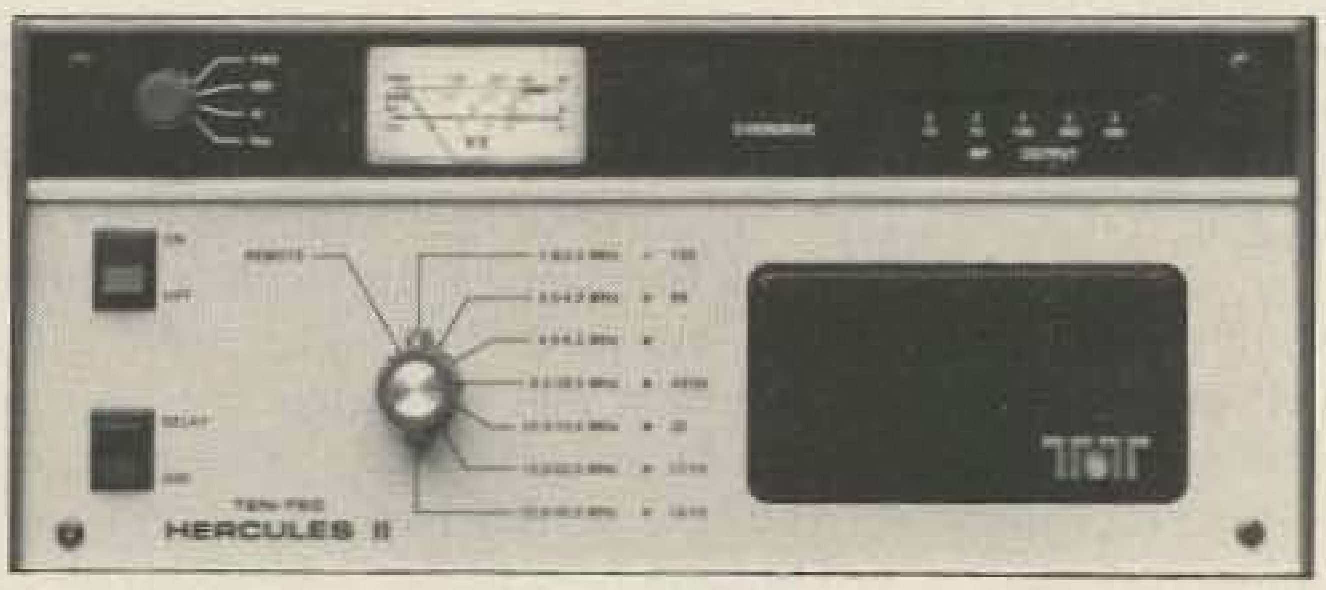

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Build A Simple Az-El For Mode L

Precision antenna pointing for under $100.

by John Molnar WA3ETD

It was a week before the scheduled launch of OSCAR 13, and I had a problem. I wanted to get on Mode L on the first day, and the only antenna system available that would operate on 1269 MHz was an eight foot parabolic dish sitting in my driveway, pointed at the horizon. I needed an alternative antenna, one that would meet several important requirements unique to my QTH: It had to be pointable in both the azimuth and elevation planes (Az-El), it had to be tripod-mounted on a second story roof with limited turning radius, it had to have enough gain to be usable with a nominal amount of uplink power (about 40 Watts at the amplifier), and it had to be built with as many "available" components as possible.

What evolved is an Az-El rotor setup, tripod-mounted, controlling a pair of 24-element loop yagi antennas stacked in the "E" plane. This project was intended to be a temporary measure, one that would allow me to get on Mode L while I was working on the "final" solution. What really happened was that this easily-reproducable weekend project worked so well that it is still in place on the roof as my main Mode L array, and doubles as a weak signal contest antenna system for 1296 work. (The dish is still in the driveway, but has found use as a Mode S downlink antenna.)

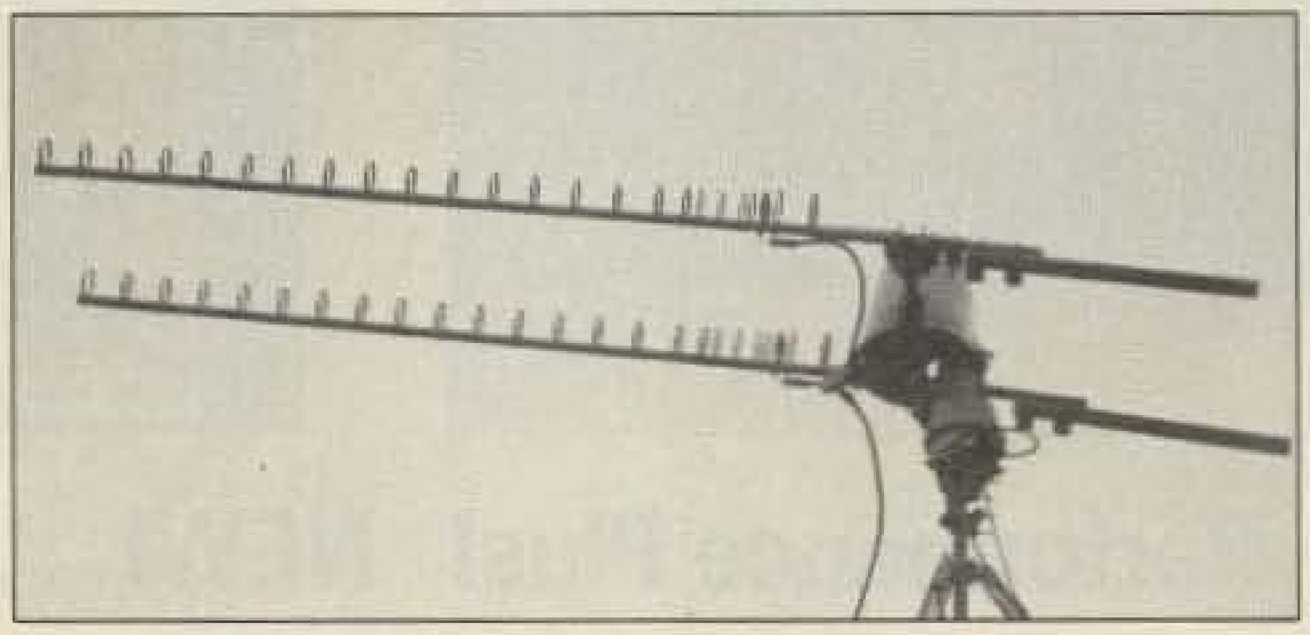

Photo A. The completed Mode L Az-El and stacked 24-element loop yagis at WA3ETD. Note "top hat" bucket that protects the elevation rotor from the elements.

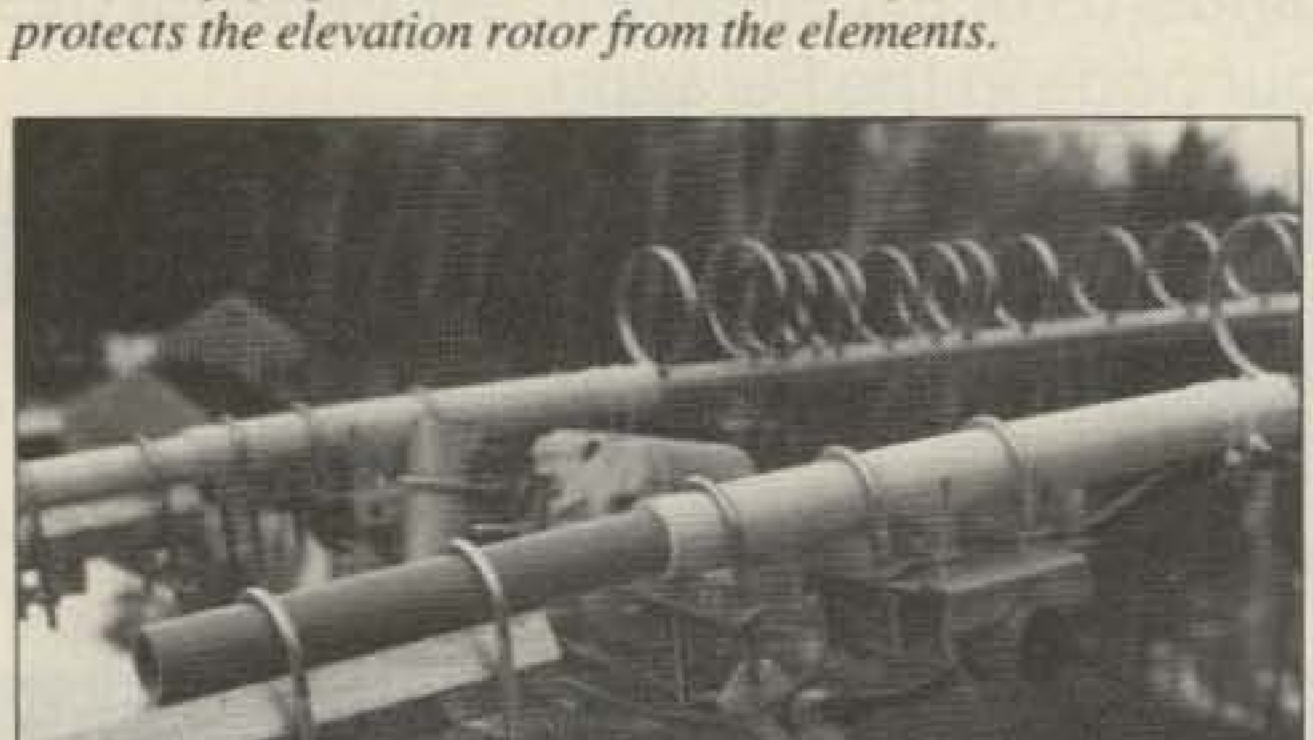

Photo B. Close-up of mounting hardware. Aluminum plate and two sets of TV U-bolts form a right angle mast-to-boom mount. The counterbalance slides on the PVC pipe, allowing adjustment for the weight of the power divider (visible below and to the right of the elevation rotor) and cable harness. A short section of steel TV mast secures the El rotor mounting plate to the Az rotor clamp. When complete, plastic end caps seal the boom, mast, and PVC tail from moisture and insects.

Az-El Rotor System

An Az-El rotor system has two functions. It must support the antenna array, and allow that array to be pointed at any point on the horizon (like your 20 meter array) as well as any point in the sky, because that is where the satellites are. I have built several Az-El systems since OSCAR 7 days, and favor a system using two separate rotors bolted together in some manner. Both rotors should be continuously adjustable and have enough resolution to point the antenna directly at the satellite in question. It is possible to use different rotors for the Az and El functions; all that is required is some means of mechanically connecting them together such that the horizontal rotor turns the vertical (elevation) rotor, which in turn supports the antenna array.

The elevation rotor typically supports the antenna array boom. The boom should be balanced to eliminate stress on the rotor, and the easiest way to balance the boom is to stack two antennas and place the rotor in the center of the boom. Thus, the boom must pass through the elevation rotor. For lightweight satellite antennas, I have found that an old favorite flea market special, the Alliance U-100, or its descendant, the U-110, work perfectly as elevation rotors, with minimal modification. These four wire control rotors and their clicker style box, designed for the home television industry, can be found in working condition at flea markets for five dollars. They work just fine on their side for elevation duty. I used a U-110 in this project. However, a U-100 modified eight years ago is still lifting antennas on my roof in the Northeast!

Most rotors will serve as the azimuth, or horizontal rotor. No modification is usually required, since the rotor is being used for turning a horizontal load. Once again, a generic hamfest CDR™-type rotor works well, especially if it has continuous control (not a "stepper"). However, a U-100 or U-110 can be used with the minor control box modification described later in this article. Kenpro (now a division of Yaesu) makes a fine azimuth rotor specifically designed for satellite service. This rotor has a flat rotating surface, tapped for bolts in four places. Almost anything can be mounted to the KR-400 rotor by using a drilled adapter plate. However, some CDR-type rotors have removable mast clamps that make them highly desirable for satellite service. Try to find one with continuous control, if possible. I was fortunate enough to have a Kenpro KR-400, obtained at a "distress sale," for my project. I used the existing mast clamp supplied with the rotor to support the elevation rotor.

So, let's get started! All you will need are two suitable rotors, some basic hardware, hand tools, and a weekend in your shop or garage.

Clamp Arrangement

Most rotors are designed to be clamped to a vertical pipe and to turn a vertical antenna mast. Some method must be devised to get the rotor to turn a horizontal mast so that the antennas can be elevated. You must make a clamp arrangement that will allow the rotor to be mounted on its side. This "90 degree clamp" can be easily created using common parts.

The idea is to mount a U-100-type elevation rotor on its side on top of a standard azimuth rotor. This can be done in two ways. If you have an azimuth rotor with a flat mounting surface, all that you will need is a six inch square adapter plate fabricated from ¼ inch aluminum plate. Or, if you use a standard mast clamp rotor, you can clamp the adapter plate to an eight inch section of standard steel TV mast (available at Radio Shack™). Then, clamp the mast section to the azimuth rotor and you will have a quick Az-El system. I used this latter approach.

Referring to Photos B and C, cut a six inch square plate of 3/16" or ¼" aluminum plate. I have successfully cut this type of plate using a saber saw with a metal cutting blade, but you could also use a hacksaw. Make sure to clamp the main piece of aluminum in a vice, and wear those safety goggles!

Most "original" U-100 rotors have four 3/16" rods threaded into the aluminum case. These served as the rotor-to-mast clamp guides, and should be removed. When looking at your U-100 or U-110, you will see an aluminum tab protruding from the rotor body, above the top set of holes originally holding the mast clamp guides. This tab is intended to prevent the rotor and antenna from sliding down the mast should the clamps become loose in TV duty. Since we intend to lay the rotor on its side on the plate, this tab must be removed. Do this by deeply scribing a line in the aluminum tab where it is cast into the rotor body. A sharp blow with a ball peen hammer at the end of the tab will usually break it off neatly at the scribe mark. I have modified several of these rotors in this manner, and once the tab took a piece of the rotor case with it, exposing the guts of the machine. No problem, a bead of RTV will seal the crack against the rain.

Now lay the rotor on its side, centered on the 6" plate. Mark and drill the plate for the four posts of the rotor. Secure the rotor and plate with 3/16" x ½" stainless hardware, and insure that it is centered on the plate.

The next step depends on your choice of azimuth rotor. If you have a flat surface on the azimuth rotor, mark and drill the plate for the hole pattern on your particular device. Then secure the plate to the rotor using several washers or small spacers between the plate and the rotor to provide clearance for the four bolt heads holding the elevation rotor. Assemble the basic Az-El by bolting both rotors to the plate.

Mounting

You are now ready to assemble a mechanically tough, compact unit. Refer to Photo B. Mount the mast clamp type azimuth rotor to the plate using a 8"–10" piece of TV mast. Drill your plate to accept two standard TV U-bolt mast clamps, and secure the plate and elevation rotor to the short mast section. Insert the other end into the azimuth rotor until it bottoms out, then measure how much mast is between the plate and the top of the rotor. Cut that much off the mast—the goal is to rest the plate directly on top of the azimuth rotor. Secure the assembly. I have found that the slight imbalance caused by the elevation rotor being slightly "in front" of the azimuth rotor in this application causes no problems in the final assembly.

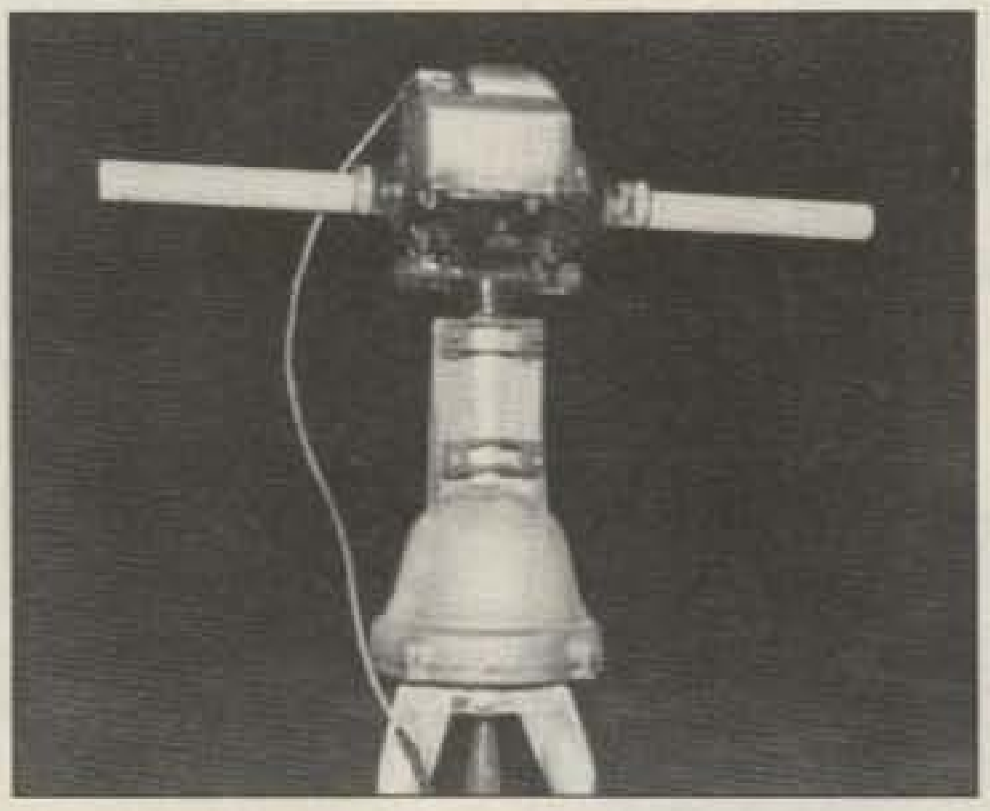

Photo D. Elements of an Az-El. In this system, the modified El rotor is united with a flea market CDR rotor with short sections of 1" od threaded water pipe components. The horizontal mast is typically about 38" long.

That's it! The tough part of your Mode L array is behind you. Mount the completed Az-El assembly on a piece of TV mast, and use a standard 3' TV roof mount tripod to hold it in the final position. Assuming that the tripod will be used in the final roof mount application, once again minimize the length of the TV mast—I try to rest the bottom clamp of the azimuth rotor directly on the top of the tripod.

Photo D shows another possible mounting scheme. The Az-El rotor connection is fabricated from short sections of 1" threaded iron water pipe and a "Tee" section. As you can see, many methods of coupling two rotors are possible.

Antenna System

The following minimum system results in a usable uplink: a single 45-element loop yagi (about 20 dBi gain), transmitter power output of 35–40 Watts, and no more than 3 dB of feedline/connector/SWR loss. I have worked many stations on Mode L in this class.

A pair of 45-element loop yagis results in a system about equivalent to a 4' dish antenna. I have used exactly such a dish as a reference antenna on 1269 MHz. The only problems with the 45-element looper are its physical length, about 12', and the fact that it is center mounted. Remember, the antenna is going to be pointed up, meaning the reflector end of the antenna points down, possibly into your roof or chimney, when center mounted. My solution to the size issue was to end mount two 24-element loop yagis, one on each end of a 30" boom, with the elevation rotor mounted in the center. Counterbalancing the array resulted in a nicely balanced package with the approximate gain of one big loop yagi.

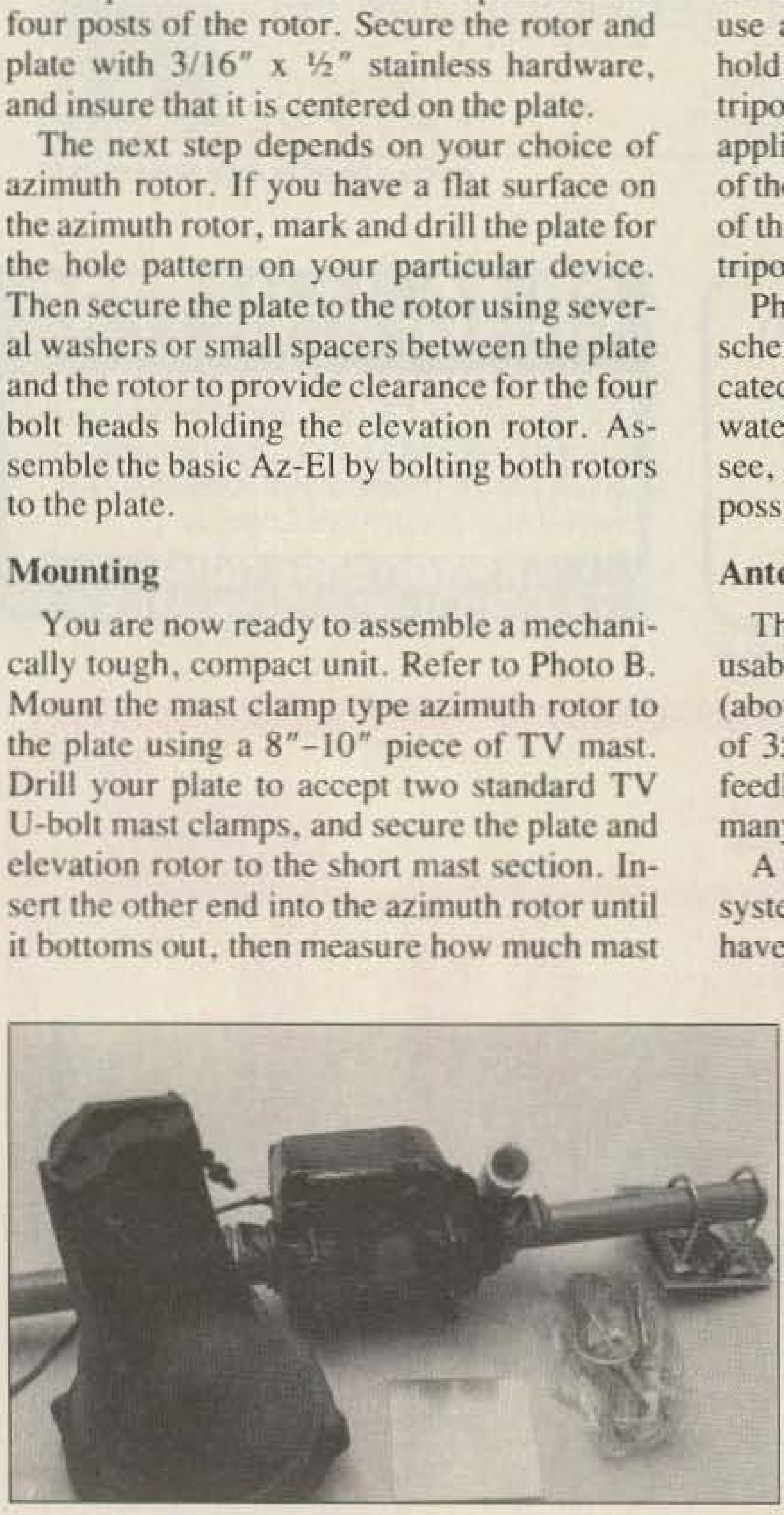

Photo C. Major Az-El components. Square ¼" aluminum plate is used to fabricate right angle mounts using standard TV U-bolts and clamps.

The loop yagis I used are sold by Down East Microwave, Box 2310, RR #1, Troy ME 04987 [(207) 948-3741]. They make antennas, power amplifiers, and components for microwave operators. If you ask for it, Bill Olson (the owner) will leave several inches of boom behind the last reflector on your 24-element looper. This makes it much easier to clamp the antenna to the "mast" running horizontally through the elevation rotor. Assuming that you choose to use the stacked 24-element loopers, make sure to request 1269 MHz driven elements as well as the mast "tail" extension when you order from Down East.

Checking Photo B, fabricate two more 6" aluminum plates. Mark and drill the plate to accept four TV U-bolt clamps, two on each side. One set clamps to the loop yagi tail, and the other to the horizontal mast, allowing the array to be elevated. This fabrication process is easy—you can bolt up the elements as you go, using a horizontal mast about 38" long. Slip the mast through the U-100, center it, and snug it down with U-bolt clamps. The goal is to position the two loopers so the antenna boom center-to-center distance is about 30", but this is not a critical dimension.

Counterbalancing

Notice how front-heavy the array seems. Although the U-100 can lift the uncounterbalanced array, all it takes is a bit of snow, ice, or wind loading to over-stress the elevation rotor. A counterbalance is a must. I fabricated a very workable counterbalance using things stacked under my work bench. There was at hand also some solid aluminum rod in the shape of an octagon about 2" in "diameter," salvaged from a local metal yard.

Secure the two yagis to the plates and horizontal mast. Free the El rotor clamps so the array swings free, touching the ground or floor in front of the tripod. Now cut two 1' long pieces of 1" i.d. Schedule 80 (thick wall) PVC water pipe, available at any hardware store. Cut a 3" slit in one end of each pipe so that it can be slipped over the tail of each yagi, and clamp the yagi to the plate by tightening the U-bolts over the PVC.

The two resulting 9" PVC tails allow the counterbalancing weights to be clamped on. In my case, the octagonal faces of the aluminum provided a ready-made surface for the U-bolt bracket. Each installation is slightly different, so judge (or use a "fruit basket scale") how much counterbalance mass is required to balance the array in the elevation rotor. Slide your aluminum bar, iron pipe, brick, or whatever forward or backward on the PVC tail until the array is balanced. Now, slide each counterbalance two inches or so forward so the array is once again nose heavy. Secure lightly. You will make the final counterbalance adjustment later, when the power divider (from Down East Microwave) and transmission line is attached to the array.

Final Assembly

That ray gun sitting in your garage is al-

most mechanically finished! Let's take a moment and consider how to feed the array from your shack. Feeding antennas at 1269 MHz is unlike your typical 20 meter, or even 2 meter, installation. Feedline selection and length are critical to the performance of your system. Connector losses really do add up, and matching everything in the system is important. If your station is in the 10–40 Watt class, strive to keep total transmission line loss below 3 dB. Needless to say, this requirement pretty well eliminates the use of RG-8 or 9913 type cables when the transmitter to antenna distance is over 35'. In my situation the transmission line is about 50', so I used an available piece of ½" Andrews foam Heliax™ from transmitter to rotor loop. A 4' piece of 9913 with type N connectors connects the transmission line to the power divider. PLEASE, do not try RG-8 coax and flea market PL-259 connectors in your installation—you are assured of being disappointed. Also bear in mind that these restrictions disappear if you have "power to burn." There are more than a few 1296 EME operators on the bird, and when you have a couple of tubes in a cavity making 300 Watts, the transmission line problems ease a bit. Once again, based on experience, the array described here can be used successfully with an ICOM 1271A 10 Watt transceiver IF line losses are kept UNDER 3 dB. Consult the Transmission Line chapter of the Handbook, or talk to a local UHF enthusiast for details. The use of Heliax transmission line is no longer considered exotic—plenty of good ½" stuff is showing up in flea markets, with connectors, having been retired from land mobile base stations.

A short piece of 9913 or 8214 line can be used to form the rotor loop. Insure that the loop is big enough to allow full 360 degree travel of the azimuth rotor. Make or buy two 16" pieces of 9913 cable with male type N connectors on each end. These MUST be exactly the same length. Connect each yagi to the power divider, either from Down East Microwave or home built (Reisert, Joe; "Power Splitters and Summers," *Ham Radio*, May 1988, pp. 80-89.). The feedline end of the power divider goes to the rotor loop. Now connect appropriate rotor control cables to each rotor, once again allowing for rotor movement. Temporarily connect control boxes and position the azimuth rotor to "South." (Use "South" for the neutral azimuth position for the loop because OSCAR 13 appears in the southeast, south, and southwest when viewed from most of the U.S.) With the clicker style elevation rotor, position it to "West," which will correspond to 0 degrees of elevation. Form rotor cable rotation loops, and tape or cable tie them to a tripod leg.

It is up to you to get this creation onto your roof or to its final resting place. Don't tell me how you did it. I used mine for a week in the back yard, on the ground, because I didn't have a helper. I did hear my own downlink signal on the "first night"—more on that later. Once you have secured the Az-El on the roof, using a tripod or chimney mount or whatever, make sure it's pointing south and at the horizon. Tighten up all the clamps—now is the time to adjust those counterbalance weights to compensate for the power divider and feed harness. Finally, heavily Krylon™ the whole thing and insert end plugs in the horizontal mast to keep the wasps out!

For the final touch, make some sort of "top hat" for the elevation rotor. I used a plastic four gallon bucket, with two cutouts for the horizontal mast. The U-100–U-110 series MUST be protected from rain. Notice how only one end has a splash ring (because the rotor was really designed for azimuth duty). Without a top hat, the rotor will be ruined in a season or so, unless it never rains. Secure the top hat with some cord, or with cable ties. Finally, ground the tripod with the aluminum ground cable available from Radio Shack. If the Mode L array is the only thing on the roof, run the 8-gauge ground wire to the appropriate ground stake or pipe. Channel the transmission line and rotor control cables to your shack, and you're ready for the final steps. Photos A and E show my completed array, using a Kenpro KR-400 as the Az rotor, and a modified Alliance U-110 as the El rotor.

Alliance U-100 Control Box Mod

You need to make one additional modification before connecting the rotors to their control boxes in your shack. The Alliance clicker style rotors allow the rotor shaft to move 10 degrees per click. You'll need much better resolution to accurately point the array in the general direction of OSCAR 13. Since the rotor motor runs continuously in between clicks, all that you need to do is find a way stop the motor in between the 10 degree clicks.

Once again, this is easily done. Power is fed to a U-110 rotor motor through terminals 1 or 2, depending upon which way the clicker was turned. You can solve the problem by installing a DPST normally-open push-button switch at the rotor control box, in series with leads 1 and 2. It works like this: Move the control knob clockwise (from "West" toward "North") to elevate the array. Remember, a setting of "West" corresponds to 0 degrees elevation, and "North" corresponds to 90 degrees, or straight up. Since the motor power leads are isolated from the rotor motor by the switch, the rotor won't move. Press the switch, hold it in, and the motor turns. After about 10 degrees of movement, the contact sender in the rotor clicks, pulsing the control knob in the switch box. However, the motor can be stopped in between clicks by releasing the switch, thereby allowing very accurate elevation settings. There is absolutely no problem in "parking" the rotor in between steps—to return to a reference setting simply hold down your push-button until the clicker reaches the indicated position and stops normally. Be careful about elevating the array past the 90 degree point. Although this is possible it is not a good idea, as the transmission line and power divider may become tangled if you elevate "over the top."

That about does it for the Az-El construction. It's time to operate!

Getting on the Air

I assume that you know how to find and track OSCAR satellites, as that discussion is beyond the scope of this article. One of the keys to successful Mode L operation is an above average 435 downlink receive station. If you can hear the Mode JL beacon clearly at around 435.651 MHz, you're in business. A mast-mounted 70 cm preamp works wonders, in case you're not already using one. Tune up to the Mode L passband center, about 435.860, as that region supports a lot of Mode L activity. As the pass proceeds, you should hear more and better quality signals as the satellite's antenna points closer to the Earth. Without fail you should hear the characteristic sound of stations trying to hear their own downlink at or very close to passband center. The corresponding uplink frequency is 1269.496 MHz. Position your new Az-El roughly on the satellite and transmit. Tune very carefully, and if all is well you will hear your downlink. Now adjust the elevation and azimuth with your push-buttons and peak up—it's not critical. I'll be looking for you—New Hampshire is semi-rare on Mode L!

Finally, be aware that, unless you are running 100 Watts or better, the early part of the Mode L window can be disappointing because the high gain satellite antenna is pointed away from Earth. I typically run about 120 Watts at the transmitter, which produces a very nice signal after line losses. However, as stated before, I heard my downlink on that first evening running 30 Watts, and the frequency correlation between up and down link had not been determined. It took about half an hour of continuous tuning to find it, but once I located it, peaking up was a simple process. I often run 50 Watts—and work more than a few stations in the 10 Watt class!

Fast, Cheap, and Easy

The project described here can definitely be completed in a weekend, for well under $100 (excluding loop yagis) if you take the effort to find and modify a couple of old rotors. The system can also be used to turn a Mode B array. However, I wanted a separate Mode L setup to minimize additional load on an already overloaded Mode B/J Az-El. Hopefully the construction tips provided will encourage you to get up on Mode L. There is a lot of bandspace up there for experimenting, and the DX gets better every day!

Finally, a caution unique to microwave operation. ANY amount of beamed energy at 1269 MHz can and will damage your vision if you allow your eyes to "get zapped." Don't wander around the front of a loop yagi array under power, and don't allow others to do it, especially when testing your array on the ground. Several weeks ago I painfully burned a finger when I foolishly moved my hand in front of a coffee can feed horn I was tuning up. The can was being driven with FIVE WATTS, a seemingly tiny amount of power by ham standards. BE CAREFUL!

See you on Mode L! 73

Home-Brew 435 MHz Crossed Yagi

Build this high-gain antenna for under $20.

by Keith A. Berglund WB5ZDP and Doug S. Howard KG5OA

So many people that I've talked to in the AMSAT booth at the various local hamfests tell me: "I'd like to get into satellites, but I can't afford the equipment!" I tell them that amateur satellite operation is like any other facet of ham radio; you can go down to your favorite radio store, "whup" out your checkbook, and buy everything you need for many kilobucks. OR, you can pick up used gear for much less than new prices, AND, where possible, save even more by home-brewing some of your equipment. One essential piece of satellite equipment that is within most peoples' ability to home-brew is the 435 MHz antenna.

Materials

My personal experience has shown that you can walk into a well-equipped hardware store and, for twenty bucks, walk out with virtually all the materials that you need for a fine 435 MHz circularly-polarized crossed yagi. Doug KG5OA and I manufactured the antenna described here using materials that are very common and easy to find.

We made the boom from a 10 foot piece of ¾ inch copper plumbing pipe, just right for a crossed yagi having 15 elements in each plane. For the elements, we used common ⅛ inch fluxless brazing rod. This material comes in three-foot-long rods and is sold by the pound at any welding supply store. We purchased three pounds worth and had some left over. We chose the copper pipe and the brass brazing rod because they are available, rigid, and can be soldered together easily. The total cost of these materials came to just under $17.00.

To complete the antenna, you will also need two N-type panel mount connectors. These N-type connectors have a good 50Ω impedance at 435 MHz. DO NOT use PL-259/SO-239 type connectors at this frequency.

The Design

A crossed yagi is nothing more than two identical perpendicular yagis sharing a common boom. Circular polarization is produced when one of the antennas is fed one quarter of a cycle (90 degrees) later than the other. You can generate this 90 degree phase shift in one of two common ways. First, if the two antennas are constructed so that all similar elements are mounted on the boom at the same location, then feed the antennas with a phasing harness having one leg a quarter of a wavelength longer than the other. This is sometimes referred to as the "time delay" method. The second method is to physically construct one yagi a quarter wavelength in space in front of the other on the boom. If you use this method, feed both antennas in phase. We selected the latter method because it can be easily constructed without sacrificing performance.

We determined the element lengths and locations by using a BASIC language computer program written by David G. Hopkins VK4ZF, based on research done by Gunter Hock DL6WU (*Ham Radio, May 1986*). I liked this program because it let me tailor the antenna dimensions based on the materials that I could easily obtain. It also gave me the option of having the elements electrically connected to or insulated from the boom (their lengths would be different). I chose the method of having the elements electrically connected because direct soldering made construction easier.

The dimensions of all of the elements, and their placement on the boom, can be found in Table 1. The two antennas are identical in every way except that one whole antenna is shifted 6-25/32 inches (17.22 cm) ahead of the other. To help in construction, I will differentiate between the two yagis by calling one the "vertical yagi" and the other the "horizontal yagi," even if it isn't quite technically correct.

Construction

The first order of business was to drill all of the necessary holes in the boom. We cleaned the copper pipe with some steel wool and then marked the locations of the "vertical" antenna elements on the boom. If I were going to make thousands of these antennas, I would have made a permanent metal jig, but, since

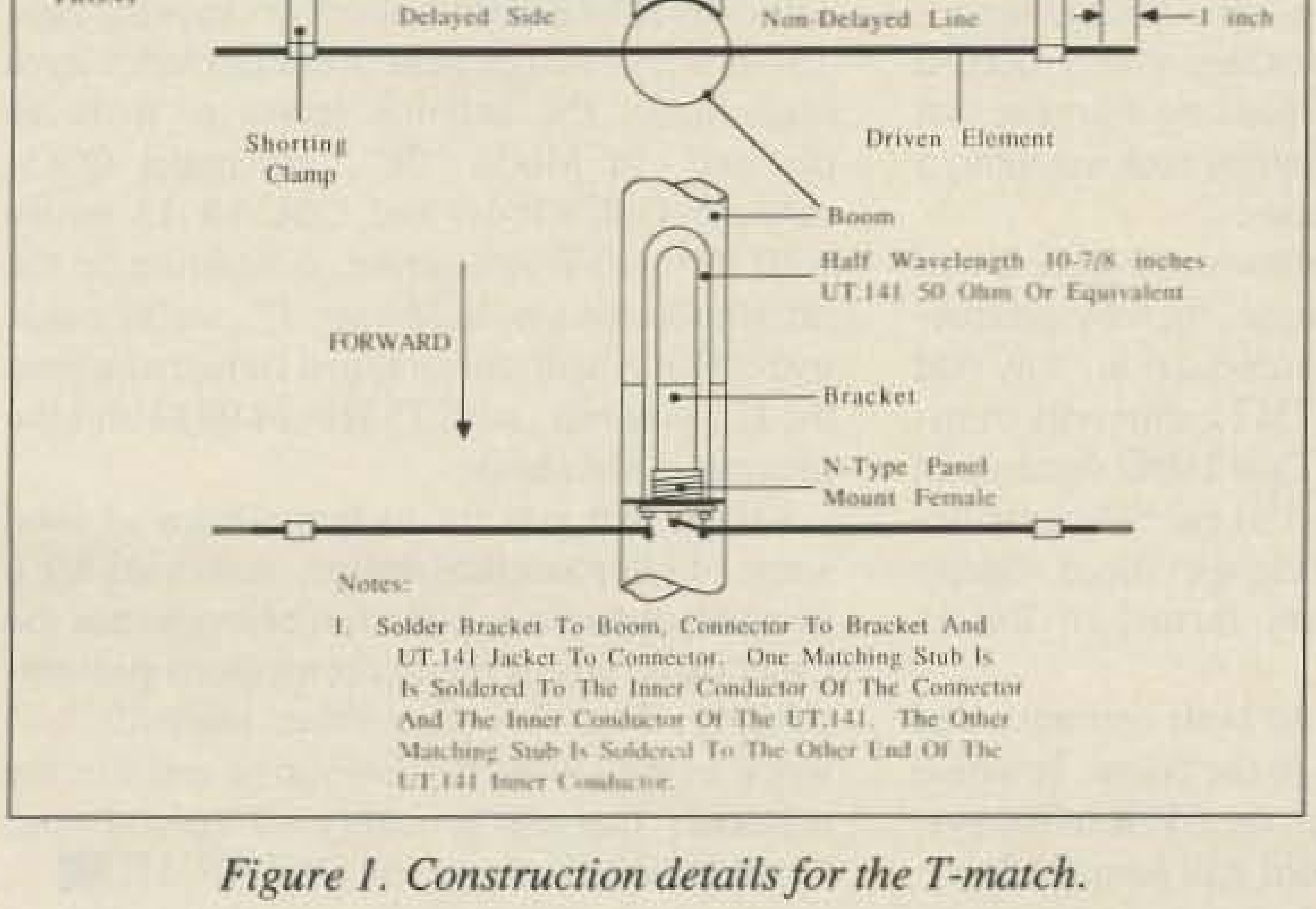

Figure 1. Construction details for the T-match.

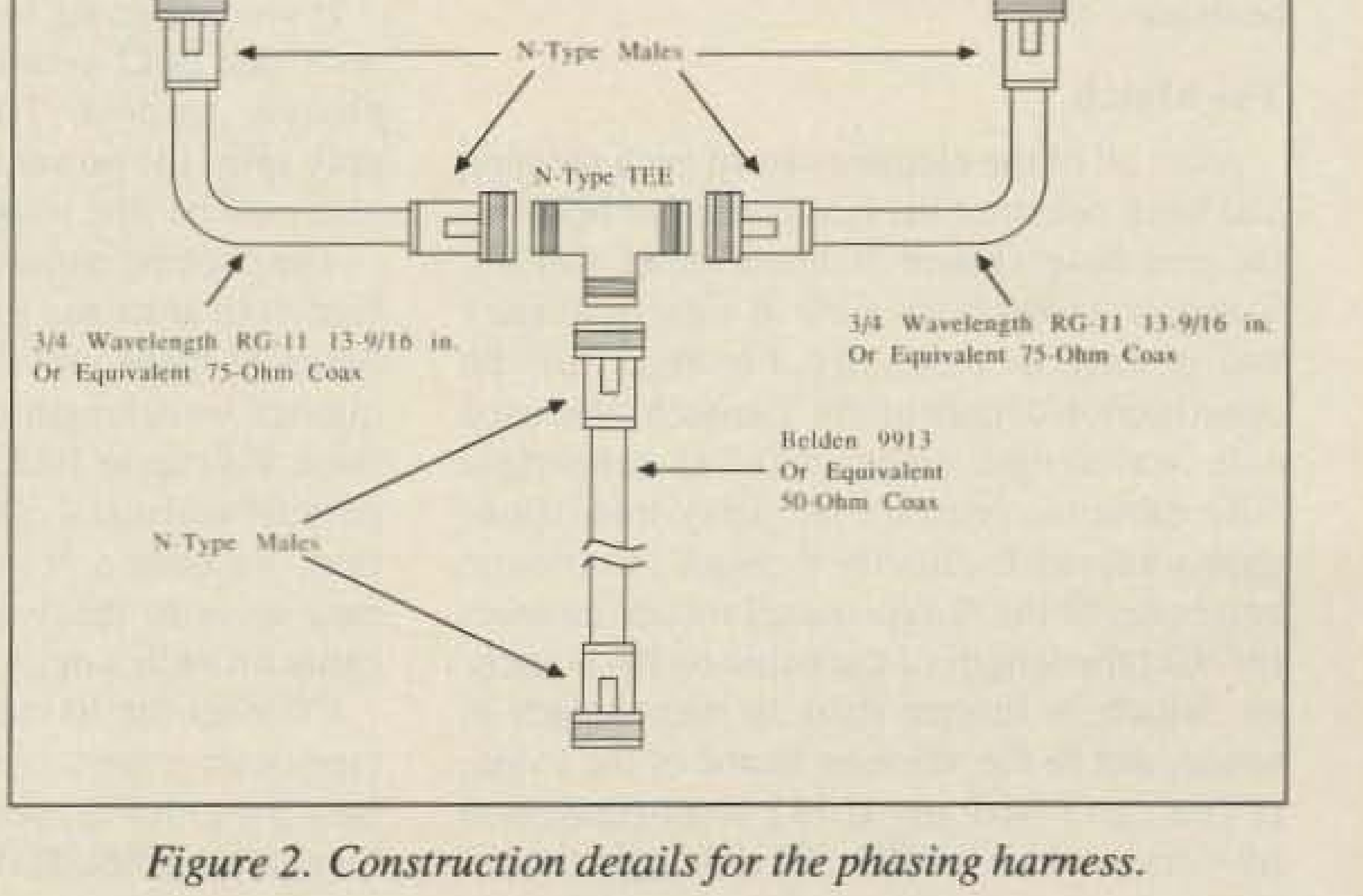

Figure 2. Construction details for the phasing harness.

we were constructing just one antenna, we made do with the materials at hand. The drilling "jig" that we used consisted of a 10 foot piece of relatively straight two-by-four. We placed the copper boom on the jig, which slid next to a guide fence clamped to the metal platform of the drill press. This fence kept the jig in the same position so that all the holes could be drilled straight through the center of the boom.

First, we drilled a ⅛ inch hole for the reflector all the way through the boom and the wood. Then, in order to hold the boom in place to drill the rest of the elements, we placed a ⅛ by 2-½ inch bolt through the wood and through the boom. When all of the vertical antenna element holes had been drilled, we removed the the bolt and rotated the boom 90 degrees. We then repeated this process for all horizontal elements.

Next, it was time to take the brass brazing rod and cut out two identical sets of 15 elements. We cut the elements with a hacksaw and then ground them to length. You should try to keep the lengths of your elements to within 1/64 inch of the given dimensions. In order to tell the difference between elements, we placed a two inch piece of masking tape on the end of each element and labeled it (D1, D2, D3, etc.).

At this point, we marked each element so that it could be accurately centered in the boom for soldering. First, we placed a pencil mark in the exact center of each element. Then, we put another mark ⅜ inch on either side of the center mark. When we placed the element through the boom, these outer marks were just visible.

We placed the boom on top of two sawhorses while we soldered the elements. We cleaned the boom with steel wool and applied flux paste around each hole and each element. Then we soldered the elements of the horizontal antenna, three at a time, using an ordinary butane torch for heat. After all of the horizontal elements were secured, we rotated the antenna 90 degrees so that the vertical elements would rest horizontally and could be attached in the same manner. While soldering, you may encounter some problems with previously soldered elements becoming soft and the element falling out. This situation can be helped by attaching a pair of vise-grips to the affected element to act as a clamp and heatsink.

The Match

After all of the elements from each antenna had been soldered in, it was time to hook up the matching system. I have found that the T-match works very well at this frequency and is easy to tune. See Figure 1 for the construction details of the T-match. We used a ½ wavelength piece of 0.141 semi-rigid 50Ω cable to construct the delay line/balun, then soldered it directly through the bottom two holes of the N-type panel mount connector. Cut the length of the cable to 10-⅞ inches, which is shorter than ½ wavelength in space, due to the velocity factor of the cable. If you can't find any 0.141 semi-rigid, you may try a piece of RG-58, although the assembly procedure may change.

We mounted the N-type connector on a 1-⅛ by 2-½ inch wide piece of copper made from a section of ⅜ inch copper refrigerator pipe. We used a hacksaw to cut a 1-⅛ inch ring of pipe, then cut the ring laterally and opened it up to form a rectangle. Next, we bent the rectangle into an "L" shaped piece and drilled it to accommodate the N-type panel mount connector. The shorting clamps were made from a ¼ inch wide piece of copper fashioned in the same manner; the matching rods were made from the same ⅛ inch brass rod as the elements.

In order to achieve right-hand circular polarization (the convention on OSCAR-10 and OSCAR-13), the T-matches must be constructed so that the non-delayed side of the vertical (forward) antenna points "up," and the non-delayed side of the horizontal (aft) antenna is clockwise from it while looking forward along the reflector end of the boom.

Tune-Up

Tuning up this antenna is really quite simple. Insert a Bird directional wattmeter, or an SWR bridge rated for the frequency, in the line as close to the antenna as possible. Tune for the lowest reflected power by sliding the shorting bars in and out. Keep in mind that the bars should be located equidistant from the center of the boom. When you determine the correct placement of the shorting bars, solder them in place. You should easily obtain an SWR of less than 1.2:1 on each antenna.

The Phasing Harness

If you are going to feed two 50Ω antennas with one 50Ω coaxial cable, you'll need a phasing harness. This phasing harness not only splits the power between each antenna, it also matches the impedances.

The phasing harness shown in Figure 2 will feed both antennas in phase, thereby producing right-hand circular polarization. Any odd quarter wavelength of 75Ω cable will transform 50Ω up to 100Ω. Two 100Ω systems in parallel will equal 50Ω. For ease of construction, we used a ¾ wavelength piece (taking into account the velocity factor) of RG-11 cable on each side.

Connect the harness to both antennas and tape or tie-wrap it close to the boom. It would be a good idea to recheck the SWR of the system at this point. It should still be quite low.

70 CM CROSSED-YAGI DESIGN DETAILS:

DESIGN FREQUENCY:	435.30 MHZ
WAVELENGTH:	26-13/16 IN
NUMBER OF ELEMENTS:	15
DIAMETER OF BOOM:	3/4 IN
DIAMETER OF ELEMENTS:	1/8 IN

ELEMENTS ARE ELECTRICALLY CONNECTED TO THE BOOM!!!

MAXIMUM PRACTICAL GAIN: 13.95 dB OVER A DIPOLE

ELEMENT LENGTHS (INCHES)

REFLECTOR	13-19/32	DIRECTOR # 7	11-19/32
DRIVEN ELEMENT	12-29/32	DIRECTOR # 8	11-1/2
DIRECTOR # 1	12-9/32	DIRECTOR # 9	11-7/16
DIRECTOR # 2	12-5/32	DIRECTOR # 10	11-3/8
DIRECTOR # 3	12-1/32	DIRECTOR # 11	11-5/16
DIRECTOR # 4	11-29/32	DIRECTOR # 12	11-9/32
DIRECTOR # 5	11-25/32	DIRECTOR # 13	11-7/32
DIRECTOR # 6	11-11/16		

DISTANCE FROM REFLECTOR END OF BOOM (INCHES)

ELEMENT	HORIZONTAL YAGI	VERTICAL YAGI
REFLECTOR	2-1/2	9-9/32
DRIVEN ELEMENT	9	15-25/32
DIRECTOR # 1	11-23/32	18-1/2
DIRECTOR # 2	16-19/32	23-3/8
DIRECTOR # 3	22-7/16	29-7/32
DIRECTOR # 4	29-7/32	36
DIRECTOR # 5	36-25/32	43-19/32
DIRECTOR # 6	44-15/16	51-23/32
DIRECTOR # 7	53-15/32	60-1/4
DIRECTOR # 8	62-13/32	69-3/16
DIRECTOR # 9	71-25/32	78-9/16
DIRECTOR # 10	81-17/32	88-5/16
DIRECTOR # 11	91-11/16	98-15/32
DIRECTOR # 12	102-1/8	108-15/16
DIRECTOR # 13	112-23/32	119-1/2

Table 1.

Final Prep

We suggest two more steps before installing the antenna. First, it would be a good idea to paint the antenna. Some knowledgeable people have told us that, due to the crystalline grain structure of brass, constant exposure to the outdoor elements will make it brittle. Painting the antenna will help prevent this, and will make it look better.

Secondly, it's a good idea to somehow plug the ends of the boom. If you don't, insects such as wasps and spiders will make their homes there. We plugged the ends of our boom with a glob of silicon "pookie." This seems to have done the trick!

Results

We put the completed antenna into service at the QTH of KG5OA about six months ago. Though no official gain measurements have been made, the antenna seems to work as planned. In Mode "B", we make QSOs through OSCAR-10 and OSCAR-13 easily with 10 to 40 Watts output, depending on the satellite's attitude. In Mode "J", we've made many QSOs with the antenna mounted above the HF antenna, with 75 feet of 9913 and the preamp in the shack.

I hope that you try to home-brew at least some of your satellite station. Antennas are a good place to start. You don't have to use the exact materials or the exact methods presented here; I'm sure that other methods will work as well. Just be innovative and use the materials that are probably all around you. Good luck and see you on OSCAR-13!

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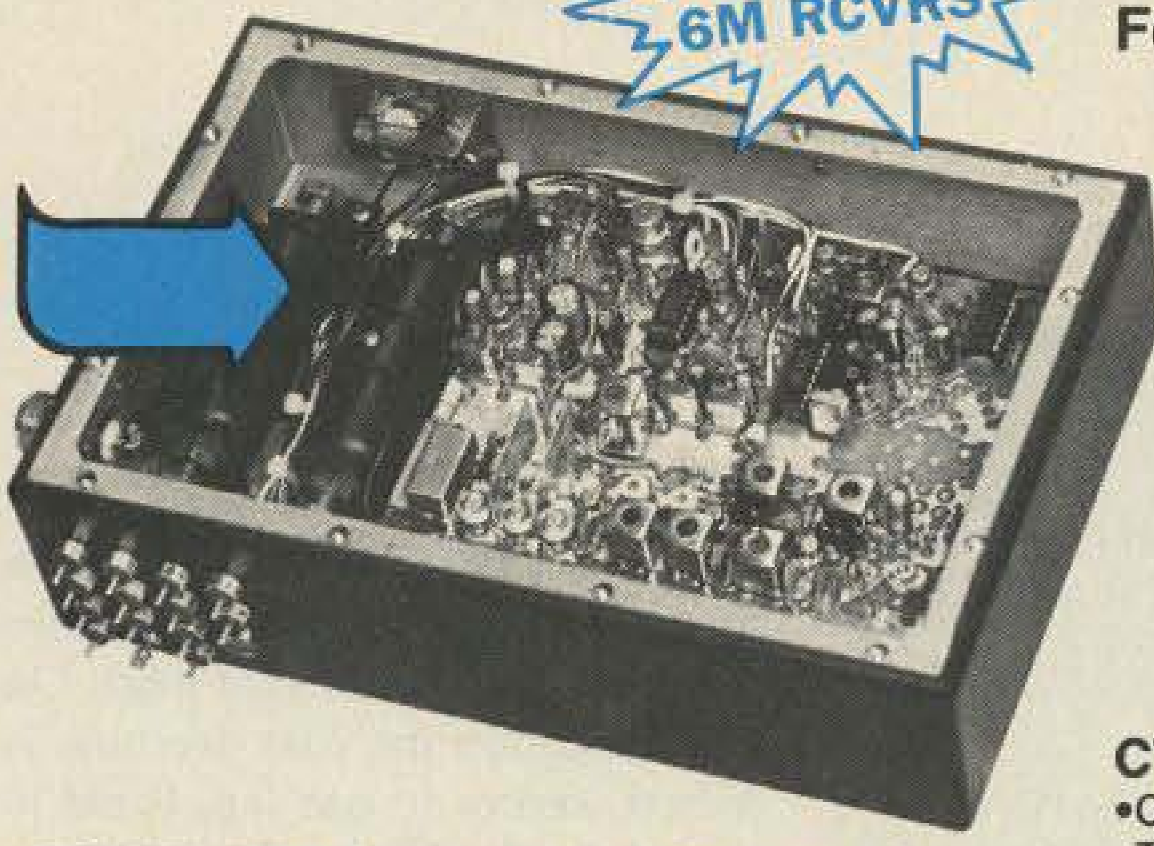

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- Sel. -6dB @ ± 6.5 KHz. -130dB @ ±30KHz. (8 Pole Crystal + 4 Pole Ceramic Fltrs.
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Complete Receiver Assemblies

- Rcvr. Board mounted in shielded housing.
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- As used in the SCR 1000. Ready to drop into your system!
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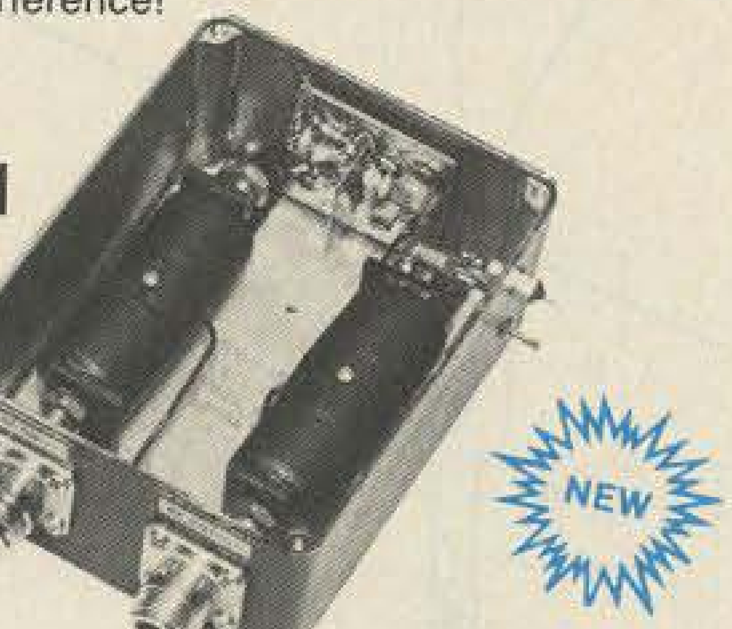

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- Extremely helpful at sites with many nearby transmitters to "filter-out" these out-of-band signals.

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ID250A CW ID & Audio Mixer Board

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- 4 input AF Mixer & Local Mic. amp.
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- Up to 4 different ID channels!
- Many other features. Factory programmed.

CTC100 Rptr. COR Timer/Control Bd.

- Complete solid state control for rptr. COR, "Hang" Timer, "Time-Out" Timer, TX local & remote Shutdown/Reset, etc.
- Includes inputs & outputs for panel controls & lamps.

Power Supply Boards

NEW

- **SCP12** 12 VDC @ 0.3A MAX. OUT.
- **SCP512** 12 VDC @ 1A & 5VDC @ 0.4A out. (1.1A total max. out.)
- **SCP512A** As above, but also w/−12VDC @ 0.1A

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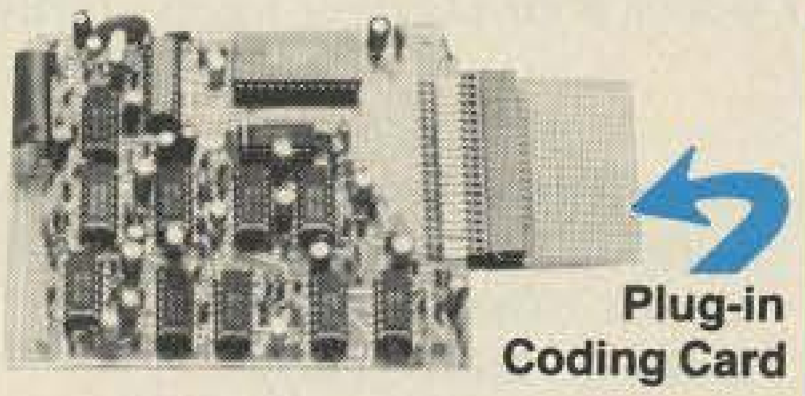

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TTC300 TOUCH TONE CONTROLLER

- High performance, Super versatile design. To control any ON/OFF Function at a remote site via DTMF Radio Link.
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NEW

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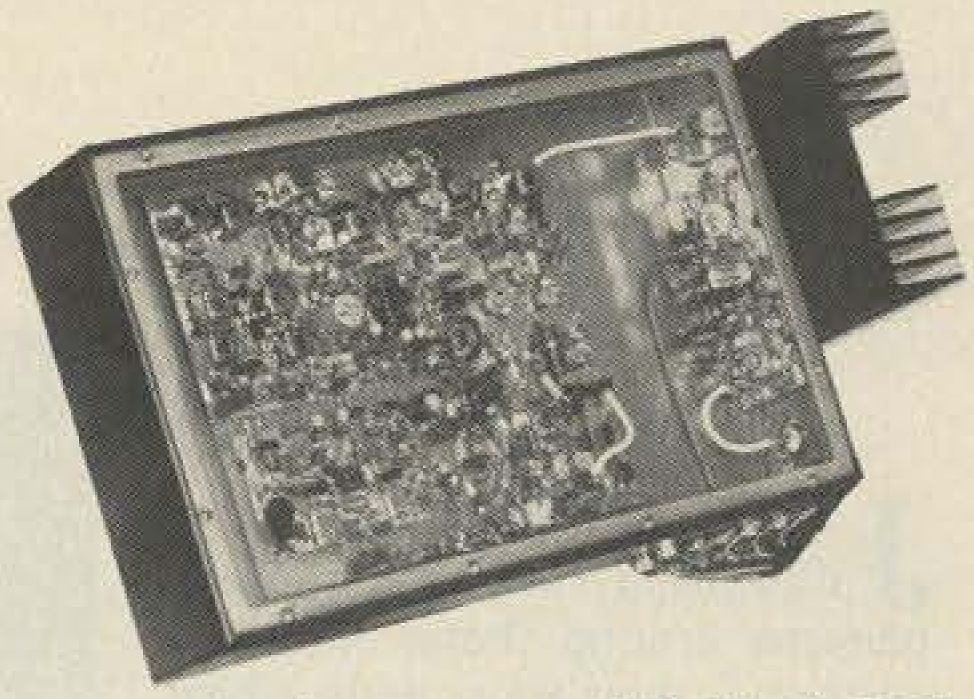
- 13.8 VDC out. 115/230 in, 50/60 Hz.
- 30A @ 70% duty, 25A @ 100% duty.
- Massive 30 lb. Transformer & Heat Sinks.



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SCT110 VHF Xmtr/Exciter Board

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- Withstands High VSWR
- True FM for exc. audio quality
- Designed specificially for continuous rptr. service. Very low in "white noise."
- Spurious − 75 dB. Harmonics − 60 dB.
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- ***SCT110 mounted in shielded housing***
- Same as used on SCR 1000 & 2000X
- Completely assmbld. w/F.T. caps, SO239 conn.
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- Similar to SCT110, 10 Wts. nom.
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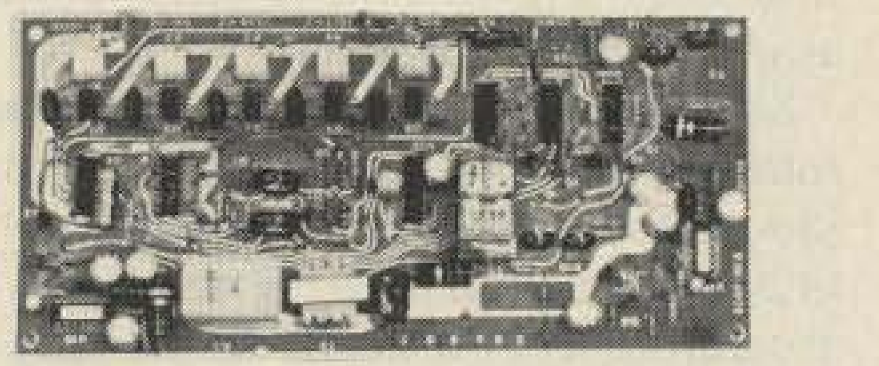

SCAP Autopatch Board

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- Write/call for details and a data sheet

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- Gas Discharge Tube shunts phone line surges to ground
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AANother Turnstile Antenna

Enhanced turnstile design for hamsat operation.

by Henry Falkner ZL1AAN

J-poles and Slim Jims have doughnut-shaped radiating patterns around them. Mounted vertically, they allow early signal acquisition when a satellite rises over the horizon. But on overhead passes, a couple of nulls spoil data acquisition. A Slim Jim is just an end-fed folded dipole, and therefore has no dBd gain.

It used to take me all week to get a bulletin off OSCAR 11 with a low fault rate, i.e., 500 or less misread characters for every 10K bytes of data.

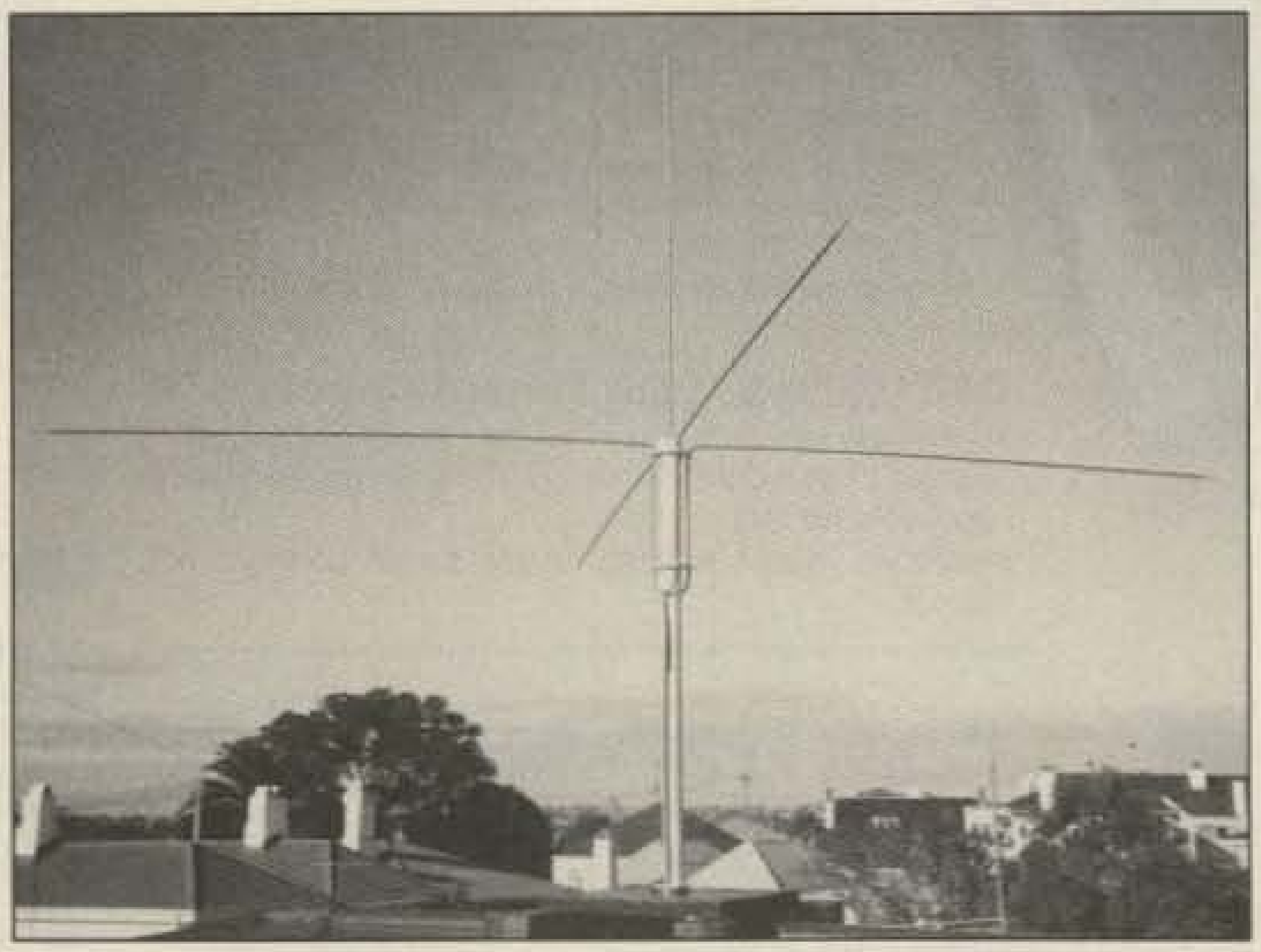

Photo A. My turnstile was derived from two collinears placed back-to-back, using ¼-wave phasing sections. The antenna has survived Cyclone Bola and three weeks of unseasonal summer rain.

Finding the Right Signal

The satellite enthusiast has to pick out one signal source in the sky, pushing out as little as 200 mW. This is like trying to find one piece of grit on a football that is covered with grit. You have to be able to recognize which piece of grit is the one you're after.

On VHF, your unwanted pieces of grit are ignition noise and strong, out-of-band utility stations, some of them mobile. They contribute to the noise on your wanted frequency because today's transceivers have untuned front ends. The first mixer has to block them as well as it possibly can.

So you write a check for the latest beam and rotator. Then you find that low-orbit satellites pass over from horizon to horizon in 10 to 20 minutes, and tracking the bird by manual control becomes hit and miss. Yes, you can use your computer to do that job for you, but you have to write out another check for the interface that talks to your rotator.

Horizontally Polarized Turnstile

There is one type of antenna that looks at the piece of sky your vertical antennas miss. This is the turnstile. It also happens that most unwanted signal sources (e.g., mobiles) radiate vertically, so their signal is vertically polarized. The turnstile looks at horizontally polarized signals. Satellites put out circularly polarized signals. It turns out that for most of a pass, a horizontally polarized antenna will give you more signal above the noise than a vertically polarized antenna.

The traditional turnstile consists of two crossed dipoles connected by ¼-wave phasing line. It needs a matching stub between antenna and feedline. The design is not considered easily matched for transmission.

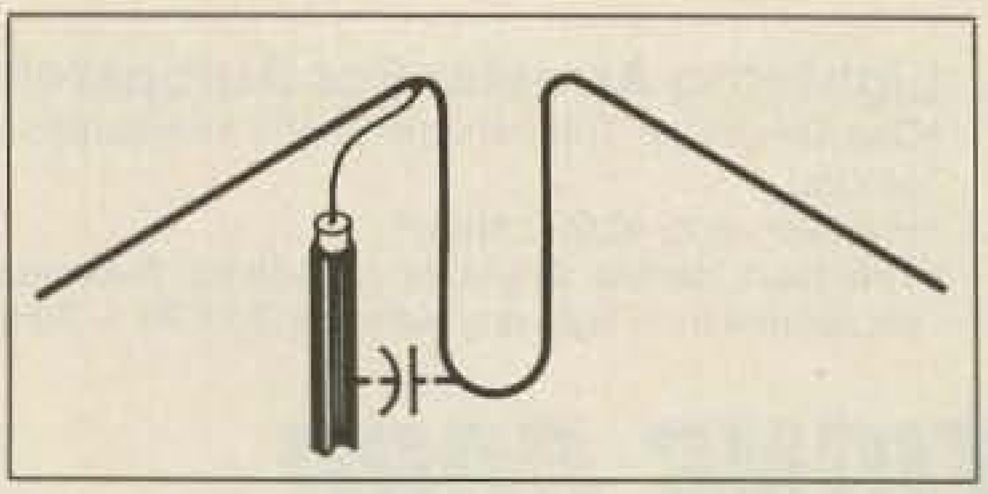

Figure 1. The basic array.

Well-Tested Design

My turnstile has four ½-wave elements at right angles. Each two are joined by a U-section ⅛-wavelength high, so you have two assemblies with a ¼-wave phasing section, as shown in Figure 1.

You need two assemblies in order to avoid a sharp null. These two assemblies are joined by another U-section ¼-wavelength high. On this U-section the coax-feedline is joined, center to one leg, braid to the other. See Figure 2. For 2 meters, the feedpoint is very close to four inches below the top of the ¼-wave U-section. This feeding method acts as a balun as well as an impedance match.

I have built three prototypes, one with ⅜-inch aluminum tubing, particle board, and a PVC pipe mast section. The other two are made from ¼-inch brass tubing, which

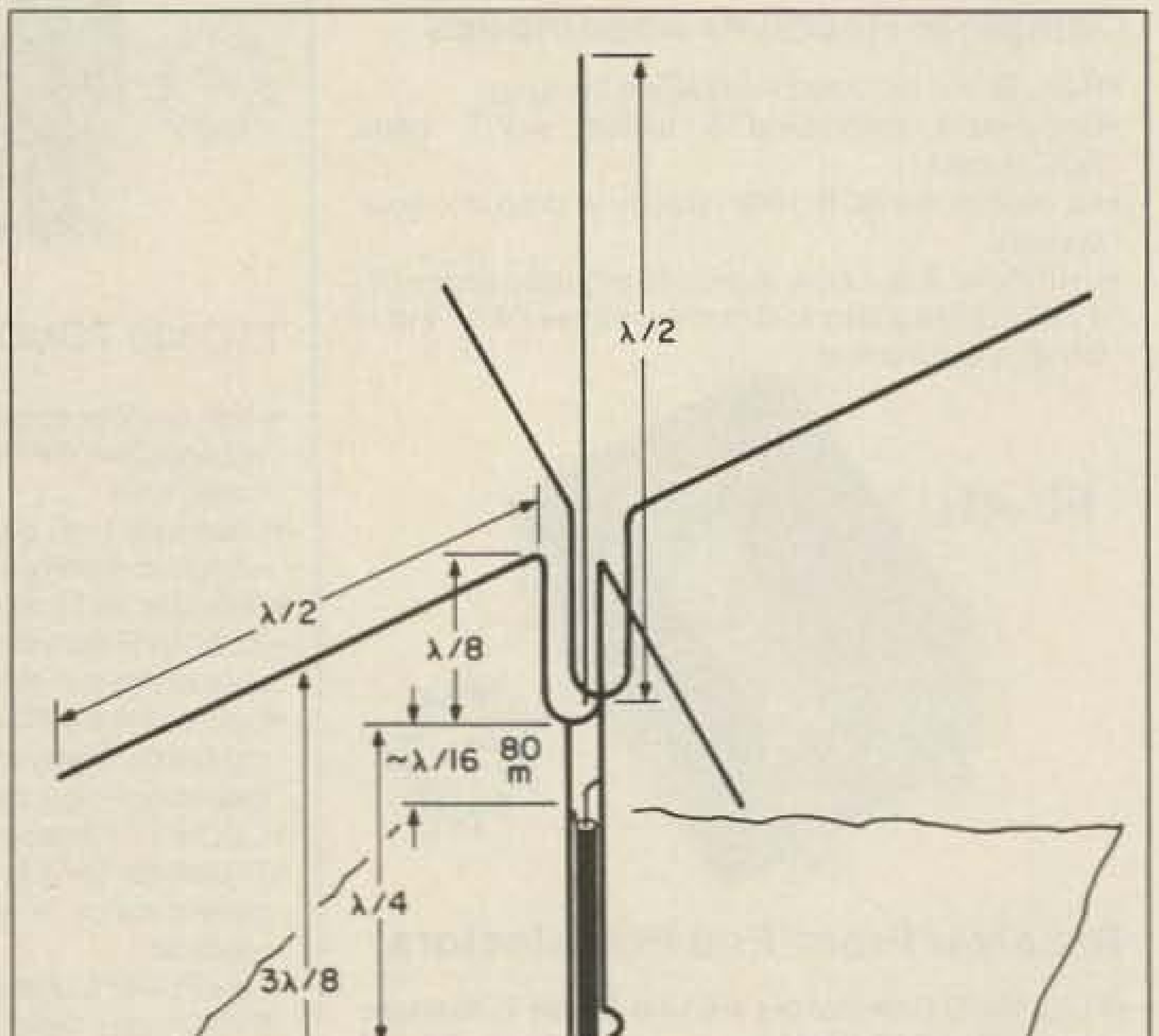

Figure 2. The turnstile has four ½-wave elements at right angles. With two assemblies, you avoid a sharp null. These two assemblies are joined by another U-section ¼-wavelength high. On this U-section the coax-feedline is joined, center to one leg, braid to the other. For 2 meters, the feedpoint is very close to four inches below the top of the ¼-wave U-section. This feeding method acts as a balun as well as an impedance match.

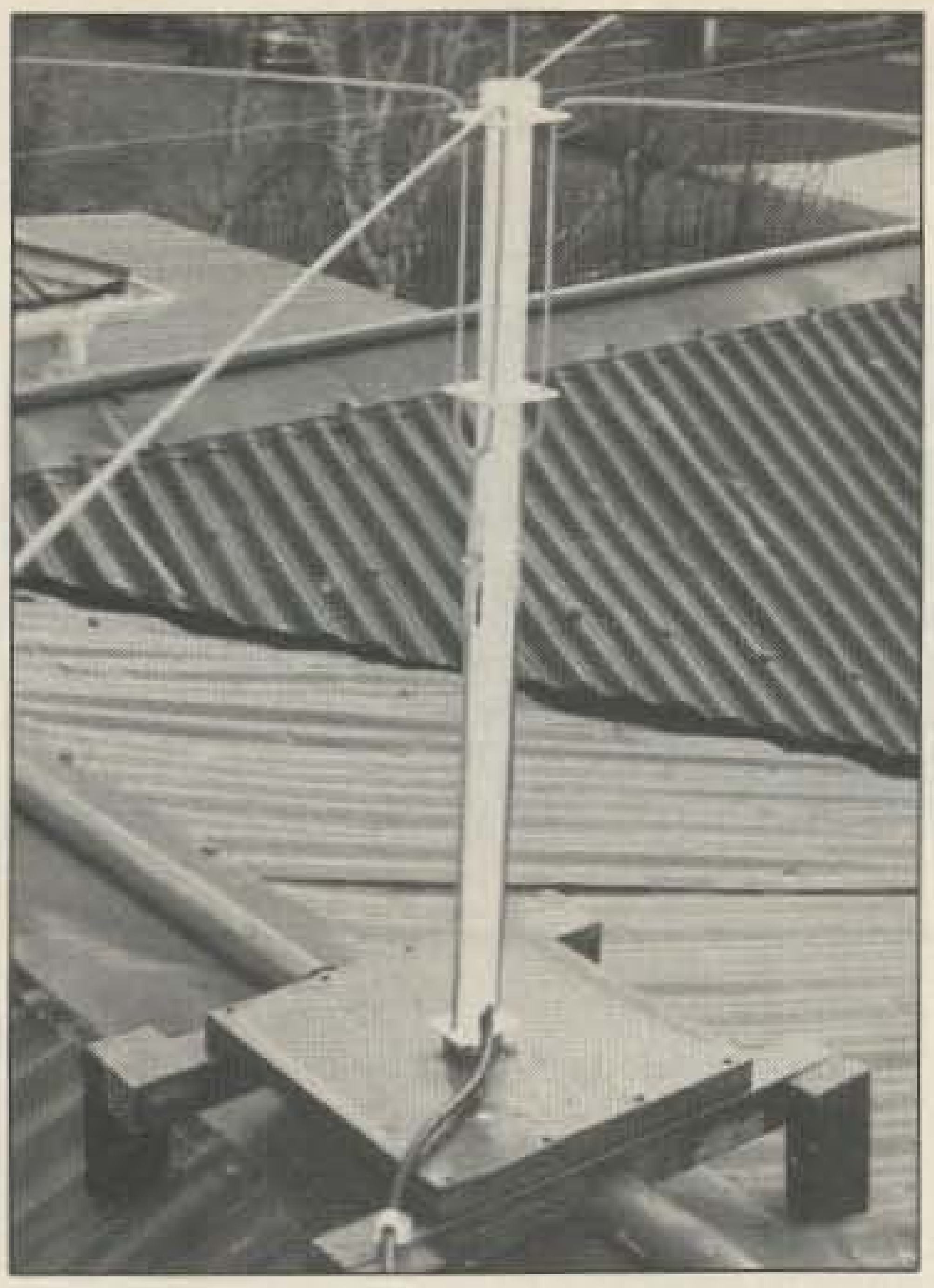

Photo B. The collinear sections are made from single lengths of ¼-inch brass tubing. The coax-feedline comes up through the PVC mast. It is matched to the turnstile by a ½-wave section joining the two collinears. The roof is the reflector.

you can bend in a vice around a piece of pipe. The photographs show the PVC supports on the ⅜-wavelength high mast section, and how the antenna is placed on the metal roof, which acts as a reflector. These three prototypes showed that the width of the U-sections is not critical. Performance is consistent among all prototypes.

"Just Take a Collinear and Bend..."

Over the last twelve months I have found that these turnstiles can receive decodable signals from less than 170 degrees longitude to more than 200 degrees longitude. Auckland in New Zealand (my QTH) is at 185 degrees longitude East. The fault rate over 10K bytes averages 100. Each week I've been able to save 5K bulletins with less than 50 errors. Frequently, the errors are as few as ten.

On overhead passes of RS-13, my downlink is as strong as a Christchurch station's using a 10-element beam. Over the whole pass, the worst reports have been 5 by 5. *Mir* was a doddle. All my six replies were acknowledged, some of them transmitted at 5 Watts instead of 30 Watts.

This design does not distinguish between right-hand and left-hand polarization. You might be able to use it as the basic element of a crossed yagi, the only drawback being the resulting dimensions at 2 meters.

Why didn't anyone think of this method before? Just take a collinear and bend the elements to 90 degrees between each other. Then replace the ½-wave phasing line with a ¼-wave phasing line, and place two of these adapted collinears back-to-back. Finally, join them with a ½-wave phasing line which matches into your coax, and you are in business.

Thanks to Irvin Spackman ZL1MO for appraisal and suggestions. 73

73 Review *by Ed Clegg W3LOY*

TS-790A

Preview of Kenwood's latest OSCAR rig.

Kenwood USA Corp.,
PO Box 22745
Long Beach, CA 90801-5745
(213) 639-4200
Price Class: $2000

This entry into the goodies available to the increasing number of OSCAR 13 operators has stirred up a lot of enthusiasm and anticipation. Although I had read all of Kenwood's magazine advertisements and press releases, I had yet to see a unit, much less enjoy the opportunity to operate one from my own shack.

I am fortunate in having available an extensive complement of laboratory-grade instrumentation as a result of an earlier venture in manufacturing ham UHF and VHF equipment. Consequently, I always feel certain that the gear in my ham shack is at the peak of performance. I spend much more time tweaking and updating than I do operating. Now, I was about to have a chance to see how close a box manufactured many thousands of miles across the sea could come to approaching the performance of the satellite equipment that I treat with such tender loving care. There was no question in my mind that a single, multiband transceiver had to be inferior to the installation of receivers, converters, transverters, preamps, linear amps, power supplies, etc., that constitutes my OSCAR station.

As I unpacked the neat and compact transceiver, I became even more convinced that it would have to run a poor second in performance to my accumulation of satellite hardware. Anything that could be packed this compactly must have lots of design compromises and performance tradeoffs!

I don't think I'm unique when it comes to getting a new "toy": I want to make it play at once. I can always read the Instruction Manual later, when the band is dead. Sometimes I want to skim through the manual briefly to orient myself, but the main objective is to connect the power supply and the antenna and "make like a radio ham."

With this radio you cannot follow this routine! You'll have to STUDY the Manual to operate the features of this radio. The 790A is really three transceivers, each with three operating modes.

After several hours of reviewing the instruction manual, I later felt qualified to do more than work 146.52 simplex, but I was still hazy about using some of the more complex features.

General Operating Features

It's very difficult to describe all of the many operating features of this remarkable transceiver. Only a "hands-on" examination will let you appreciate the intricacies of the design.

First of all, the front panel's 43 switches and rotary controls are intimidating enough even before you realize that a majority of them serve different functions, depending upon the chosen position of some of the others. Unfortunately, even after intensive study of the manual, some of the interdependence of these controls is not apparent.

From the operator's viewpoint, the 790A consists of three multimode transceivers. At any given instant you can listen on two different bands with independent selection of mode, tuning, squelch threshold, volume, etc. One of these two is designated as the "MAIN" receiver, while the other serves as the "SUB" receiver. A single panel switch lets you reverse the two. The principal operating difference is that the MAIN unit also functions as the transmitter. The SUB Receiver will continue to serve its selected functions regardless of the current mode of the MAIN unit. The frequency of either unit can be tuned without affecting the other. The only limitation is that the MAIN and the SUB may not be on the same band.

The selected status of the MAIN and the SUB sections can be exchanged at any instant by means of the MAIN/SUB function key. Each section has an A and B VFO, selectable at will. Either active section can be switched to operate from any one of 59 programmed memory frequencies; all attributes of mode, offset, CTCSS, etc., are retained in memory. Flexibility of frequency, mode, offset, tone, squelch, audio volume, etc., is virtually unlimited. I don't have the time or the space here to include all of the many more things that you can do with this unit!

Satellite Operation

Although the TS-790A can fully service the operating needs of any VHF/UHF/microwave enthusiast, it will probably appeal principally to the ham who operates (or plans to operate) using the OSCAR, UoSAT, JAMSAT and RS Satellites.

Unfortunately, the unit I received to review did not have the optional 1200 MHz module, UT-10. So, I was unable to put it through its paces on OSCAR 13, Mode L. I was, however, able to do all of the other exciting things provided by both OSCAR 10 and OSCAR 13 on Modes B and JL. In addition, I had two QSOs with Alexander U4MIR, on the Russian MIR space platform. All this in just a few days!

Automatic Down Link Frequency Finder

One of the problems that I have had with my present equipment has been the need to set my separate receiver and transmitter to the appropriate uplink and downlink frequencies, corrected for Doppler and the round trip time delay. The TS-790A neatly solves this by allowing you to program into memory the appropriate numerical value representing the sum of the uplink and downlink frequencies, a constant for each of the satellites. You can store and retrieve this number for as many as ten different transponders, then just tune the SUB receiver to the desired frequency and push the SAT key. This will automatically move the MAIN unit to the appropriate transmit frequency. Alternatively, you can set the MAIN section to the desired transmit frequency first, and then push the SAT key. The SUB receiver will automatically move to the appropriate down link frequency. I am certainly going to miss this capability when I have to relinquish the 790A and am forced to do it the hard way again.

I found only one area where the transceiver needed help. On both 2 meter and 70 centimeter operation, the input signal required to activate the S Meter was far in excess of the level of signals received from existing Phase III satellites. This is not necessarily a bad thing because, except for installations with very short feedlines to the antenna system, you'll want to install a preamp at or near the antenna.

In my specific installation, the GaAsFET preamplifiers determine the system noise floor. With these in line, the TS-790A S Meter is indeed quite comfortably scaled. Incidentally, the MAIN section has a conventional analog meter for signal strength display, while the SUB section boasts a very fine resolution LCD display for signal strength. I was pleasantly surprised to measure the actual noise-floor of the receiver on both 2 meters and 70 cm at about 0.019 fV (for 3 dB S+N/N). Adding my GaAsFET preamp improved this by about 2 dB to 0.015 fV.

MANUFACTURER'S SPECS

General

Frequency Ranges:	144 to 148 MHz 430 to 450 MHz 1240 to 1300 MHz
Power Requirement:	13.8 VDC 2.5 A Receive (no signal) 8 to 12 Amps on Transmit depending on frequency and mode.
Dimensions (WxHxD):	13-15/32" x 5-9/32" x 14-17/32" (342 x 134 x 369 mm)
Weight:	20.2 pounds (9.2 kg)
Freq. Stability:	Less than 3 PPM (except on FM)
Operating Temp:	−10 to +50 degrees C. +14 to +122 degrees F.

Transmitter

Output Power:	2 Meter Band	35 Watts LSB/USB 45 Watts CW/FM
	70 cm Band	30 Watts LSB/USB 40 Watts CW/FM
	23 cm Band	10 Watts all modes
Spurious Radiation:	2 Meters/70 cm	Less than −60 dB
	23 cm	Less than −50 dB
Carrier Suppression:		More than 40 dB (1500 Hz reference)
Unwanted Sideband:		Down more than 40 dB
Maximum FM deviation:		+/−5 kHz
SSB Freq. Response:		400 to 2600 Hz at −6 dB
Microphone Impedance:		600Ω

Receiver

NOTE: The TS-790A actually has two receivers for each of the three bands; a "MAIN" and a "SUB" receiver. At any given time it is possible to operate the unit with two independently controlled receiving systems active. The only restriction is that the two receivers must be on separate bands.

Circuitry:	2m Band	SSB/CW—Single Conversion FM—Double Conversion
	70 cm Band	SSB/CW—Double Conversion FM—Triple Conversion
	23 cm Band	SSB/CW—Triple Conversion FM—Quadruple Conversion
Sensitivity:	SSB/CW	Less than .16 fV @ 10 dB S+N to N all bands.
	FM	Less than 0.22 fV at 12 dB SINAD on all bands.
Selectivity:	SSB	2.1 kHz at −6 dB 4.8 kHz at −60 dB
	CW	500 Hz at −6 dB 2 kHz at −50 dB
	FM	12 kHz at −6 dB 24 kHz at −60 dB
Audio Output:		1.5 Watts across 8Ω load at 10% THD

(There is also a TS-790E model with somewhat different specifications, principally more restricted frequency coverage.)

Power output on both bands was in excess of that specified by Kenwood. I was initially surprised at the specified higher output ratings for the FM modes vs. the SSB modes. Presumably this is a function of linear range vs. saturation operation for FM. The unit employs multi-stage "bricks" for all the RF Power stages on both 70 cm and 2 meters, and as the driver stage on 1200 MHz. A discrete bipolar transistor serves as the 1200 MHz PA.

Summary

Early in this article I expressed my doubts regarding the ability of a package as compact and attractive as the TS-790A to have the capability to compare favorably with a multi-component dedicated satellite assembly of equipment. I can now say that my doubts were unfounded. Other than the definite desirability to add external low noise preamps, this unit matches my equipment across the board. And the XYL might let me bring a package this attractive up from the basement "studio"!

I have only one major concern about operation with transceiver-type multiband equipment. You must be very, very careful to never activate the transmit function on the band where you have your receiving preamplifier, or goodbye, GaAsFET. Once you're comfortably familiar with the MAIN and SUB sections of this unit, this situation shouldn't be too high a probability. But, I nearly did it twice. Fortunately the MAIN was in the SSB mode with the microphone gain all the way down. Whew!

I have neglected to say as much about the FM operation and the many scanning features as the radio deserves. Look for a full report on this unit in a future issue of *73*. 73

Mode S Receive Techniques

Here's how to get on hamsat's newest active mode.

by John W. Molnar WA3ETD

Most satellite operators are familiar with the systems required to access OSCAR-13's Mode B and Mode L. However, OSCAR-13 offers yet another challenge—Mode S—which requires the user to receive an S-band microwave downlink signal at 2400.325 MHz.

The Experimenter's Mode

For now, the only Mode S transponder can support a couple of simultaneous QSOs. Right now, simultaneous QSOs are infrequent, but the trend in amateur satellites is toward our higher microwave frequencies that can support high speed digital communications as well as all the conventional modes.

This article describes several receive-only systems that will allow the experimenter to copy the Mode S downlink and beacon. (The Mode S uplink is in the 70 cm band.) If you already own a 2304 MHz transverter, you are well on your way to receiving the Mode S beacon. I will describe the minor modifications which allow the LMW 2304 and SSB Systems transverters to receive on 2400 MHz. I will also discuss the required low noise preamplifier, and the antenna systems.

LMW Transverter Mod

In my initial attempt to copy the Mode S beacon, I used an LMW 2304 transverter with IF output at 144 MHz. This medium-priced transverter is marketed by *Down East Microwave, Box 2310, RR 1, Troy ME 04987. (207) 948-3741.* The local oscillator uses a 93–95 MHz overtone crystal, multiplied twelve times. The resulting signal is directly used in the LMW 1296 transverter, and is doubled to the 2160 MHz range in the 2304 MHz unit.

You can convert the LMW to 2400 MHz for Mode S by replacing the Local Oscillator (LO) crystal, retuning the LO, then retuning the receive mixer. The only difficult part of the conversion is retuning the filters on the LMW Universal LO board. They are very sharp. Some method of determining RF output at 1128 MHz is necessary, such as a diode RF probe and sensitive voltmeter.

Obtain a 94.00 MHz fifth overtone series crystal from your favorite quartz outlet. Replace the existing crystal with the new one on the UVLO board. Disconnect both LO output cables from the points marked "X" and "Y" on the board. The LO should tune up with no problems at 94.00 MHz.

I found that the fastest way to accomplish the tune-up was to listen for the progressively higher harmonics on a VHF receiver (or scanner). Observe the output at point "Y" on the board, and peak it with VC9. Although output point "Y" originally provided LO for the transmit mixer, I used it to drive the receive mixer, as the additional output allows some margin for error when peaking the filters, VC5–VC7. Note that the tune-up procedure offered in the LMW manual will also work, since the new crystal is within the operational range of the UVLO board.

Once the LO is tuned up, it is a simple matter to peak up the receive mixer. The only critical adjustment is VC5 on the mixer board. A signal source is required to peak up the mixer. Most signal generators provide output at 150 MHz, and the 16th harmonic of 150 MHz is 2400 MHz. Again, I found that the only adjustment required on the mixer is VC5. Adjusting the preceding amplifier sections had no real effect because the stages are very broad. Once the following step has been completed the LMW transverter is ready for Mode S.

SSB Transverter Mod

Another transverter suitable for 2400 MHz work is the SSB Electronics unit available from *Transverters Unlimited, Box 178, New Boston NH 03070.* The required components are the SLO-13, the local oscillator, and the SRM-13 receive mixer. These modules are provided with BNC connectors for system interconnections.

The SSB components are a snap to convert. You only need to swap crystals! Replace the existing rock with the 94.00 MHz crystal specified for the LMW unit. The SSB LO uses the same multiplication scheme: crystal frequency x 24 plus 144 MHz IF = receive frequency. The filters in the SSB unit are obviously not as sharp as those in the LMW, as no adjustments were required to copy the 2400 MHz test signal.

Low Noise Preamplifier

Both receive mixers described above have internal low noise preamplifiers with noise figures in the 1.5–2.0 dB range. Considering the received signal levels and feedline losses at 2400 MHz, you need a high quality external preamp for this application.

Last fall, Al Ward WB5LUA presented a paper on state-of-the-art low noise preamplifiers at the Microwave Update 1988 convention. I acquired one of his S-band preamp kits, which uses an ATF10135 device, and has a noise figure of around 0.6 dB. Al offers his PC board and device through the mail, and it is a natural for Mode S (or 2304 weak signal work) downlink. In fact, it's necessary. Write him at *AL Ward WB5LUA, Rt. 9 Box 132, McKinney, TX 75069.* You can build the preamp in an hour. It doesn't need a tune-up.

Antenna System

You need an antenna system with gain of 25 dBi or better to copy Mode S. I used a four-foot parabolic dish originally used by Public Service for point-to-point communications. This dish has a focal length-to-diameter ratio (f/D) of 0.375, which puts it at the outer limit of being easy to feed with circular feedhorn. I constructed a custom coffee-can feed using copper roof flashing, although I believe an actual one-pound coffee can would work at 2400 MHz.

About the circular waveguide feedhorn for 2400 MHz: The horn is 5.125″ long and 3.25″ in diameter. There is a 1″ probe made of #12 bare copper wire soldered at the center conductor of a Type "N" panel connector. The connector is then soldered to the feedhorn. The center conductor and probe are exactly 2.9″ above the closed end of the feed.

For specific details on microwave feedhorns, refer to the *ARRL Handbook* and the RSGB *VHF/UHF Manual.* Any dish four feet or more in diameter should work as long as you are able to point it at the satellite at apogee. You could also use yagi antennas, but you would have to stack several of them to obtain the necessary gain. Four Down East Microwave 45-element loop yagis, stacked, would possibly work, and have much less wind loading than a dish. As far as the numbers go, the four-foot dish at 2400 MHz has 26 dBi of gain, assuming 50% feed efficiency. Four 45-element loop yagis exhibit about 25 dBi when stacked.

Putting It all Together

The preamplifier should be connected as close to the feedhorn as possible. I connected the WB5LUA preamp to my horn with 6″ of 0.141″ semi-rigid hardline, and used a 24″ piece of 9913 to connect the preamp to the LMW transverter sitting below the dish. The LMW has enough gain at 144 MHz to drive a 10-foot piece of 9913 running into my basement shack. A motorcycle battery provided power to the LMW. I was able to copy the Mode S beacon during initial tests with this system. Signals were 4 to 6 dB above the noise.

Hopefully, this information will tempt you to try Mode S. If you are already on 2304 MHz, you could have a usable station for the cost of a crystal and a preamp which will serve you well during the next UHF contest. Consult the normal AMSAT information outlets for Mode S scheduling, as the transponder is not activated on a regular schedule. For more information on Mode S, you can also contact *Bill McCaa KØRZ, Box 3214, Boulder CO.* 73

Number 31 on your Feedback card

HAM HELP

Your Bulletin Board

We are happy to provide Ham Help listings free on a space available basis. To make our job easier, and to ensure that your listing is correct, please type or print your request clearly, double spaced, on a full (8½" x 11") sheet of paper. Use upper- and lowercase letters, and print numbers carefully—a 1, for example, can be misread as the letters l or i, or even the number 7. Thank you for your cooperation.

Wanted: Used shortwave receivers—Japan Radio NRD-515, ICOM R-71A, Kenwood R-5000 or Yaesu FRG-8800, etc. Please send information on price and condition. Thank you.

Steve Hayes
5900 218th Ave. E.
Booney Lake WA 98390

Needed: A schematic and/or manual for the SWAN 350B. I will gladly pay all costs in reproducing/mailing. Thanks.

Gene A. Hill/ZS6ATG
(N5JRC)
Pretoria/Dept. of State
Washington DC 20520-9300

Wanted: Source for new or used Touchtone™ pad and front panel for Heath VF-2031 Handi-Talkie. Heath has discontinued. Thanks very much.

Bob Workman WA4ZZN
PO Box 942
Atlantic Beach NC 28512

Desperately seeking reasonably priced schematic for grid dip in pints or quartz. Any info appreciated. Tnx.

Mac PH0NEY
Yellow Brick Rd. W.
SE Central Vassalboro NH

I need a manual/schematic for a Yaesu FTdx 560 transceiver. Will pay for any costs.

Martin Roe WB0JNV
4903 Riverside Trail
Berrien Springs MI 49103

I need a RTTY program for the Commodore 64 to use with my home-built RTTY demodulator. I need a program I can type in.

Randall Reese
45 House, Apt. 504
8/1 Sukhumvit 45
Prakanong
Bangkok Thailand

Wanted: Instruction manual (tube element settings) for Lafayette Tube Tester Model TE-55. Will pay photocopy and postage. Please help!

Jock Fisher VK1LF
PO Box 94
Lyons, Canberra
A.C.T. 2606 AUSTRALIA

Please help, need diagram or book and DB Meter for N T 46154B (RBA-7), Serial no. 1820.

E.J. Ainsworth K5OPO
Star Route Box 120
Braxton MS 39044

Need for Hallicrafters HT-37 transmitter: control-socket plug 86-PM11 Amphenol (has 11 pins), and microphone plug 75-MC1F Amphenol (has one center contact and screws on). I would appreciate any help. Please write with price.

Rick Bledsoe
HCR 1 Box 4004
Shell Knob MO 65747

Old manual needed! I just picked up a Hallicrafters SR-150 rig, and need to get a copy of the operator's manual and schematics. I will gladly pay any reasonable costs incurred. Thanks very much!

Jim Bail KA1TGA
19 Granite Street #6
Peterborough NH 03458

I am looking to complete a collection of U.S. and Canadian ham-call license plates to go on display. I will pay any reasonable mailing costs incurred. Thanks!

Bryan Hastings NS1B
64 Concord Street
Peterborough NH 03458

AMSAT Satellite Tracking Software

Pick from a passel of great tracking programs.

by Keith Pugh W5IU

Predicting when to listen for a satellite and where to point the antennas are basic requirements for successful amateur satellite communications. Before home computers, Equator crossing information was published and used with graphic devices, such as the OSCAR LOCATOR, to keep up with the low-altitude satellites with circular orbits. These methods are satisfactory, inexpensive, and still used today. However, graphic tracking methods for the Phase III, high-altitude satellites with the more complex elliptical orbits are much less satisfactory. Satellite tracking by home computer has become very popular.

Good Idea at the Right Time

AMSAT Satellite Tracking Software began with an article titled "BASIC Orbits," by Dr. Tom Clark W3IWI, in the March/April 1981 issue of *Orbit* magazine. He described his program, written in North-Star Basic, in detail, and provided the program listing.

President of AMSAT at the time, Dr. Clark donated the rights to the program to AMSAT and thought of starting the AMSAT Software Exchange as a medium for distributing the program and collecting donations for AMSAT from users. Having just suffered the loss of the Phase IIIA satellite, AMSAT badly needed funds to begin the Phase IIIB project.

Not everyone had a North-Star computer, so many hams converted the program. As versions tailored to other computers appeared, the authors donated the rights to AMSAT, and the programs were added to the AMSAT Software Exchange. Programs became available for virtually all of the popular home computers.

Hams, being hams, were not content to simply translate this program to other computers. Many hams enhanced the program so that it would permit real-time operation, do graphics, and be friendlier. Dr. Bob McGwier N4HY stands out for contributing a "fast search algorithm." This key modification led to the QUIKTRAK series of programs.

What started as one program and an idea for the AMSAT Software Exchange has blossomed into the premier fund-raising program for AMSAT and a body of sophisticated satellite prediction/tracking software for virtually all home computers.

Show and Tell

Hams created further capabilities, such as computer control of antenna pointing and automatic receiver/transmitter control for Doppler correction. I call these features "Show and Tell." Graphics, automatic antenna and station control, for example, are the "Show" and the basic tabular data output is the "Tell."

These programs give predictions for any satellite with Keplerian data, including weather satellites, the US space shuttle, and the Soviet space station *Mir*. You can use the information for visual observation as well as for antenna pointing. The new QUIKTRAK Version 4.0 will also provide predictive capability for the position of other celestial bodies.

BASIC Orbits and QUICKTRAK

Before launching into detailed descriptions of the programs, I give generic descriptions of the BASIC Orbits (W3IWI) and QUIKTRAK programs for reference.

BASIC Orbits (W3IWI): Prediction is based on Kepler's equations for any elliptical satellite orbit, including the circular orbit, since no orbit is perfectly circular. In addition to the classical Keplerian element set of six numbers, a seventh derived element, Mean Motion Rate (also decay rate or drag factor in orbits per day), has been added improve accuracy principally on low-altitude "birds."

The six primary elements are: (1) Inclination (degrees), (2) Eccentricity (dimensionless), (3) Argument of Perigee (degrees), (4) Right Ascension of Ascending Node (degrees), (5)Mean anomaly (or orbit "phase") at reference epoch (degrees), and either (6) Semi-major axis of ellipse (kilometers) or (6) Mean motion (orbits per day). A definition of each of these elements is available in *The Satellite Experimenter's Handbook* and in the original *Orbit* article. In the US, NASA/NORAD generate these Keplerian element sets, and NASA distributes them by subscription. AMSAT distributes them through its nets, publications, and computer BBS.

You must enter the Reference Epoch (valid time for the element set), with the element set as a starting point for extrapolation to the predicted time. You can also enter a default satellite beacon frequency (or net passband frequency) for computation of Doppler correction along with the Keplerian data.

Keplerian elements and your QTH data are stored within the program as DATA statements, making the updating of the program rather tedious. You can store multiple sets of Keplerian elements (usually 20). Fortunately, you won't need to update very often, except the data for very low-altitude birds, such as UoSAT OSCAR 9, the US space shuttle, and the Soviet space station *Mir*. Your QTH data consists of: (1) your call, (2) station latitude (degrees), (3) station longitude (degrees), and (4) station altitude (meters). This program also includes a table of Greenwich Sidereal Times on January 0.0 in days for various years. You must update this sidereal table periodically, by editing the DATA program statements, to keep it current. The original table covered 1979 through 1985.

When running the program, you will be prompted for entry of: (1)Start time, (2)Duration of the prediction period, (3) Time step between predictions, (4)Satellite of interest, (5)Frequency for Doppler correction (default or new entry), and output device (screen or printer). In most cases, you can select to output data at all times or just when the bird is in view. After you enter this information, the program will step through the predictions methodically.

Output from the program consists of: (1) Date, (2) Time in UTC, (3) Azimuth in degrees relative to North (0=North, 90=East, 180=South, and 270=West), (4)Elevation

in degrees relative to the local horizon (0=on the horizon, 90=straight up), (5) Sub-satellite point (latitude and longitude of the point on the Earth's surface directly below the satellite), (6) Range from your station to the satellite, (7) Height of the satellite above the Earth, (8) Orbital phase (0–256), and (9) Doppler correction in Hertz.

Only Date, Time, Azimuth, and Elevation are necessary for most operations. This program is perfectly adequate for all satellite tracking. It is the basis for all other AMSAT programs with the exception of the new QUIKTRAK Version 4.0. Dr. Tom Clark W3IWI deserves a round of applause for this excellent work.

QUIKTRAK

From its roots in the W3IWI program and the AMSAT AMS-81 project for the Timex/Sinclair ZX-81 computer, QUIKTRAK, by Dr. Bob McGwier N4HY has evolved into one of the most useful satellite prediction programs ever written. He borrowed the prediction algorithm from W3IWI and evolved the menu structure from the AMS-81 program. AMS-2064, one of the original programs for the Commodore Vic 20 and C-64, also shares this menu structure. To this solid beginning, Dr. McGwier added his own Newtonian fast search algorithm. This algorithm bypasses the long, step-by-step search for the Acquisition of Signal (AOS) and Loss of Signal (LOS) times. N4HY's algorithm has added practicality to the SCHEDULE mode in the AMS-81 and AMS-2064 programs.

N4HY originally wrote two versions of QUIKTRAK for a Commodore C-64 and the IBM-PC in BASIC. The user interfaces are almost identical. I will discuss these programs in two sections: common features for both programs and features unique to the IBM-PC. Compiled versions of both programs are supplied for increased speed. There are two versions of this program for the IBM-PC; one that uses the standard processor only, and another that takes advantage of the additional calculation speed the math co-processor offers.

Common Features: Both programs have: (1) SCHEDULE Mode, (2) TRACK Mode, (3) QTH DATA file handler, and KEPLERIAN DATA file handler.

For each orbit of the selected satellite above the horizon at the QTH, SCHEDULE mode provides a listing of (1) Date and time of Acquisition of Signal (AOS), (2) Date and time of Loss of Signal (LOS), (3) Peak elevation angle for circular orbit satellites or maximum distance between two observers for elliptical orbit satellites, (4) Time for peak elevation or maximum DX, (5) Azimuth for peak elevation or maximum DX, and (6) Orbit number. You can display or print out a satellite's schedule for an entire month and scan it for the best passes.

The TRACKING Mode provides the detailed display/printout of data for each pass. The same data is available in this mode as the W3IWI program output. Of course, you can enter this mode without running the SCHEDULE mode first.

Using the QTH DATA file handler, enter your station data, such as call, latitude, longitude, altitude, year, angular update interval (most versions), printer parameters, and colors, in the case of the Commodore program. Data is automatically saved on exiting.

Use the KEPLERIAN DATA file handler to enter Keplerian data for up to fourteen satellites. Change data by overwriting old data. Saving data is as above.

These four features provide a complete, user-friendly program for all of your satellite prediction needs. Data maintenance, advance planning, and increased speed are real advantages over the original W3IWI program.

IBM-PC Features: WINDOW TRACK, and its companion WINDOW TRACK DATA or CITIES file handler, compute the mutual visibility between your station and your friend's station in Tasmania through OSCAR 13. You can display computations for your QTH and up to fourteen other user-specified locations throughout the world for any satellite. Enter the geographical name, latitude, longitude, and altitude for each location in the same manner as Keplerian or QTH data using the WINDOW TRACK DATA or CITIES file handler.

Elliptical orbit satellites, such as OSCARs 10 and 13 are "spin stabilized;" their antennas point toward the center of the Earth from apogee under ideal conditions. When illumination of the solar panels is not ideal, the attitude of the satellite is "squinted" or "off-pointed," and communications capability is compromised. At other times, the satellite points away from the Earth to varying degrees due to the changing angles between your QTH, the satellite, and the attitude of the satellite's spin axis.

Using Bahn Latitude and Bahn Longitude as measures of the satellite attitude relative to the orbital plane, QUIKTRAK computes the off-pointing angle (PA) for each step of the prediction. A PA of zero degrees means that the satellite antennas are pointed directly at your QTH at that time. A PA of 90 degrees means that the satellite antennas are perpendicular to the line of sight between your QTH and the satellite position.

From this information, and with knowledge of the satellite antenna beamwidths, you can understand the variation in signal quality. Satellite control stations use this information in planning the mode schedule. For example, Mode L is scheduled for orbital phases when PA is at a minimum, since its antennas have narrower beamwidths than Mode B. Mode S is even more critical than Mode L. Understanding this, you won't waste time operating when signals are weak and spin modulation heavy due to off-pointing.

You can enter the satellite mode of operation vs. its orbital phase along with the Keplerian data in order to display the correct operating mode with each line of data. In the nongraphics versions of QUIKTRAK, you can only specify this schedule by orbital phase. In the graphics versions, you can also specify mode by the day of the week for satellites that don't schedule mode by orbital phase.

On most of the nongraphics versions, you can change from the total angle-change increment method of TRACK mode output, to W3IWI's time-increment method by following the starting time entry with the letter "t." You will then be prompted for the time increment period.

QUIKTRAK in this form still does not have the fancy graphics of the "Show" programs, but it certainly has the "Tell." The IBM-PC version is the root program for the APPLE, TRS-80 Model 4, and CP/M versions.

IBM-PC/XT/AT and Clones: N4HY QUIKTRAK 4.0

This is AMSAT'S premier program. It is a many-featured satellite prediction, tracking,

AMSAT Satellite Tracking Programs

Computer	Program Name	Generic Type	Memory	Dist. Media
IBM-PC	QUIKTRAK 4.O	QUIKTRAK	640K	5¼ & 3½ disk
IBM-PC	ORBITS 2	W3IWI	256K	5¼ disk
IBM-PC	ORBITS 3	W3IWI	>256K	5¼ disk
IBM-PC	QUIKTRAK 2.1	QUIKTRAK	64K	5¼ disk
C-64	SUPERTRACK	QUIKTRAK	64K	5¼ disk
C-128	ORBIT	W3IWI	—	5¼ disk
APPLE	APPLE QUIKTRAK	QUIKTRAK	64K	5¼ disk
APPLE	APPLE W3IWI	W3IWI	<48K	5¼ disk
APPLE	KØRZ AUTO-TRACK	W3IWI + CIRC.	<48K	5¼ disk
TRS-80 MODEL 4	N4HY QUIKTRAK	QUIKTRAK	64K	5¼ disk
TRS-80 MODEL 1	W3IWI	W3IWI	32K	cassette
TRS-80 MODEL 3	W3IWI	W3IWI	32K	5¼ disk
TRS-80 COLOR	W3IWI	W3IWI	32K	cassette
TRS-80 MODEL 100	AUTO-TRACK	W3IWI	<32K	cassette
ATARI	W3IWI	W3IWI	—	5¼ disk
TI99/4A	W3IWI	W3IWI	32K	cassette
HP-41	ORBIT I	W3IWI	—	mag cards
HP-41	ORBIT II	W3IWI	—	mag cards
CP/M	N4HY QUIKTRAK	QUIKTRAK	64K	various disks

and planning package, based upon new algorithms developed by Dr. Bob McGwier. Written in "C" and compiled for speed, it supports all features of IBM-PC QUIKTRAK along with the following features:

(1) User-selectable EGA-VGA or CGA graphics. Satellites are displayed in real-time on a map of the world. For the single satellite tracking mode, two scale factors are supplied: (a) the whole world and (b) one level of magnification around the satellite's position. A second graphics mode displays multiple satellites on a world map. In the single satellite graphics mode, you can also display the satellite footprint, the Sun line, the satellite groundtrack, and all pertinent numeric data. For educational and planning purposes, you can speed up the action and obtain a vivid demonstration of orbital dynamics. A new and highly detailed map, containing geographical boundaries, comes with the EGA-VGA graphics.

(2) Real-time tabular data screen for multiple satellite visibility from your QTH. This includes AOS and LOS status for each satellite. Data lines are color-coded for easy recognition of out-of-view, in-view, or transitioning conditions.

(3) Real-time tabular data screen for one satellite to your QTH and multiple other locations selected from the CITIES file. Data lines are as above. Pointing-angle information is displayed for all locations.

(4) Displays Equator crossing data or apogee times and location.

(5) In all prediction modes, you can send data to the screen, the printer, or a disk file.

(6) ANSI.SYS is not used in any form (as it was in Version 3.2). Screen manipulations are done by optimized routines and write directly to the screen for maximum speed (not great for DoubleDos or DesqView, but speed is essential in manipulating EGA-VGA graphics files, since they are over 112,000 bytes for each screen when fully expanded).

(7) All internal timekeeping is done in true Julian days from January 1, 1954, the year of the first satellite launch. There will be no more leap year anomalies from trying short cuts.

(8) Visible satellite (*Mir*, the space shuttle, etc.) Search and Track features for those who are interested in visual observation. This routine checks to see if (a) the satellite is above the horizon, (b) the Sun is more than ten degrees below the horizon (it is dark), and (c) whether or not the satellite is in the sunlight (not in eclipse). No moonlight phenomena are accounted for. Of course, it does not predict cloud cover.

(9) A new Window Search feature allows you to choose two of 101 cities (included in your data files, and which you may modify), to find windows of mutual visibility.

(10) The Auto Tracking function (antenna rotor and radio control) is enhanced to include multi-satellite functions, both tabular and graphic. You choose the order in which the satellites are tracked internally with the data editor. This establishes tracking priority. There is a great deal of flexibility in setting up frequency data, since frequency changes with satellite mode, etc. The interface support is identical to the one supplied with with the Kansas City Tracker and Tuner. You will need your own TSR (terminate and stay resident) driver to run any other interface.

(11) You can now choose between Mean Anomaly (measured in degrees) and Orbital Phase for display in the real-time tracking functions.

(12) In the real-time, single satellite, tabular mode, you can display all of the data you could possibly want regarding the satellite's orbital mechanics.

(13) One hundred satellites are in each satellite data file. One hundred cities, in addition to your own QTH, are stored in each city data file. You can keep as many of these files as the hard disk drive will hold.

(14) All data entry is in full-screen editors. Automatic data reading and loading functions read the NASA/NORAD two-line format or the AMSAT format.

(15) All function selection is menu-driven.

(16) There is also an optional program for tracking the sun, moon, and planets. You can listen to Jupiter and sun noise. These routines are more accurate than other widely used programs. Routines which have corrections for parallax, mutation, etc., are included.

> *". . . (A-O-10, A-O-13) antennas point toward the center of the Earth from apogee under ideal conditions."*

ORBITS 2

Written by Roy Welch W0SL, this program provides moderate graphics and tabular data capabilities more than adequate for all amateur radio satellite operator needs. Based on the original W3IWI program, its ancestry is obvious in the batch output functions for a single satellite. But the similarity ends there. To use the graphics functions, you need the equivalent of an IBM Color Graphics Adapter and a color display. Its major features are:

(1) Real-time satellite tracking in tabular or graphics mode. You can track up to eight satellites in this mode at a time. In graphics mode, the map is in a single color of the user's choice on a black background. You can select a single, high priority satellite and footprint. All eight satellites will continue to move on-screen in real-time.

(2) Automatic control and tracking of the high priority satellite. You can control antenna azimuth and elevation rotors with the Kansas City Tracker interface.

(3) A batch output mode is provided for one satellite at a time, similar to the W3IWI prediction program. Select screen or printer.

(4) You can enter Keplerian elements into three different files which contain up to eight satellites each, with menu-driven switching. This permits the tracking and prediction routines to use any of the three files. You can display all eight satellites in a given data file with the display routines.

(5) Enter ground station geographical data under program control. Besides the color, you can also decide how you want the map presented on the screen (centered at 0, 90, 180, or 270 degrees longitude).

(6) Compiled for speed. There is also a version that works with a math co-processor as well as the standard processor version.

(7) Extensive prompting throughout, including error routines to protect against improper or invalid input to prompts. You can also print out the documentation file which contains the operating instructions.

While not as feature-loaded as QUIKTRAK 4.0, this program provides all the necessary data along with good real-time capability, graphics, and auto tracking.

ORBITS 3

Functionally, this program is equivalent to ORBITS 2, but it is also designed to take advantage of the IBM Enhanced Graphics Adapter (EGA). You can set up the map, satellite, and footprint in contrasting colors on a higher resolution screen for a more pleasing map display.

QUIKTRAK Version 2.1: This is the latest version of the original N4HY QUIKTRAK program for the IBM-PC. Its functions and features are the same as described above. There are no graphics.

The Commodore Computer

C-64 SUPERTRACK is a combination of N4HY QUIKTRAK for the C-64 and a real-time graphics program called MAPTRAK. The entire package was written and assembled by N4HY. MAPTRAK will track up to eight satellites at a time on a world map similar to the ORBITS 2 map. A novel method correlates the numeric data for each satellite with its position on the map. Angle track data for the number one satellite goes to the Game Port and can be used by a suitable hardware interface to the antenna rotors (the original interface for KenPro Rotors may still be available from some distributors).

GROUNDTRACK is a third operational mode which plots the predicted satellite groundtrack on the graphics map of the world. MAPTRAK and GROUNDTRACK share the same Keplerian and QTH data files in QUIKTRAK so that QUIKTRAK's file handlers can support all three programs. This program will also run on the C-128 in its C-64 mode.

C-128 ORBITS is a program specifically written to take advantage of the unique capabilities of the C-128. ORBITS uses time-based incrementing with user-selected increments. This results in uniform time increments between data lines. The ORBITS program features automatic page formatting and pagination. As many as 20 satellites may be entered into Keplerian files. It requires an 80 column monitor and a Commodore compatible printer.

The Apple Computer

Apple QUIKTRAK, Ken Knudson W5PLN's translation of the IBM-PC version of QUIKTRAK, supports all IBM features. You need an 80 column card. Due to the large variation in Apple hardware and accessories, there may still be some incompatible combinations. However, the program runs on most II+, IIe, IIc, and IIGS computers if they have at least 64K of memory, the 80 column card, and a compatible printer. Use of a parallel printer interface in the IIc has caused some trouble.

Apple W3IWI: Dr. Bill McCaa K0RZ did this translation of the original W3IWI program for the Apples still out there with limited memory and no 80 column cards. It supports all original W3IWI features. Larry Papke WB5MPU has contributed a good Keplerian data file handler.

K0RZ Auto-Track

Originally written for circular orbit satellites, this program was one of the first automatic station and antenna control programs available through AMSAT. A more recent version, based on the W3IWI program, is also available. These programs were written for specific clock and A/D-D/A hardware from Mountain Computers. The hardware may be hard to get now, and originally it was somewhat expensive. The complete setup was described in *ORBIT* magazine, Number 11, July/August 1982. A reprint of this information comes with the program.

The Radio Shack TRS-80

Bob Rogers W8JLE accomplished a translation the IBM-PC's QUIKTRAK for Model 4.

Straight translations of the W3IWI program for Models 1, 3, and the Color Computer versions of the original W3IWI program are available. Credit for the translations should go to W0CY, N5AHD, W8JLE, and others.

AUTO-TRACK for the Model 100 is a real-time, dedicated antenna controller, inspired by the WB5IPM Antenna Control Interface described in the May and June 1987 issues of *QEX*. N9HR and W8JLE generated this real-time version of the W3IWI program to supply the data to the interface. The program computes data for six satellites.

HP-41 Programmable Calculator

Both of the following versions were adapted from the original W3IWI program by Roy Welch W0SL.

ORBIT I: This program will output Azimuth and Elevation in real-time, or all W3IWI parameters in the prediction mode. Special requirements are: HP-41C plus a QUAD memory, or an HP-41CV or HP-41CX. A card reader is desirable but not essential for program entry. The program is slow but accurate, and makes an excellent primary or back-up program in a very portable package.

ORBIT II: This program is the same as ORBIT I with the addition of functions from the Time Module for input of Date and Time for the real-time mode. The Time Module is an optional plug-in module for the HP-41C and the HP-41CV. The HP-41CX has the Time Module installed internally as part of the calculator.

Atari, Texas Instruments, and CP/M Machines

Atari Models 400, 800, and other 8-bit Models: W8JLE's son translated the original W3IWI program for the 8-bit ATARI models. Of the two versions available, one runs with Atari BASIC and the other with M BASIC. The translations support all W3IWI features.

Texas Instruments TI99/4A: Original W3IWI program translated for the TI99/4A, with all W3IWI features supported.

CP/M Machines. Roger Ley WA9PZL translated the original QUIKTRAK program for CP/M machines, such as the XEROX 820, KAYPRO, and Heath H-89. A universal format program will work with most CP/M machines. Please specify format and machine. You can use all features of the original QUIKTRAK.

Needed: New Authors and Volunteers

See the table for the AMSAT Software Exchange's current offerings. Other software may be available on special order. Please inquire if your computer isn't listed. New programs are always being contributed to the exchange.

New computers come on the market, and old ones become obsolete. AMSAT Software Exchange is constantly in need of authors/translators. For example, the Apple II series is probably the most widely used computer in the schools of the world. A good program for the Apple, combining most of the features of QUIKTRAK, and a basic graphics program such as MAPTRAK, would be very desirable. Also, as another example, the TRS-80 Color Computer could use a software update.

We badly need volunteers to keep programs, literature, and distribution copies up to date on several of the older W3IWI versions. If we can't find people to do these tasks, we will have to drop these programs from the AMSAT Software Exchange.

Obtaining AMSAT Software

A list of current programs, along with recommended donations and ordering instructions, may be obtained from *AMSAT SOFTWARE EXCHANGE, PO Box 27, Washington, DC 20044.*

The popular programs are available from an AMSAT booth at many hamfests, along with instructions and demonstrations, and from your local AMSAT Area Coordinator.

I hope you have found this review helpful in selecting a satellite prediction/tracking program to fit your needs. If I have made any errors or oversights in reviewing the above software, or if I have failed to give credit to anyone, please let me know.

QUIKTRAK 4.0 and TRS-80 Model 100 AUTO-TRACK will be in distribution by the time you read this article. There may be some minor changes to these programs as they are completed. See you on the birds! 73

73 Review by *Bob Kosa N5LCO*

Automatic Antenna Tracking with SAT TRAK III

Dedicated hardware antenna tracking controller.

SAT TRAK III
Applied Digital Research, Inc.
PO Box 10184
Sarasota, FL 34232
Phone: (813) 378-3410
Price Class: $300 and $350

Photo A. The front. . .

Photo B. . . .and the back panel of the SAT TRAK II controller. Note the minimum of controls.

If a group of satellite chasers were to pool their ideas into one wish list and build a controller based on those ideas, they would have the SAT TRAK III. SAT TRAK III, manufactured by Applied Digital Research, Inc., is a microprocessor-controlled automatic satellite antenna rotor controller. At last! No more paging through computer printouts of tracking information, or fumbling with the buttons on the rotor controller! Thanks to SAT TRAK III, making contacts on low orbit satellites is easy—you can concentrate totally on making the QSO.

Features

SAT TRAK III is easily interfaced to several major brands of rotors. Operation is simple, smooth, and accurate. A detailed manual and user friendly software quickly guide a new owner through the installation.

The tracking software, battery backed-up system clock, and memory, microprocessor, and relay control circuits are all assembled on one printed circuit board. To track a satellite, all you need to do is change the twelve-position rotary switch mounted on the front panel. A flashing LED indicates tracking status (satellite-above-horizon).

SAT TRAK III does not need to be connected to an external computer while tracking a satellite. You can use an RS-232 or a TTL level compatible dumb terminal to initialize the system, then disconnect the terminal from the controller until it is time to enter new Keplerian element sets.

SAT TRAK Chassis

SAT TRAK III is housed in a compact plastic box which measures 8" x 6.25" x 2.5". [This is just the right size to place underneath my Kenpro KR-5400 El-Az (elevation-azimuth) dual controller.] The inside of this box has been sprayed with a conductive coating to prevent interference to adjacent equipment in the ham shack (probably a requirement for the FCC Class B computing device certification). As a precautionary measure, I checked for interference with modes A (2 meters up, 10 meters down), B (70 cm up, 2 meters down) and J (2 meters up, 70 cm down) and did not encounter any problems. Yet, even with the excellent RFI shielding, I would still prefer a metallic box.

> *"To adjust the voltages to levels within range of the A/D, tweak the two trim pots on the printed circuit board. This is the only hardware adjustment required by SAT TRAK III."*

Inside of SAT TRAK III is an innovative printed circuit board whose brain is an Intel 8052AH microprocessor with a BASIC interpreter. The tracking program is kept as "firmware" in a 16 Kb EPROM. This circuit board also has an accurate Timekeeper™ clock chip with 2 Kb RAM and an integral lithium battery. The station and satellite data, maintained in 8 Kb of RAM, rely on the clock battery to prevent memory loss. This battery is said to have an approximate life span of ten years under normal conditions. An 8-bit analog-to-digital converter samples the rotor potentiometer feedback voltages (stall sensor), the SATELLITE SELECT switch, and the TRACK ENABLE switch.

Five triacs mounted vertically on the board control elevation "up/down", azimuth "left/right", and azimuth braking. Adjacent to each of the triacs is a red LED which is used primarily as a troubleshooting aid for any hardware problems. Mounting the LED's on the front panel may cause unnecessary clutter, but, on the other hand, it gives the user a better understanding of the status of the tracker.

Another very handy feature is an amber

LED which is mounted above the tracking switch. This LED will blink "on" once every 6 seconds when the satellite being tracked is below the horizon. Conversely, it will blink "off" once every 6 seconds when the satellite is above the horizon. If you like bells and whistles (in the truest sense), Applied Digital Research has provided schematics for three simple add-on alarm circuits which may be used to indicate satellite-above-horizon status.

Set Up

To install the unit, first connect an RS-232 extension cable from the DB25 socket on the back of the tracker to a serial port on a computer or terminal (see the "Features" section above). Applied Digital Research supplies a small AC/DC adapter with the tracker. Plug this into the wall. The communications software should be set to 8 bits, no parity; or 7 bits, even or odd parity; one stop bit and 4800 baud. The baud rate may be changed at a later time. When SAT TRAK power is turned on, tracking automatically begins within seconds. Entering a cr> (carriage return or the enter key) will let you leave the tracking mode and return to the main menu.

"The SAT TRAK III is an innovative and intelligent stand-alone automated antenna tracking controller."

The first time that the tracker is turned on, you will have to set the system clock by choosing the "CLOCK SETUP" command option and synchronizing the battery backed-up clock with WWV. This clock should be accurate to within a few seconds over the period of a month. If any deviation does occur it may be compensated for in the "CALIBRATE" function of the CLOCK SETUP option.

Station Setup

To set up the station, you must make two cables to connect the rotor controller box to the interface of SAT TRAK III. Each cable should consist of an 8-pin mike plug and a 5-conductor shielded cable. The manual contains wiring diagrams for the Kenpro/Yaesu KR-5400 A/B, KR-400, KR-500 and CDE type rotors. Older Kenpro rotors, like the KR-5400, will require a minor modification by running a wire from the 26-volt AC tap of the transformer (switch common) to the back of the controller box. Connect the rest of the wires in parallel to the lines on the terminal boards on the back of the Kenpro El-Az controller box.

Calibration

Next, you must calibrate the unit. This is a vital part of the installation setup because it enables the microprocessor to equate the rotor feedback voltages to the azimuth and elevation angles (degrees). Before you turn on the power to calibrate SAT TRAK III for any rotor combination, make sure that the tracking switch is in the "disable" position. This prevents erroneous movement of the rotor to positions which might damage the antennas or coax.

Any time the power is turned on, SAT TRAK will automatically return to the tracking mode. The screen output contains all the pertinent tracking information (see Figure 2). The microprocessor performs El-Az coordinate calculations on approximately six second intervals. Simply entering a cr> will return the program to the main menu "COMMAND OPTIONS". From there, choose "TEST ROUTINES".

There are two functions within the TEST ROUTINES: "ROTOR FEEDBACK VOLT METER", and "MANUAL POSITION CONTROL". If you choose the ROTOR FEEDBACK VOLT METER function, SAT TRAK will display the voltages seen by the A/D for both azimuth and elevation. To adjust the voltages to levels within range of the A/D, tweak the two trim pots on the printed circuit board. This is the only hardware adjustment required by SAT TRAK III. Next, to establish some validity to the calculations performed by the micro, you must return to the main COMMAND OPTIONS menu and from there choose the "SETUP AND STATION DATA" option. (Figure 3, reproduced from the manual, illustrates the simple and precise path of the software.) After entering the station latitude, longitude and elevation, SAT TRAK begins to ask several other questions, such as "ACTIVATE ANTENNA FLIP?" and "AZIMUTH ROTOR STOP AT NORTH OR SOUTH?" in order to determine the exact configuration of the rotors in the station.

After you have determined the physical configuration, you must calibrate the system by recording the voltages at the minimum and maximum meter readings. The microprocessor samples the rotor pot feedback voltages and stores them as calibration data in the random access memory. The final question in the setup option is "CHANGE BAUD RATE?" No

```
COMMAND OPTIONS

1 = RUN SATELLITE TRACKER
2 = LIST/UPDATE SATELLITE DATA
3 = CLOCK SETUP
4 = SETUP AND STATION DATA
5 = TEST ROUTINES

SELECT COMMAND 1-5 ?
```

Figure 1. Main Menu Command Options

TRACKING DATA FOR SATELLITE #3 = RS-10/11
(hit cr> to go to setup menu)

AZ	EL	RANGE	HEIGHT	LAT	LON	PHASE	DOPPLER	TIME
198	1	3495	989	2.6	104.3	205	0	21 : 10 : 19
198	2	3421	989	3.3	104.2	206	561	21 : 10 : 30
199	2	3384	989	3.6	104.2	206	600	21 : 10 : 36
199	3	3348	989	3.9	104.2	206	596	21 : 10 : 43
199	3	3311	989	4.3	104.2	207	599	21 : 10 : 49
199	4	3274	989	4.6	104.2	207	608	21 : 10 : 55
199	4	3237	989	5.0	104.1	207	598	21 : 11 : 1
200	4	3195	988	5.4	104.1	207	585	21 : 11 : 7
200	5	3158	988	5.7	104.1	208	596	21 : 11 : 13

Figure 2. Tracking Data Display

DATA FOR SATELLITE 3 = RS-10/11

MEAN MOTION (ORBITS/DAY)	13.719267
MEAN ANOMALY (DEG)	220.6177
INCLINATION (DEG)	82.9264
ARG PERIGEE (DEG)	139.5954
RAAN (DEG)	358.7229
EPOCH YEAR (YY)	89
EPOCH DAY AND FRACTION	4.9602995
ECCENTRICITY	1.2783 E-3
DECAY (ORBITS/DAY^2)	2.64 E-6
BEACON FREQUENCY (MHZ)	29.407

Table 1. Typical Keplerian Element Data

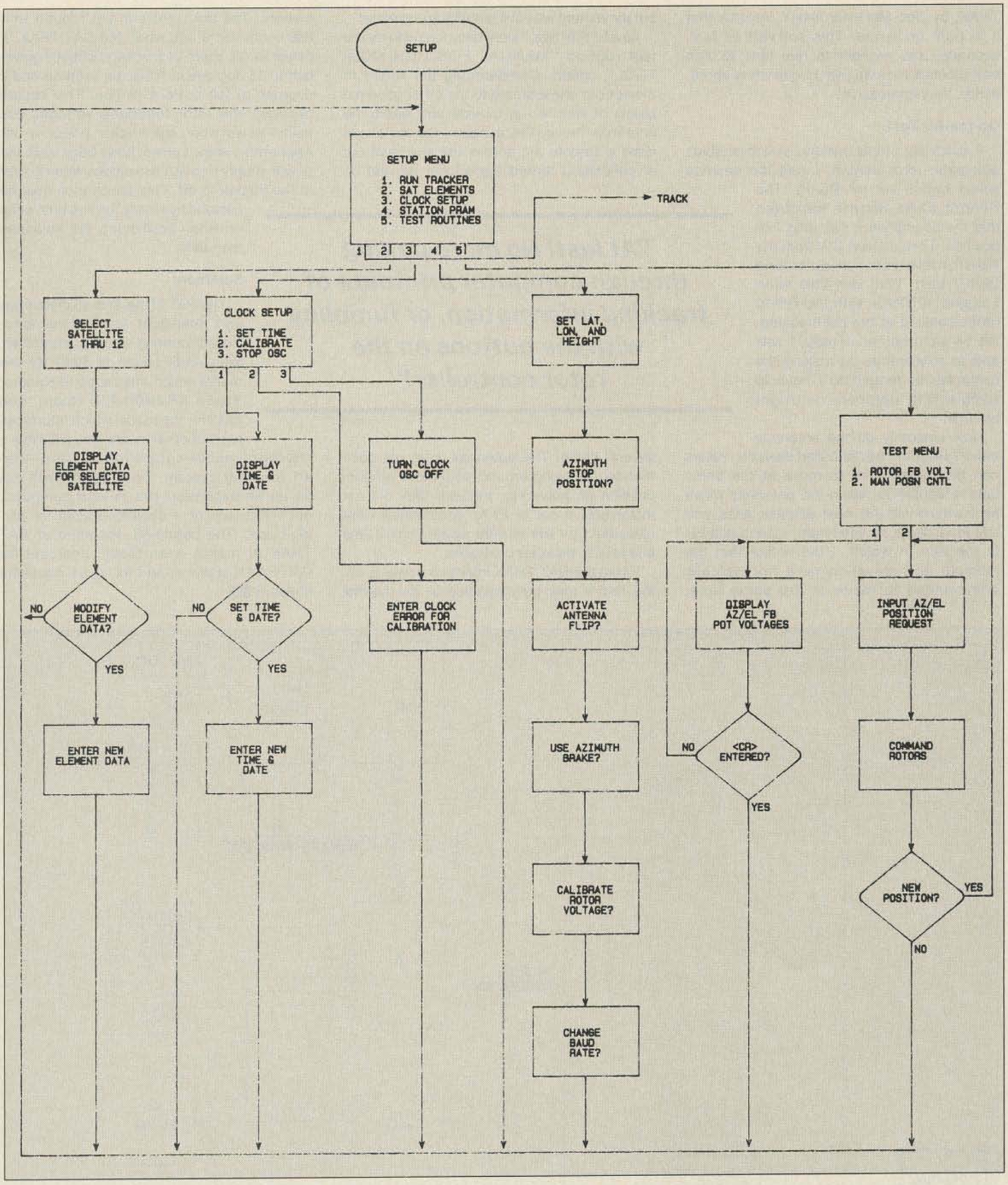

Figure 3. Flow chart for tracker setup and station data.

thanks, 4800 baud should be fast enough.

Now you must add some credibility to the tracking data. Return to the main menu and choose the "LIST/UPDATE SATELLITE DATA" option. This will display a list of satellite-select switch positions, and the corresponding satellite names. The tracking algorithm uses Keplerian element data (see Table), sets consisting of strange numbers with even stranger names like "Mean Motion", "Mean Anomaly", "Inclination", and "Epoch Day", to name but just a few. You can get the background information that you need on several computer bulletin boards, in AMSAT news letters, and from NASA. Then, simply select the satellites of choice and enter the new values when prompted.

Ready to Track

Is SAT TRAK calculating valid El-Az data? A quick comparison with AMSAT's QUIK-

TRAK, by Bob McGwier N4HY, reveals that it is right on target. This software is fast, accurate, and as near to real time as can be expected. No leap year bug to worry about, either. Very impressive!

On-the-Air Test

A quick flip of the tracking switch enables automatic rotor control. I had the satellite select switch set for RS-10. The Kenpro El-Az meters indicated that the beams were swinging into position. Time to play! CW from the RS-10 robot came in at around 29.407 MHz. With very little effort I logged 12 QSOs with the RS-10 robot, peaking at, but not breaking, the 55 wpm barrier. Finally, I was able to concentrate on making the contacts. No longer do I have to fumble with up/down, left/right buttons!

How smoothly do the antennas move? Both the azimuth and elevation rotors can be commanded to move at the same time. I wanted to watch the antennas move so I waited for the next satellite pass and this time, like a devoted ham, I stood outside in the rain to watch. I did notice that the azimuth and elevation were not typically commanded to move at the same time, but movement was still smooth and precise.

As a further test, I went back inside to try the test routine "MANUAL POSITION CONTROL" option. Commanding the rotors to move from one extreme to the other gave me plenty of time to run outside and watch the antennas move. Once again, the antennas drew a smooth arc across the sky. Just out of curiosity, I turned the tracker off and on several times. The antennas were not commanded to swing around wildly to a random position on power-up. Instead, they did not move until a set of El-Az coordinates were calculated for the current system clock time and sent to the rotor controller.

"At last! No more paging through computer printouts of tracking information, or fumbling with the buttons on the rotor controller!"

When the SAT TRAK interface power is off, the rotors may be controlled in the normal manner. The only problem that I found with this controller is that when the SAT TRAK III power is off, there is a voltage offset equivalent to 45 degrees at full-scale azimuth and 2 degrees at full scale elevation. This occurs because the rotor feedback voltages are pulled down when the tracker power is off. Apparently, some current flows back up to the power supply through two diodes when power to the tracker is off. This annoyance may be avoided by simply turning both units on when positioning the antennas manually.

Summary

The SAT TRAK III is an innovative and intelligent stand-alone automated antenna tracking controller. With retail prices at $299 for the model which interfaces to Kenpro/ Yaesu KR-5400 A/B rotors, and $349 for the model which interfaces to most other rotors, you will have a microprocessor-controlled state-of-the-art tracking system. This device will not tie up an expansion slot in your computer, nor will it require a dedicated serial or parallel port. The hands-off operation of SAT TRAK III makes it an ideal candidate for GATEWAY stations, and for all avid satellite chasers. 73

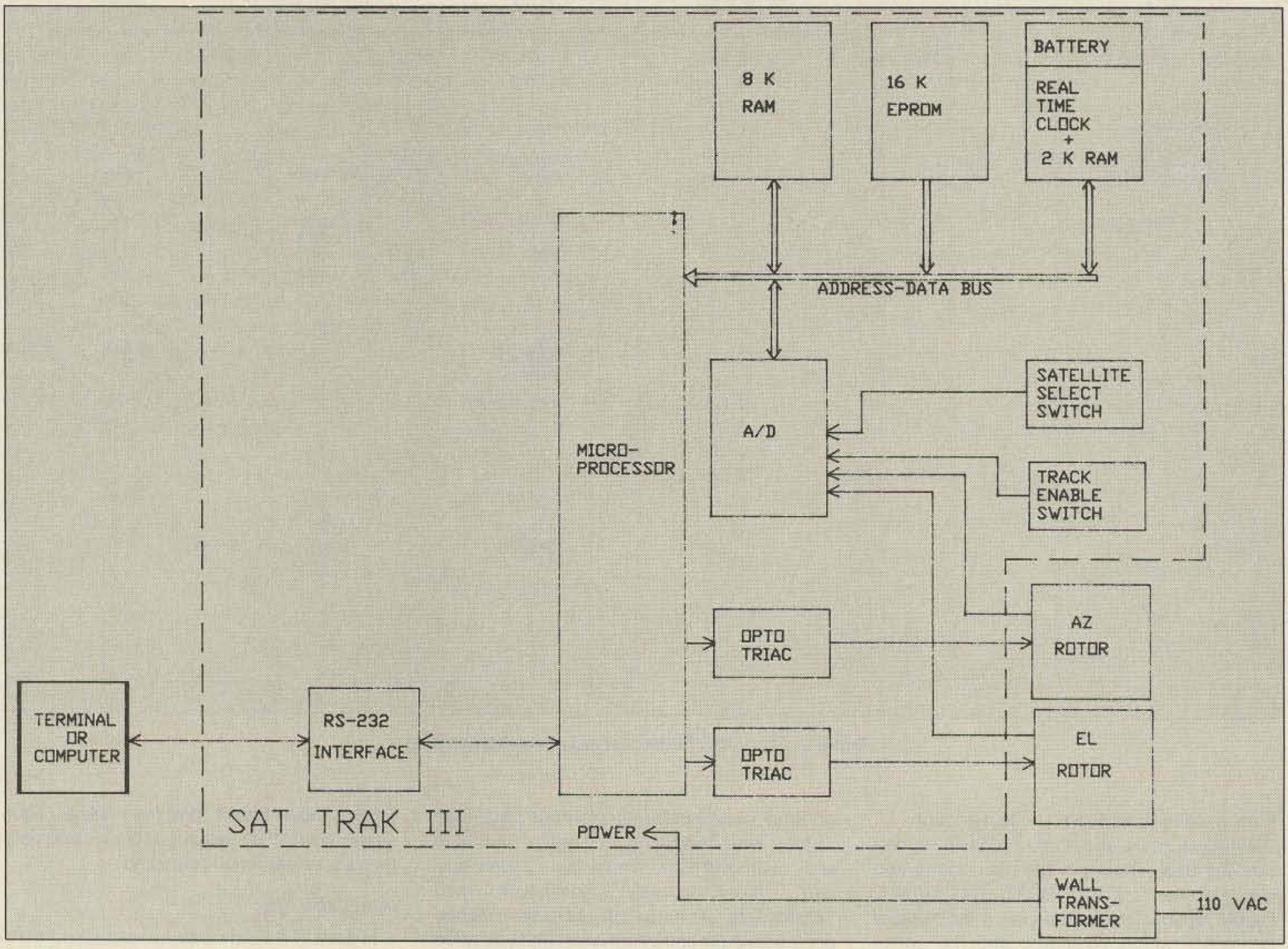

Figure 4. Block diagram of the SAT TRAK III controller.

Mode L, My Way

Clever way to reduce line loss for the 1269 MHz uplink.

by Ralph E. Herzler WA8WBP

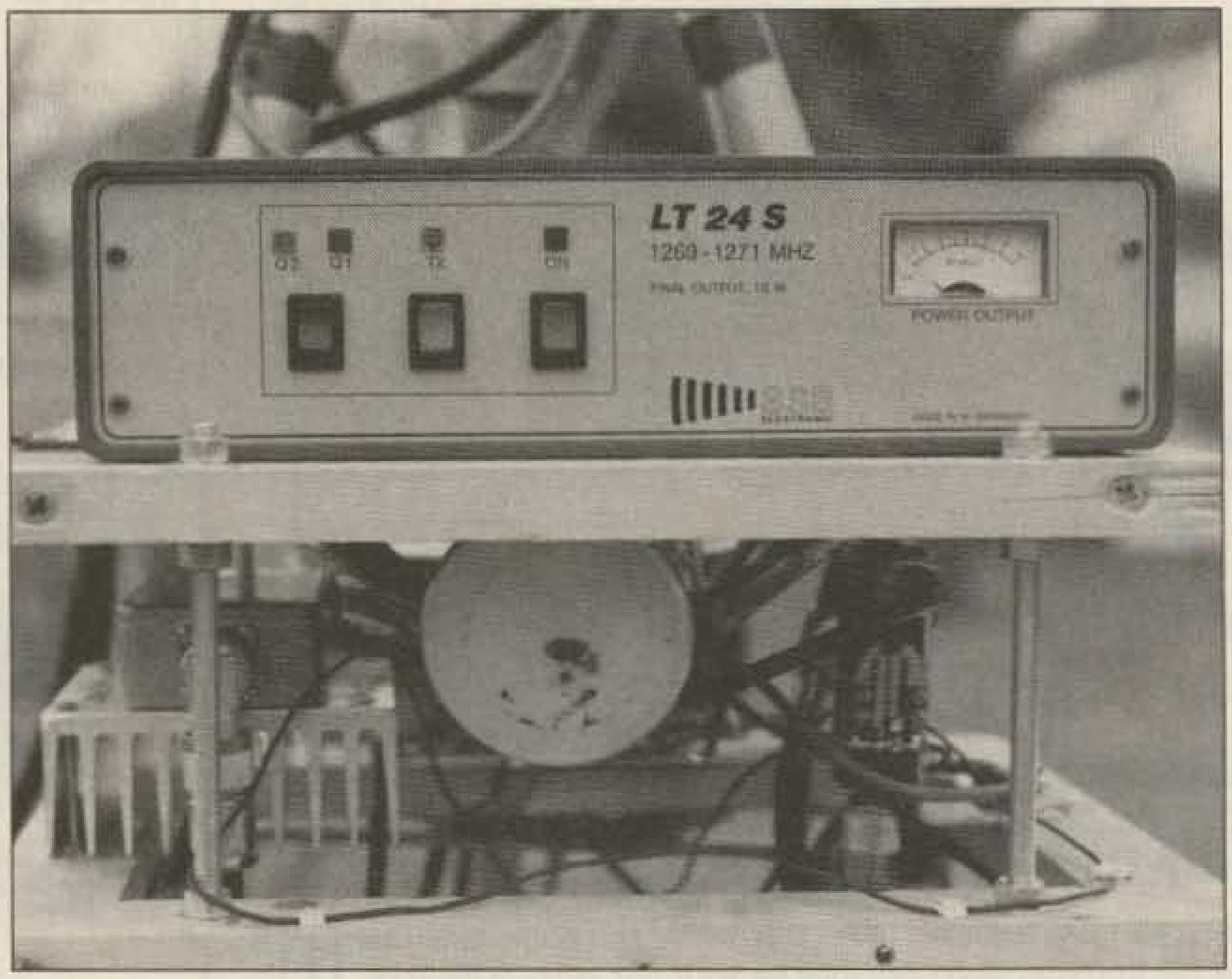

Photo A. Front view of 1269 MHz converter, capacitor, and linear amplifier. The amp, available from Downeast Microwave, converts 10 Watts of drive to 35 Watts of output.

Several years ago, I was bitten by the satellite bug, and I have enjoyed satellite operation ever since. It is more challenging than 2 meters or the "low bands." After a start on Mode B (435 MHz uplink and 145 MHz downlink), I gained confidence in 435 MHz operation. It works very well, but I discovered that line losses begin to really matter at high frequencies.

Moving to Mode J operation Mode B was easy—just reverse the uplink and the downlink for the bands. I needed only to install a preamp in the 435 section of the antenna array, since that's the band I now received on.

One Mode led to another... soon I learned that Mode J is applicable to a subband segment of the total Mode JL spectrum. Curiosity led me to listen in on the Mode L segment, which is several times wider than the Mode J portion.

Mode L was again a whole different realm. In this mode, the downlink is still on 70cm, but the uplink is on 1.2 GHz band! I was now in the microwave region, which to me seemed a tricky operation with high transmission line losses, vacuum tubes with high anode voltages, and (horrors) water cooling in direct contact with high voltage. I thought there had to be a better way, and that is what this article is about!

Search for Less Line Loss

I listened to these resourceful Mode L operators, and gathered a lot of basic information. I even wrote to Fred Crowedeaux WD5GQM to find out how he developed such a fine Mode L signal, and I learned that he had done some basic work with feedline losses. At his installation, 12 Watts of 1269 energy had dropped to 4 Watts through 55 feet of Belden 9913. He resolved this by using hard line in place of 9913. According to the *ARRL Handbook*, however, even the best hard line loses over 2 dB per hundred feet at over 1 GHz.

According to AMSAT, in the *Amateur Satellite Report* (August 22, 1988), you should shoot for 30 Watts applied to a 20 dBi antenna array in order to have good SSB contacts "under most conditions." Since I am 100 feet away from my antenna, I would need at least 60 Watts of 1269 energy in my shack, and 100 feet of ⅞" hard line to do the job. Hard line that size is about four dollars per foot. Type N fittings are $55 each. Thus, the transmission line system alone would run over $500, and I was still dealing with very high output power on 1.2 GHz. There had to be a better way!

> ***". . . even the best hard line loses over 2 dB per hundred feet at over 1 GHz."***

The Solution

After some nights of light sleeping, the answer came to me—I would convert a 2 meter signal to 1269 MHz at the antenna to avoid the line losses that result if you do this conversion in the shack. Obviously, this was not a complete answer because, with the antenna I had in mind, I still had to develop about 35 Watts to do the job. It did have merit, though, since Modes J and L both use 435 MHz for a downlink, leaving the 2 meter signal available for this project.

For satellite operation, I use the ICOM 271A and 471A connected to the ICOM CT-16 interface for the transceiving system.

For tracking the birds, I use the N4HY program interfaced to the Kenpro 5400A rotor control via my trusty Commodore 64.

Antennas

My antennas are the KLM 40CX and the Cushcraft A144-20T, plus my home-brew helix for 1269. The 1269 helix was designed from data published in the fourth edition of the *RSGB VHF/UHF Manual*, with modifications. Table 12 of this publication suggested a spiral of ¼-⅛" tubing wound at three inches diameter. Because I had a random length of ¼" aluminum tubing, I wound it over a form to produce three inches OD, and found that I had 12 turns. According to the table, this would produce a gain of 16 dB.

Next, I needed to devise a method of supporting the helix. The usual center support with helical "spikes" looked flimsy. Why not support it externally? I used three pieces of 1½" x ½" nylon, notched to accept the helix. The helix is tied to the nylon supports with 20-pound fishing line and anchored with epoxy cement. The reflector is a piece of aluminum sheet 7" in diameter, sawed from the bottom of an old frying pan. There is nothing magic about these materials. I had the tubing and an old frying pan, and my nearest Cadillac Plastics outlet had the nylon.

Impedance Matching

The *VHF/UHF Handbook* suggested using a quarter-wave matching transformer for the helix antenna since its characteristic impedance was 140Ω. I did not really like this approach, and I was bemoaning this fact in a QSO with Wally Nelson W7KRC, when he remembered an article in the June 1981 *QST* describing a better way to attain a 50Ω feedpoint. Instead of terminating the helix at the center of the reflector, you terminate it along its periphery, with the last several inches flattened parallel to the reflector. Then you adjust the impedance for minimum SWR by changing the distance between the flattened section and the reflector. Much more desirable! I tried it and it worked. This funny looking contraption was supposed to have enough gain for my purpose.

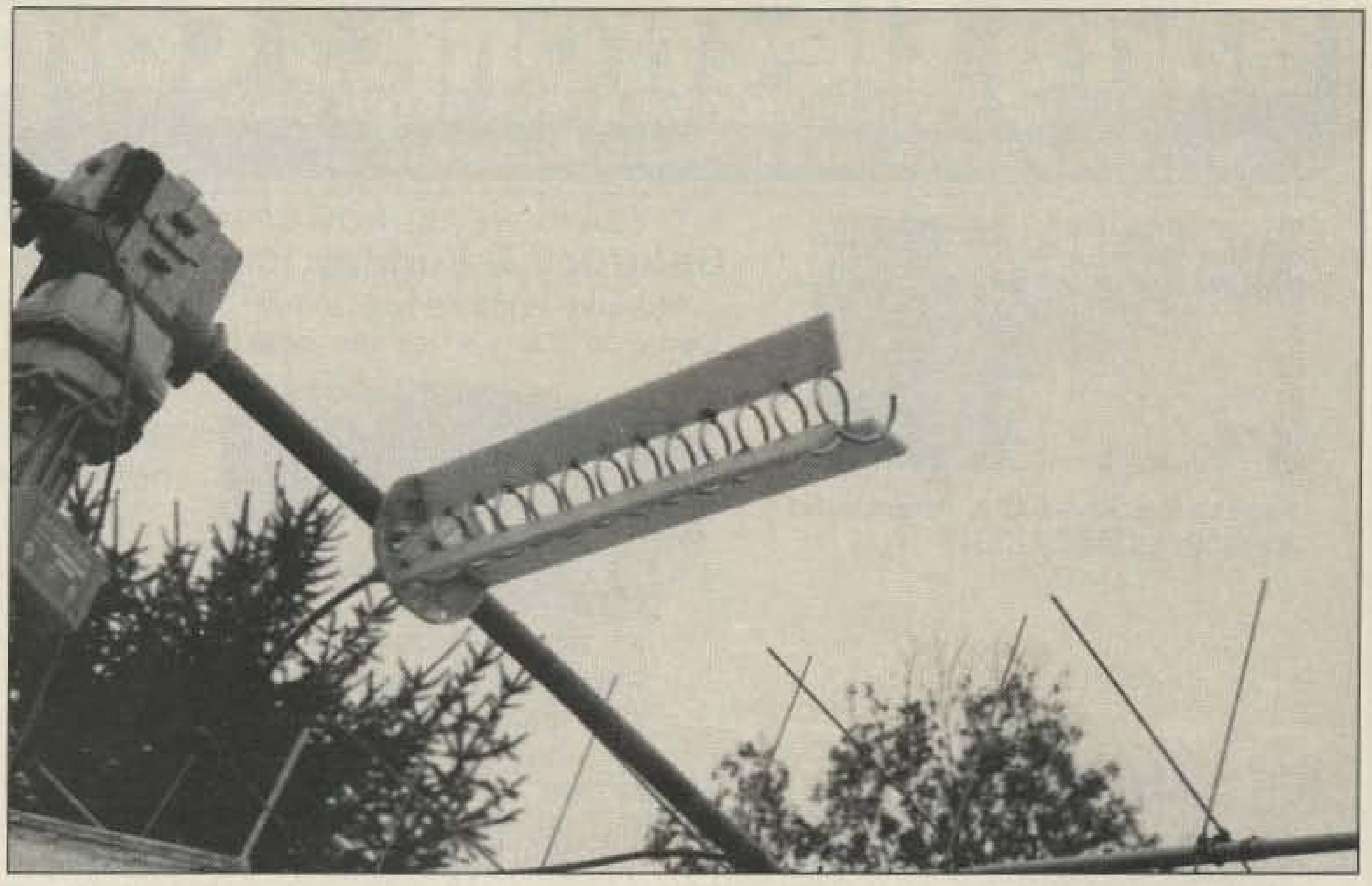

Photo B. The home-brew 1269 MHz helix antenna. Plans for it came out of the RSGB VHF/UHF Handbook. The reflector was cut from the aluminum bottom of an old frying pan.

The Power Amplifier

Research led me to believe that power levels above 10 Watts at 1269 MHz weren't possible with solid-state devices, simply because appropriate transistors did not exist. I guess no one had told Bill Olson W3HQT at Downeast Microwave about this. He offered a very nice amplifier that develops 10 Watts of drive to a little better than 35 Watts. That beat running a 120 volt line to the antenna and developing a typical high voltage vacuum tube amplifier. My tower is only eight feet high, but, still, I didn't want to fool with a thousand volts while standing on a step ladder.

The Transmit Converter

For this, I first contacted Transverters Unlimited. They only carried full transverters, and I didn't need the receive portion, nor did I want to chance problems with the transmit/receive switching in such a unit. Bob Morton NI1W, who represents Transverters Unlimited in the US, advised me that SSB in West Germany was about to bring out their LT24S transmit converter that would do the job I wanted.

I ordered one, and after some weeks it finally arrived, complete with instructions in German! The local high school German instructor translated the instructions literally, which I then had to re-translate into meaningful directions. Suddenly, I learned that this unit was designed for 14.5 volt DC power with a 13 volt minimum requirement. So much for using my solar charged storage battery. It had to be the full 13.8 volts from my heavy duty station supply, and that meant burying a heavy conductor in December in Michigan. I used a stranded #8 wire for the positive conductor. The negative return was carried on the tower legs and on the aluminum sheath of two lengths of hard line through various interconnections.

Getting Underway

I used a 12 volt Dow-Key relay to switch my 2 meter RF from its normal path, to a 2 meter antenna to the new converter and to provide 13.8 volts to the new devices. The relay is activated by a small switch in the shack which sends the control voltage to the tower on a spare wire in the rotor cable.

Next, as my wife whistled into the mike, I set my 271A for minimum RF out, and adjusted the converter to show full 10 Watts out to a dummy load and 2–4 Watts on normal voice peaks. I then installed the 12" x 14" x 9½" open-bottomed cover over the equipment and got on the air.

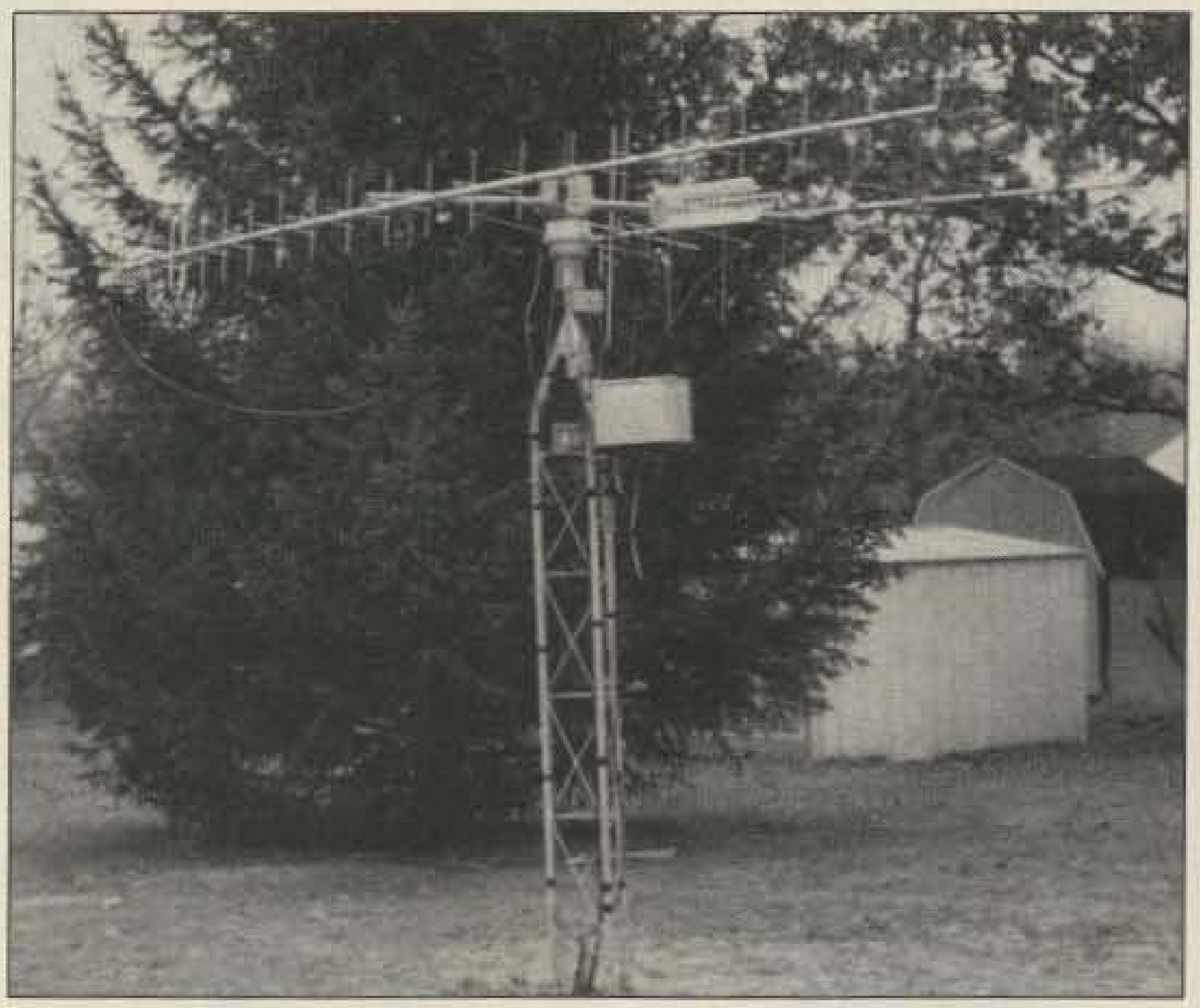

Photo C. The Mode-L antenna array. The gray box under the antenna is the weatherproof container for the 2m/1269 MHz converter and linear amp.

Proof Of The Pudding

A ham was calling CQ on Mode L. My signal was strong enough, but it sure didn't sound good. The following day, I rechecked the input level on the converter and found it right where I had set it. Then, on a hunch, I checked the DC voltage while my bride whistled and talked again. The DC was modulating right with her input, so I went to work and cleaned up my DC negative return line. This seemed to correct the problem, but since I had a 42,000 µF capacitor on hand, I placed it across the 12 volt line for insurance. Viola! Success!

Finale

Many may wonder about operating this electronic jewelry out in the weather. I built a galvanized steel box, open at the bottom for cooling, and used soldered lap seam construction. It is secured to the wooden equipment rack with half a dozen wood screws. There is easy access for coax and power lines, adequate cooling, and weather security; the latter because the "skirt" of the box extends well below the equipment.

Having a Mode L system that works is a fine reward in itself. Even more of a reward is having a truly unique approach, and telling other Mode L operators about it. My transmission line from the power amplifier to the antenna is five feet of Belden 9913. From the reports I get, the loss there is acceptable! I really hope that one of the manufacturers will latch onto this scheme and offer a helical antenna integral with (no transmission line) a converter and an amplifier—the ultimate suggestion by my good friend, Bob Machan WA8L.

I hope you will enjoy putting together this Mode-L station—without having to spend a bundle on hard line and microwave power amps!

CIRCLE 41 ON READER SERVICE CARD

Polarizing/Matching Selector

Choose your phase.

by Gerald Klatzko ZS6BTD

During line-of-sight (LOS) communication, which is the case with satellite communication, maximum signal transfer will occur when the antennas at both ends of the circuit have the same polarity. This doesn't apply to HF communication because polarization is lost after the electro-magnetic waves have passed through the ionosphere.

The polarity of the antenna is decided by its position with respect to mother Earth. This position also defines the polarity of the electric field parallel to the axis of the radiation.

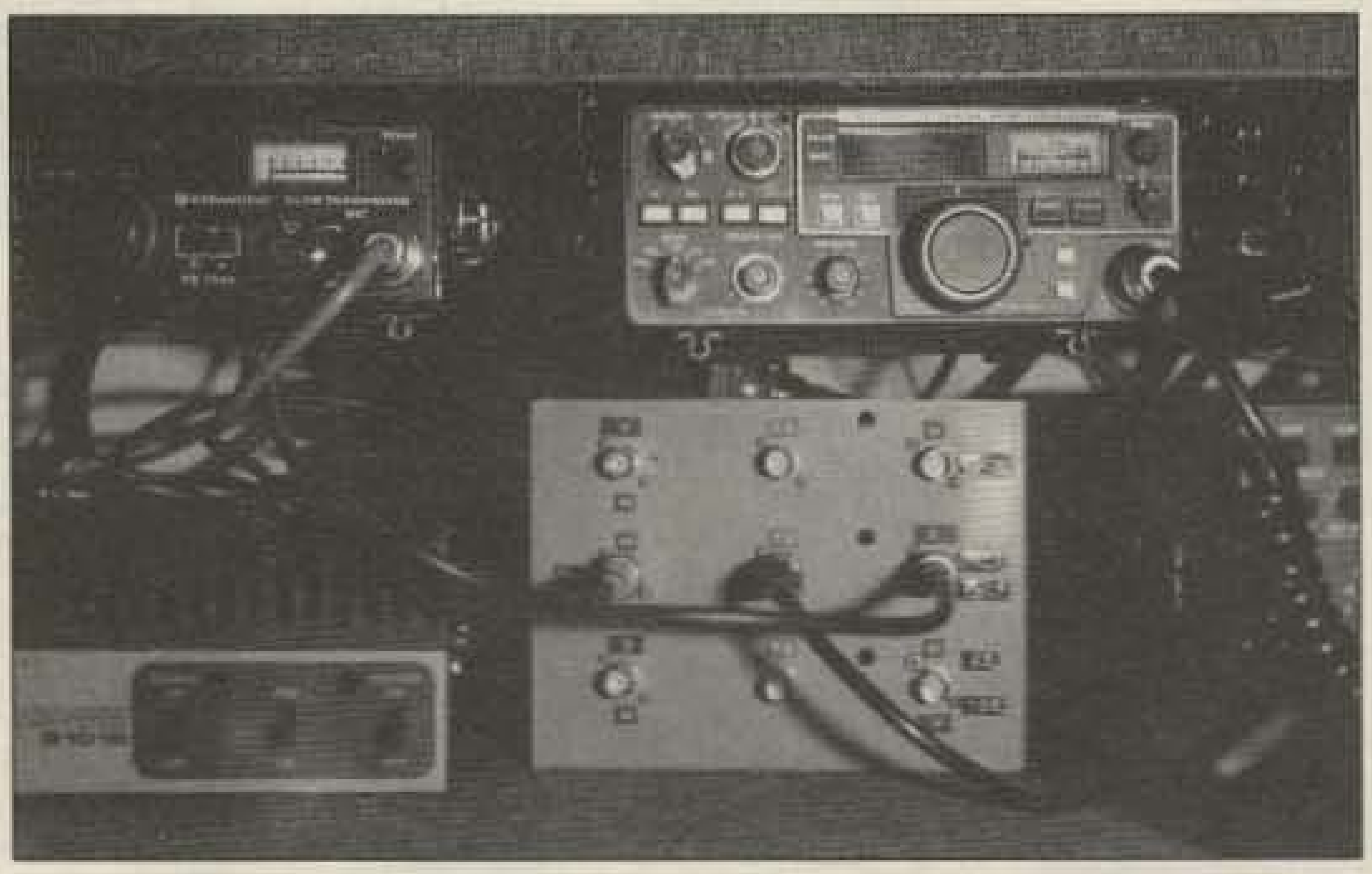

Photo A. Front panel of the polarizing angle-matching selector.

Matching Polarity

An antenna perpendicular to Earth is vertically polarized, and one parallel to earth is horizontally polarized. Cross-polarization between the transmitting and receiving antennas results in extreme reduction of signal strength, approximately 20 to 30 dB, or a reduction of from 100 to 1000 times. For a strong signal it's essential that, on both transmit and receive, the polarity of the ground station's antenna and the polarity of the satellite's antenna match.

Unfortunately, the satellite continuously varies its attitude with respect to the ground station. To maintain polarity, we have to create a facility at the ground station to vary our antenna polarization from vertical to horizontal, to RH circular, to LH circular, to 45 degrees linear, and to 135 degrees linear.

Experimenting with Antenna Systems

Talking to satellite operators around the world, and asking each one what type of antenna he uses and what he does about polarization, we have heard some weird and wonderful tales of typical amateur ingenuity and resourcefulness.

The most ingenious is Rex of Ruislip G4JUJ, who has mounted two yagis side by side, about 1 wavelength apart, with each boom axially rotated by individual motors. While Rex is listening to a received signal, he adjusts the angle between the two yagis until he gets the best possible signal. From his experience on OSCAR 10, he knows approximately where to set the two positions.

We found proponents of vertically polarized antennas, horizontally polarized antennas, and circularly polarized antennas. Each proponent will tell you that his system gives the best results—after all, he built it or bought it and he gets excellent results with it, so surely it must be the best.

The Proof of the Pudding...

Now the little nagging doubt sets in—they all have different systems and they all claim to be right. Which one do you accept? Which one will give you the best results? The only way to find out is to "suck it and see!" as we say in South Africa. But how?

I could not get geared-down motors and

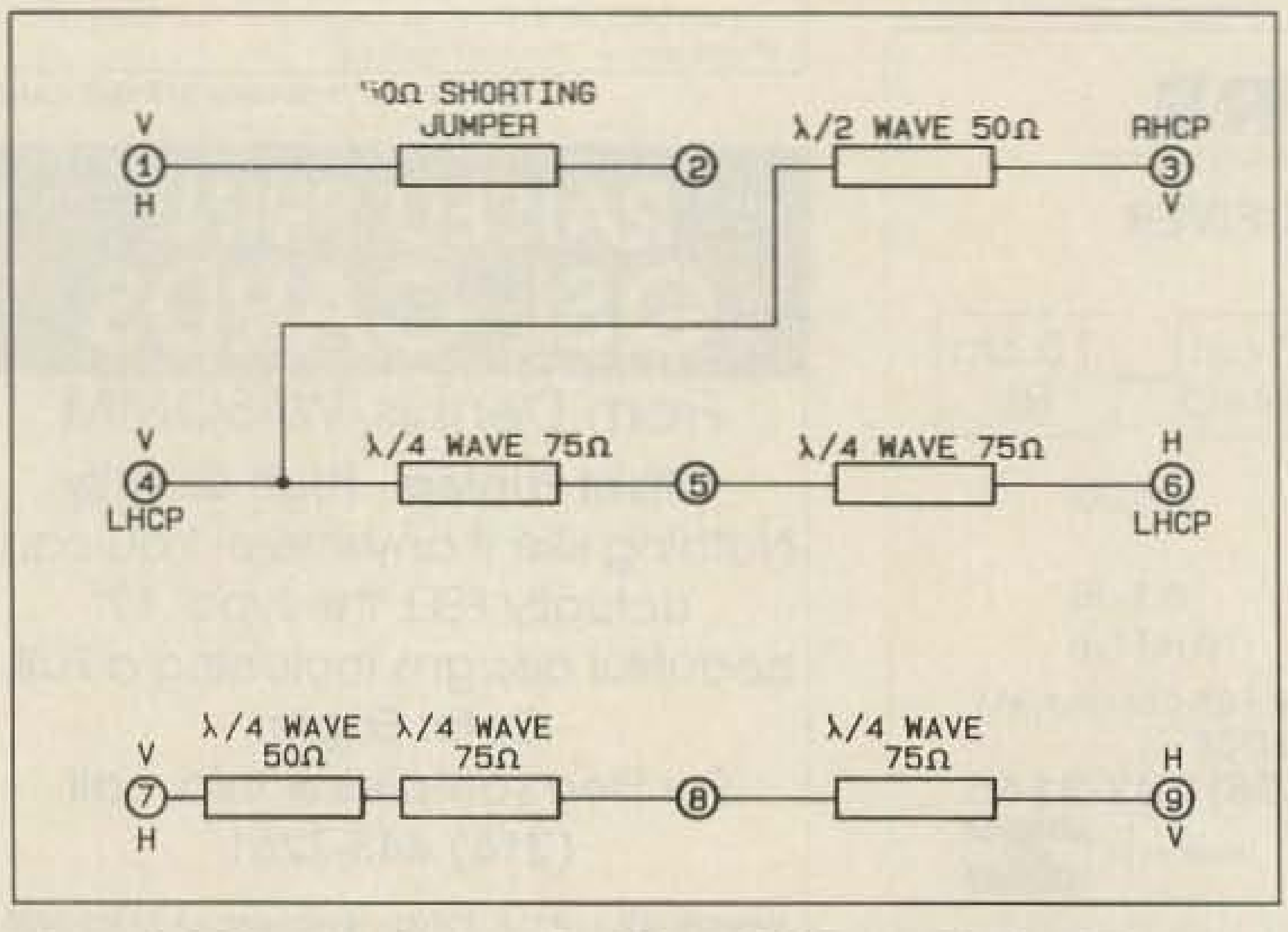

Figure 1. This unit is designed for 70 cm. BNCs are 50 ohm. The coax is positioned as close as possible to the BNC.

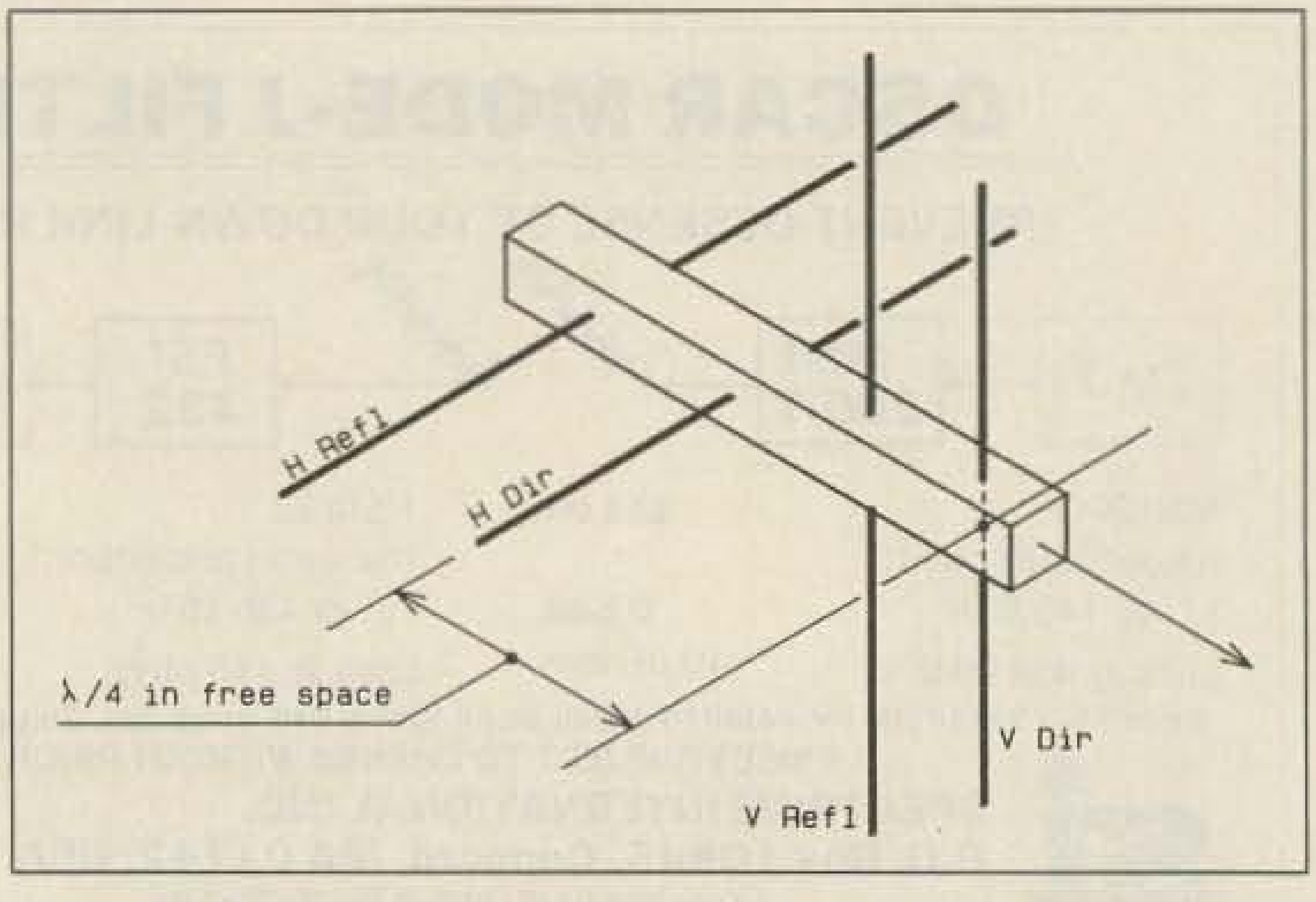

Figure 2. A crossed yagi antenna that consists of two dipoles at right angles to each other. The arrow to the right of V Dir shows the direction of maximum gain.

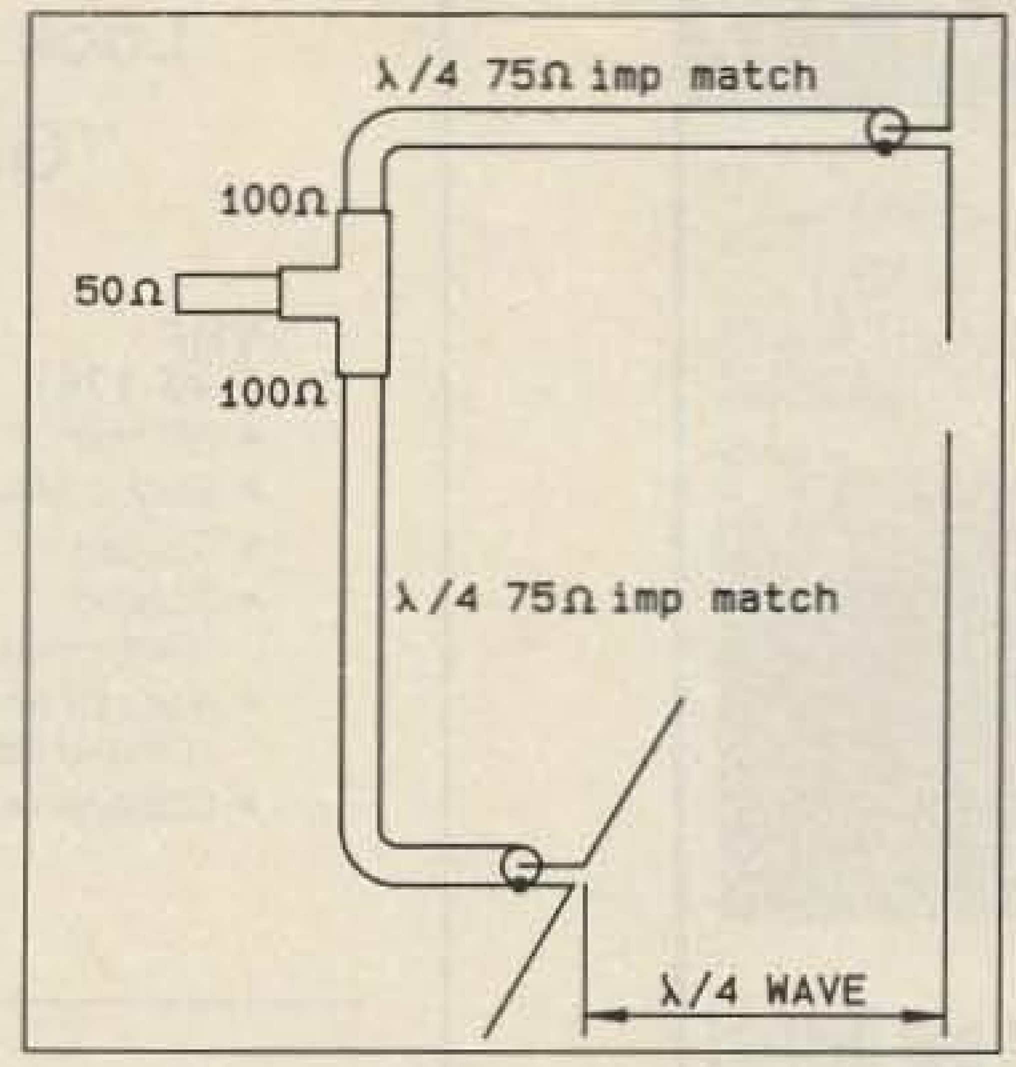

Figure 3. The TX line plugs into BNC(5). BNC(5) is joined to BNC(4) and BNC(6) by ¼-wave, 72 ohm impedance matching lines.

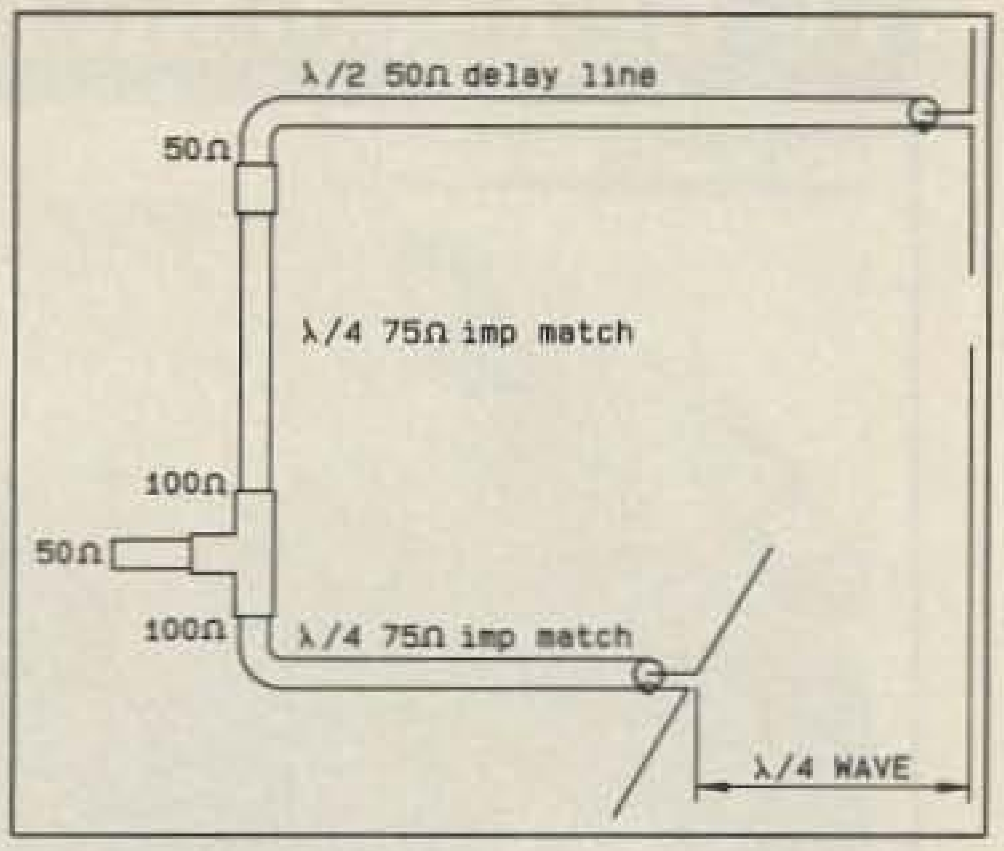

Figure 4. The TX line remains in BNC(5). However, the vertical antenna now plugs into BNC(3), in order to insert the ½-wave, 50 ohm delay line. The horizontal antenna remains in BNC(6).

special bearings to fit the available booms, and I didn't relish making rotation indicators to show the axial angle. Neither could I get the extra low-loss, high-Q special switching coaxial relays to mount up at the antennas to do the change-over switching. However, I still wanted a system with which I could test the effects of various antenna polarizations for myself. I decided to use 18 BNC sockets mounted on a panel, with the sockets selectable by means of three fly-leads to simulate the three wiper-arms shown in the book: one fly-lead from the transceiver, one from the vertical antenna, and one from the horizontal antenna.

By repositioning the two antenna fly-leads, I could easily change the antenna polarization. This enabled me to halve the number of BNCs to 9. I now had a simply-built, inexpensive unit that met all the requirements to carry out the comparisons of the various polarizations.

The unit in Figure 1 is designed for 70 cm. The BNCs are 50 ohm chassis-mounting types. A copper foil skirt is pop-rivetted to one corner of the BNC, then wrapped around the shield of the coax. Position the coax as close as possible to the BNC in order to maintain a constant 50 ohm impedance. You can easily check the impedance by leaving a VSWR meter connected in-line while transmitting low power through the polarizing unit. Adjust the wrapping of the skirt to obtain the lowest VSWR. Copper foil is also used to join shield-to-shield of the delay/matching line between terminals 7 and 8.

I measured the velocity factor of the coax with a dip oscillator at 146 MHz (because I do not have a 438 MHz dip oscillator) to establish a ½-wavelength. Then I cut this in three to get the correct ½-wave at 438 MHz, and in ½ again for the ¼-wave line.

The Six Positions

P1 = VERTICAL: The very short jumper (approx. 85 mm), joins TX BNC(2) to BNC(1). The fly-lead from the vertical antenna is connected to BNC(1).

P2 = HORIZONTAL: As P1 above, but now the fly-lead from the horizontal antenna is connected to BNC(1).

P3 = LHCP: The TX plugs into BNC(5). BNC(5) is joined to BNC(4) and BNC(6) by ¼-wave, 72 ohm impedance matching lines only. See Figure 3.

P4 = RHCP: The TX remains in BNC(5). However, the vertical antenna now plugs into BNC(3) so that you can insert the ½-wave, 50 ohm delay line, as in Figure 4. The horizontal antenna remains in BNC(6).

P5 = 45-degree LINEAR POLARIZATION: The TX plugs into BNC(8). The horizontal antenna plugs into BNC(9) to connect to the 72 ohm, ¼-wave matching line, and the vertical antenna plugs into BNC(7) to connect to the ¼-wave 50 ohm delay line in series with the ¼-wave 72 ohm matching line.

P6 = 135-degree LINEAR POLARIZATION: The TX remains in BNC(8), but the vertical and horizontal antenna fly-lead positions are opposite the P5 positions.

Circular Polarization

What is circular polarization? It is where the polarization of a signal is constantly rotating about its axis. You can achieve this with the crossed yagi configuration when the horizontal and vertical yagis emit the same signal 90° out of phase (recall that this can be done with the yagi elements physically spaced 1/4 wavelength apart and fed in phase, or with the elements physically spaced in phase, but fed 1/4 wavelength apart). Circular polarization is compatible, with no more than a 3-dB power loss with either vertical or horizontal polarization.

A circularly polarized antenna system is the most useful single configuration to have for satellite work. The antennas on our most popular satellites (A-O-10, A-O-13, F-O-12) are circularly polarized, and the linear antennas on the other birds are always changing their orientation.

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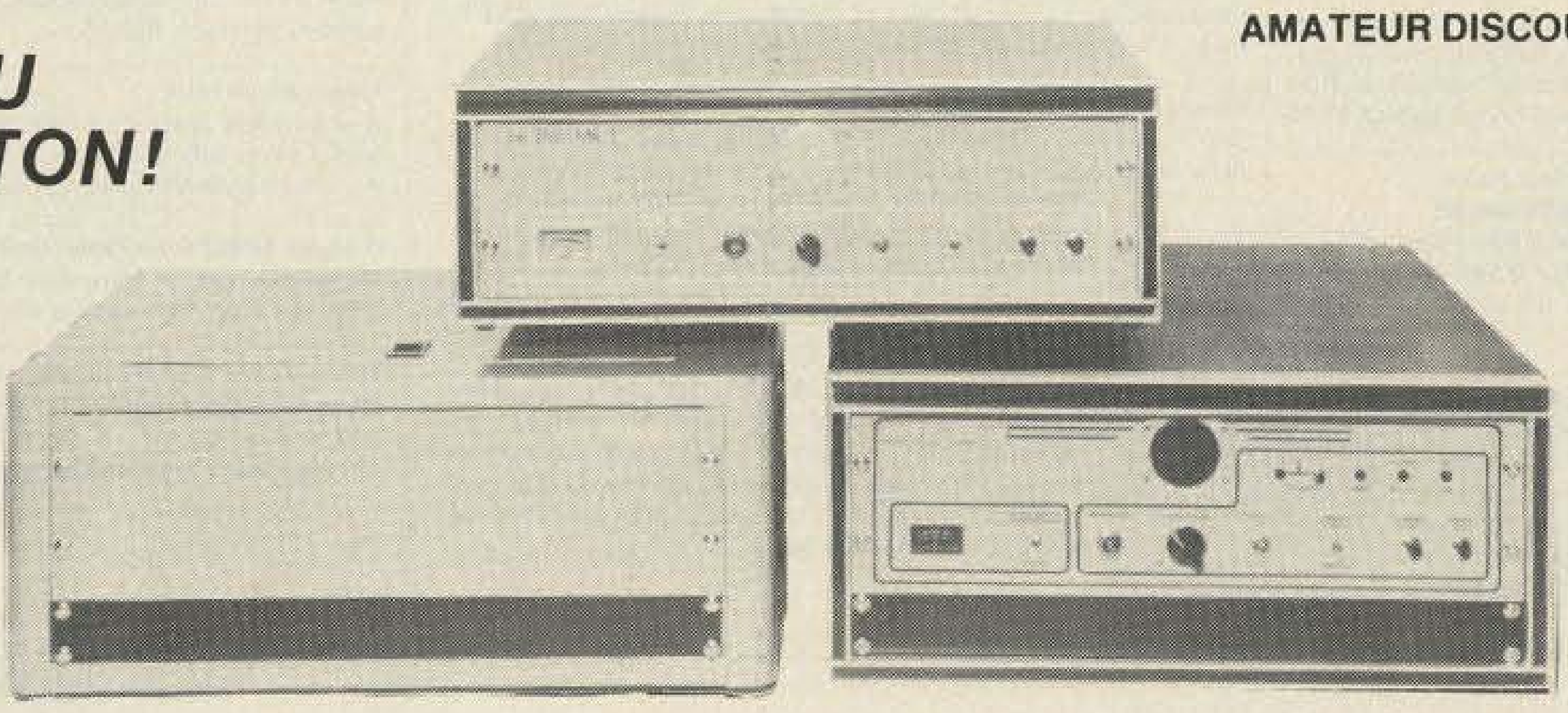

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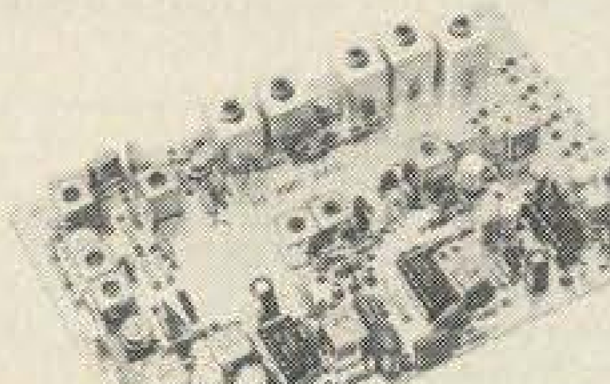

R4V

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R4U

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Spurious Response: -85 dB

Intermodulation: -70 dB

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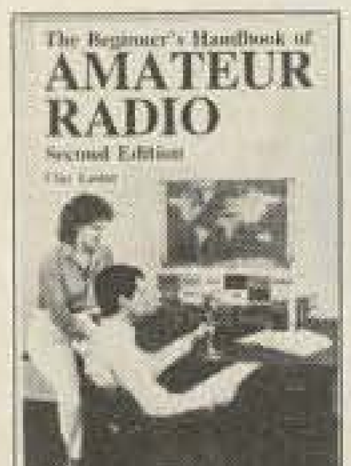

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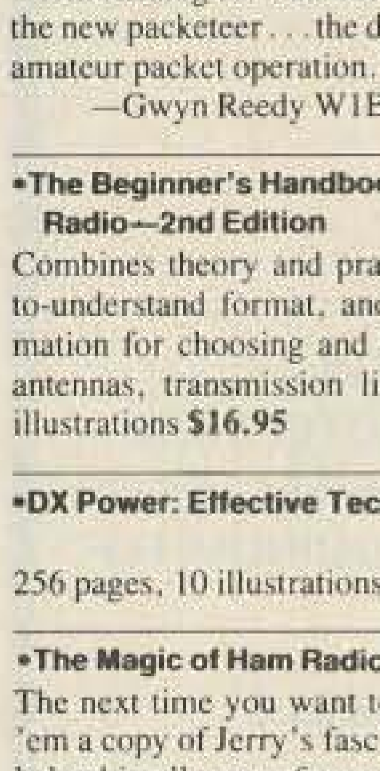

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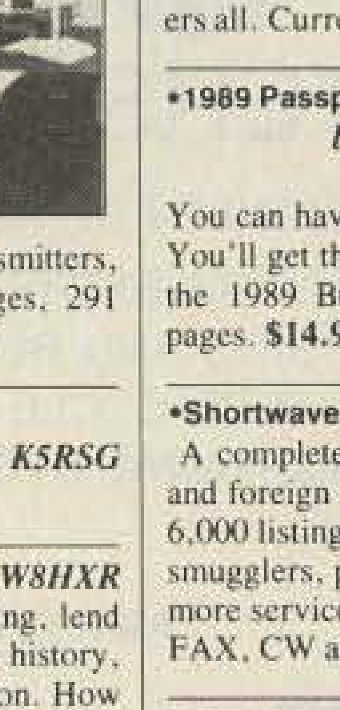

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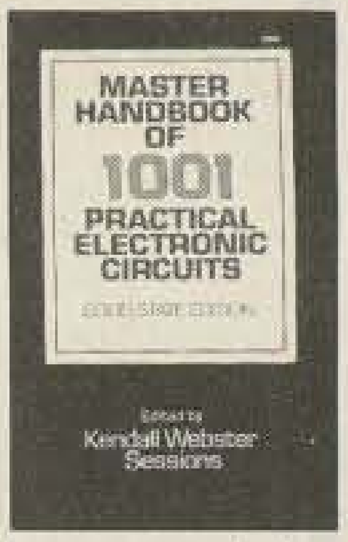

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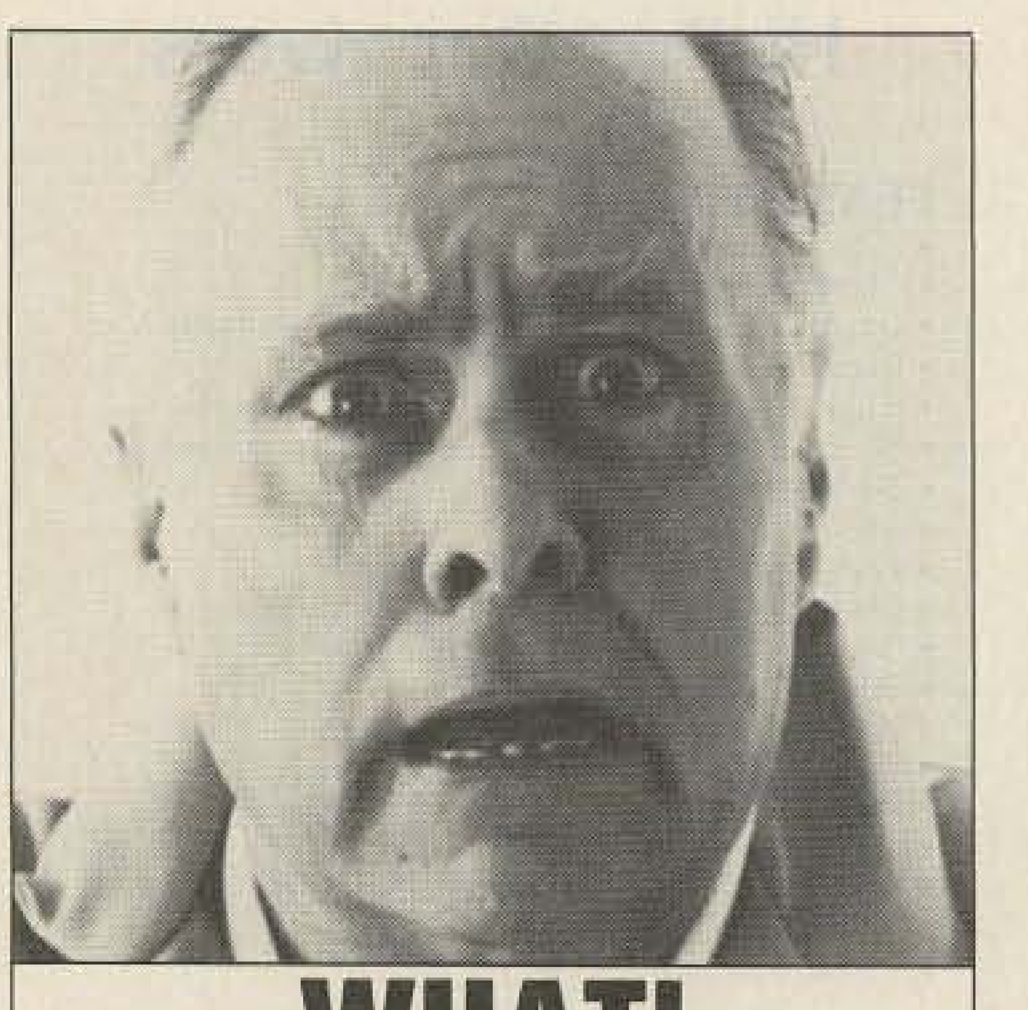

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Frequency range: 29-54, 118-174, 406-512, 806-956 MHz.
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Priority control • Search/Scan • AC/DC
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10 Meter Mobile Transceiver • New Features
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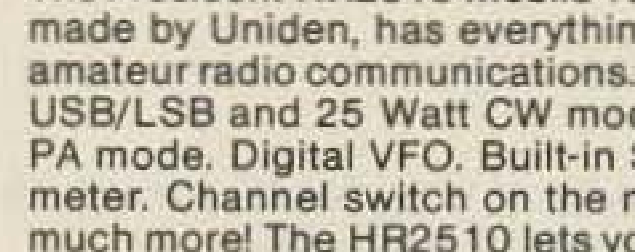

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Experimental OSCARs

Extraterrestrial DXing

by Jeff W. Ward G0/K8KA

Photo A. Roger Peel G8NEF working on an engineering model of the UoSAT-OSCAR-11 on-board computer. Photo by Martin Sweeting G3YJO.

If you're excited by all this talk of orbits and OSCARs, your trusty 2 meter FM rig or VHF scanner can bring your first QSL from space! Three times each morning, and three times again each evening, UoSAT-OSCAR-9 and UoSAT-OSCAR-11 come within range of your shack. Simply break away from your favorite 2 meter repeater (interrupting the inevitable discussions of local weather and traffic patterns), tune to 145.825 MHz, and wait. Sometime between 7 and 10 o'clock local time, you'll hear a UoSAT downlink.

Most of the time the downlink transmits computer data, which sounds like a continuous packet radio transmission, but every few minutes the digital voice of UoSAT will say "73 FROM UoSAT IN SPACE. PLEASE QSL." Send your reception report to UoSAT Headquarters, and you'll receive a satellite QSL card. Even a handheld with a rubber duck antenna can get you this extraterrestrial DX.

UoSAT (pronounced "Ewe-owe-sat") stands for University of Surrey Satellite. Two OSCARS, UoSAT-OSCAR-9 and UoSAT-OSCAR-11, were built by radio amateurs, students, and faculty members at The University of Surrey (UoS), which is in the city of Guildford, in the county of Surrey, England.

AMSAT activities at UoS started in 1974 when Martin Sweeting G3YJO began tracking OSCAR-7 from The University's amateur radio club station. Two years later, this station changed from a normal OSCAR user station to an important AMSAT command center, because OSCAR-6 needed almost continuous care from ground controllers. Yagi antennas on a navy surplus battleship gun mount were linked to the university's main frame computer for automatic tracking. Roger Peel G8NEF programmed this system, which included a punched tape link (remember paper tape?), and helped prolong OSCAR-6's lifetime by preventing deep discharge of the on-board batteries.

The next logical leap for the group at Surrey was to design, build, and command its own OSCAR satellites. It took a lot of negotiation, but by 1979 the appropriate authorities had been persuaded to part with the necessary funds, a launch opportunity had been identified, and the UoSAT-A program was underway.

UoSAT-OSCAR-9

AMSAT planners decided that UoSAT should compliment and not duplicate the AMSAT and Radio Sputnik communications satellites already in orbit and on the drawing board. Thus, UoSAT-OSCAR-9's primary missions were technical experimentation and education, instead of two-way communications.

An orbiting satellite can be a valuable educational and technical tool if it is easy to access and provides interesting information, so UoSAT-OSCAR-9 was fitted with several scientific experiments and an array of data transmission beacons. The experiments include 2.4- and 10-GHz microwave transmitters, a magnetometer which measures the Earth's magnetic field, a Charge-Coupled Device (CCD) camera to take pictures of Earth, Geiger counters to measure radiation in space, and HF propagation beacons on 7, 14, 21, and 28 MHz. Data from these space experiments is available to everyone who monitors UoSAT.

The UoSAT-OSCAR-9 HF beacon experiment can provide your next experience in satellite SWLing. This requires a little more planning than simply waiting for the VHF beacon. Ask a local AMSAT member for some orbit predictions for UoSAT-OSCAR-9, and when it should be in range, listen for CW transmissions on 29.510, 21.002, or 14.002 MHz. Don't forget that the Doppler shift will make the signal frequency seem higher when the satellite is coming toward you and lower when it's going away. The beacon transmits "AMSAT" in Morse code, then unmodulated carrier for signal-strength measurements, then a line of Morse telemetry. The 29 MHz beacon will be the strongest, since it is not attenuated by the ionosphere as much as the lower frequency beacons.

When you've found one of the HF beacons, compare your HF Acquisition Of Signal (AOS) and Loss Of Signal (LOS) times with those for the 2 meter signal. You may find that over-the-horizon propagation makes the HF signals audible longer than the VHF signals. This is just one of the many fascinating areas of AMSAT satellite experimentation.

As well as carrying so many experiments, UoSAT-OSCAR-9 uses several different downlink data formats. Like all AMSAT satellites, it can generate Morse code telemetry (on board voltages, currents, temperatures, and experiment values), but with so much information, it needed faster ways of getting the data down to Earth. ASCII and Baudot RTTY from 50 to 1200 bits per second are available. Since the packet radio revolution of the last few years, we tend take 1200 bits/s amateur radio for granted. In 1980 the micro computer was just finding its way into amateur radio shacks, and UoSAT-OSCAR-9 was the first OSCAR satellite designed for computer reception.

For simpler ground stations, UoSAT-OSCAR-9 carries the digital voice synthesizer (DIGITALKER™) that you can hear on 2 meters. The DIGITALKER has given thousands of school children around the world their first direct experience with satellite communications. A DIGITALKER (this time on UoSAT-OSCAR-11) also helped a joint Canadian-Soviet ski team cross the Arctic during the spring of 1988. The location of the team was measured by search and rescue satellites, passed on to the university via landline Telex, and then sent by UoSAT-OSCAR-11 DIGITALKER to the skiers on the ice. School children throughout the world followed the progress of the SkiTrek by listening to UoSAT and reading AMSAT-NA educational bulletins from packet radio BBSs.

UoSAT-OSCAR-11: You Want It When?!

The most important and precious part of any AMSAT mission is the launch, so when AMSAT supporters at NASA/DELTA offered a piggy-back launch for a second UoSAT satellite, it was impossible to refuse, even though the launch date was only six months away! In six months, just about enough time to organize the average club Field Day, the UoSAT team would have to design, build, test, rebuild, and prepare an entire satellite for launch.

An international team rose to the challenge. The satellite "bus," which includes the structure, power supplies, on-board computer, telemetry, telecommand, and navigation systems, was designed and built at UoS. In Canada, Stan Kazmiruk VE3JBA and his team tested batteries—temperature cycling them in modified freezers, vibrating them in the back of a station wagon on bumpy roads, and X-raying them at the local dentist's office.

Photo B. Mike Blewett G4VRN (left) and Richard MacBeth G8VLY examine UoSAT-OSCAR-11 in the University of Surrey clean room. The solar panels are removed to permit access to modules and the wiring harness. Photo by Martin Sweeting G3YJO.

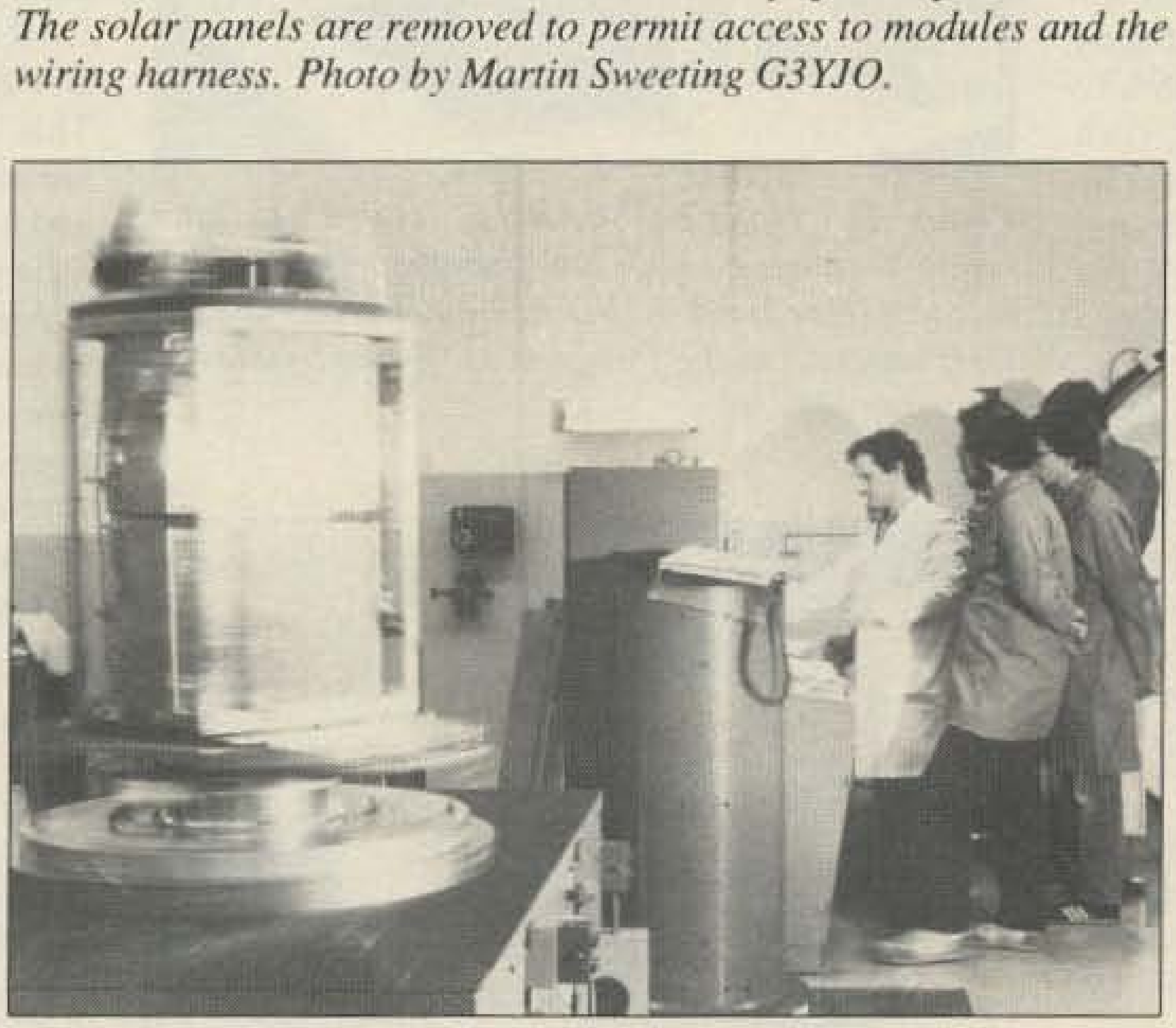


Photo C. Spin balance testing UoSAT-OSCAR-11 at British aerospace test facility. Photo by Martin Sweeting G3YJO.

Another North American team involving some 20 people designed and constructed the first digital store-and-forward communications transponder, the Digital Communications Experiment (DCE). With some difficulty, they got a microcomputer with 124K bytes of memory on 3 printed boards into a 1-inch high module box. Many tall tales from the UoSAT-OSCAR-11 campaign cannot be confirmed, but Harold Price NK6K's video tapes show the traditional amateur technique of banging the box in use during hardware debugging at the launch site!

Despite the rapid development necessary to meet the launch deadline, UoSAT-OSCAR-11 was an entirely new satellite. The mission objective was to further the educational, scientific, and experimental aims established by UoSAT-OSCAR-9. On board experiments include three Geiger counters, an electron spectrometer, a micrometeorite detector, a CCD camera, and a 192K byte memory bank for camera images or computer data. In 1983, microcomputers were becoming more common in OSCAR ground stations, so UoSAT-OSCAR-11 designs support computer data links up to 9600 bits/second.

UoSAT-B was launched on March 1, 1984, on a NASA/DELTA launcher from Vandenberg Air Force Base in California, and officially became UoSAT-OSCAR-11 when it was injected into orbit over Turkey. On the first day, the satellite seemed in good health and on board computer programs were loaded, but the next morning UoSAT-OSCAR-11 was silent and would not respond to commands. Nothing was heard for weeks, although the university team kept trying to command the silent satellite.

As a last resort, amateurs from the Stanford Research Institute in California used a dish antenna in Greenland to listen for a local oscillator signal from the satellite's 1.2 GHz receiver. The SRI dish received this 1 µWatt signal, confirming that the satellite was alive and the orbit predictions were correct. Two days later, Neville Bean G8NOB successfully commanded the satellite using a redundant uplink receiver.

The fault which had kept UoSAT-OSCAR-11 silent was isolated to a data carrier detect circuit in the uplink receiver, which kept the satellite from accepting commands. Since the on-board computer and the computer in the DCE could choose to ignore the detect signal, they were used to bypass the failure and UoSAT-OSCAR-11 is now fully operational.

PACSAT Experiments

Unlike UoSAT-OSCAR-9, UoSAT-OSCAR-11 can be used for communications. The Digital Communications Experiment (DCE), built by the North American team mentioned earlier, can receive messages from computers on the ground, store them in on-board RAM, and re-transmit them later in orbit. This is called "store and forward communications."

The DCE was financed by the Volunteers In Technical Assistance (VITA), to test and demonstrate hardware and software for this new technique. AMSAT wanted to build a store-and-forward satellite called PACSAT for amateur radio communications, and VITA wanted to see if store-and-forward communications (on non-amateur frequencies) would help them provide disaster relief and development information to field workers in the Third World. The DCE on UoSAT-OSCAR-11 proved that store-and-forward communications from a small, inexpensive satellite would work, leading the way for the Fuji-OSCAR-12 packet radio mailbox and several advanced digital communications OSCARs now under construction.

Messages sent via the UoSAT-OSCAR-11 DCE must pass through gateway stations, which issue commands to the satellite for storing and reading messages. The gateway stations are usually also packet radio BBS stations, and messages are forwarded by packet between gateways and end-users. UoSAT DCE gateways operate in New Zealand (ZL1AOX), Australia (VK5AGR), The United Kingdom (GB2UP), South Africa (ZS6SAT), and Germany (DB2OS). Project OSCAR is constructing a USA gateway.

In addition, isolated stations in Antarctica (ZL5BA) and Pakistan (AP2SUP, AP2PUL) communicate with amateurs worldwide using the DCE. UA3CR in Moscow has also used the DCE. The gateway system is an unusual way to access OSCAR satellites. It allows stations without satellite equipment to use the DCE, and the DCE gateway operators manage the limited memory available in the DCE.

On the other hand, part of the fun of OSCAR operation is directly accessing the satellites. New packet radio satellites UoSAT-D, the AMSAT-NA Microsats, and Fuji-OSCAR-12 are designed for open access to all amateurs, not just gateways.

Connecting Your Computer to UoSAT

If listening to the DIGITALKER and the HF beacons has excited your imagination, you'll want to decode some of the digital data from the UoSAT downlinks. Both satellites continuously transmit experimental data, and telemetry and news bulletins on their 145.825 MHz downlinks at 1200 bits/second. On board computer programs schedule experiments and determine what data to transmit, so the content of the downlink will vary as the satellite passes your station.

To decode the data, you need a computer (or a simple ASCII terminal) and a demodulator. Although demodulators specifically designed for UoSAT provide the best results, you can also try a telephone or packet radio modem which uses the Bell-202 tones. (The Bell-202 demodulator will receive UoSAT-1 correctly, but output data will have to be inverted to receive UoSAT-2.) When you graduate to receiving data from UoSAT, you must make sure that your receive signal is fairly strong. Although weak signals from a handheld are OK for the DIGITALKER, high-speed data communications requires better links.

A UoSAT demodulator is available from *AMSAT-UK, 94 Herongate Rd, London, E12 5EQ, United Kingdom.* Please send an envelope with IRCs for a complete price list of all AMSAT-UK satellite goodies. UoSAT data decoding software for the Commodore-64 computer is sold by Project OSCAR. Send an SASE to *Project OSCAR, Box 1136, Los Altos CA 94023-1136.*

Most of the data transmitted by UoSAT is 1200 bits/second ASCII, with even parity bits. Telemetry frames describe the state of all spacecraft systems and experiments every five seconds.

The on-board computer status messages and the news bulletins are in plain ASCII text. You can read them on screen or send them to a printer. To understand the telemetry and the WOD, you need to decode the data either by hand or with computer programs. The UoSAT Data Booklet, available from AMSAT-NA and AMSAT-UK, contains complete information on data decoding.

If you are naturally curious, you'll want to decode UoSAT data just for the fun of it, to find out what the strange signals mean. Once you have "cracked the code," you can try many interesting experiments. By plotting the output of the on-board magnetometer, you can determine how fast UoSAT is spinning in the Earth's magnetic field. By watching the battery voltage and the satellite's temperature, you should be able to see exactly when the satellite passes into or out of the Earth's shadow. Whole orbit data surveys of the Geiger counter on UoSAT-OSCAR-9 clearly show the enhanced radiation which causes auroral displays at high latitudes. Continuously transmitting 1200 bits of data per second, the UoSATs generate a wealth of information. It's up to you to use it!

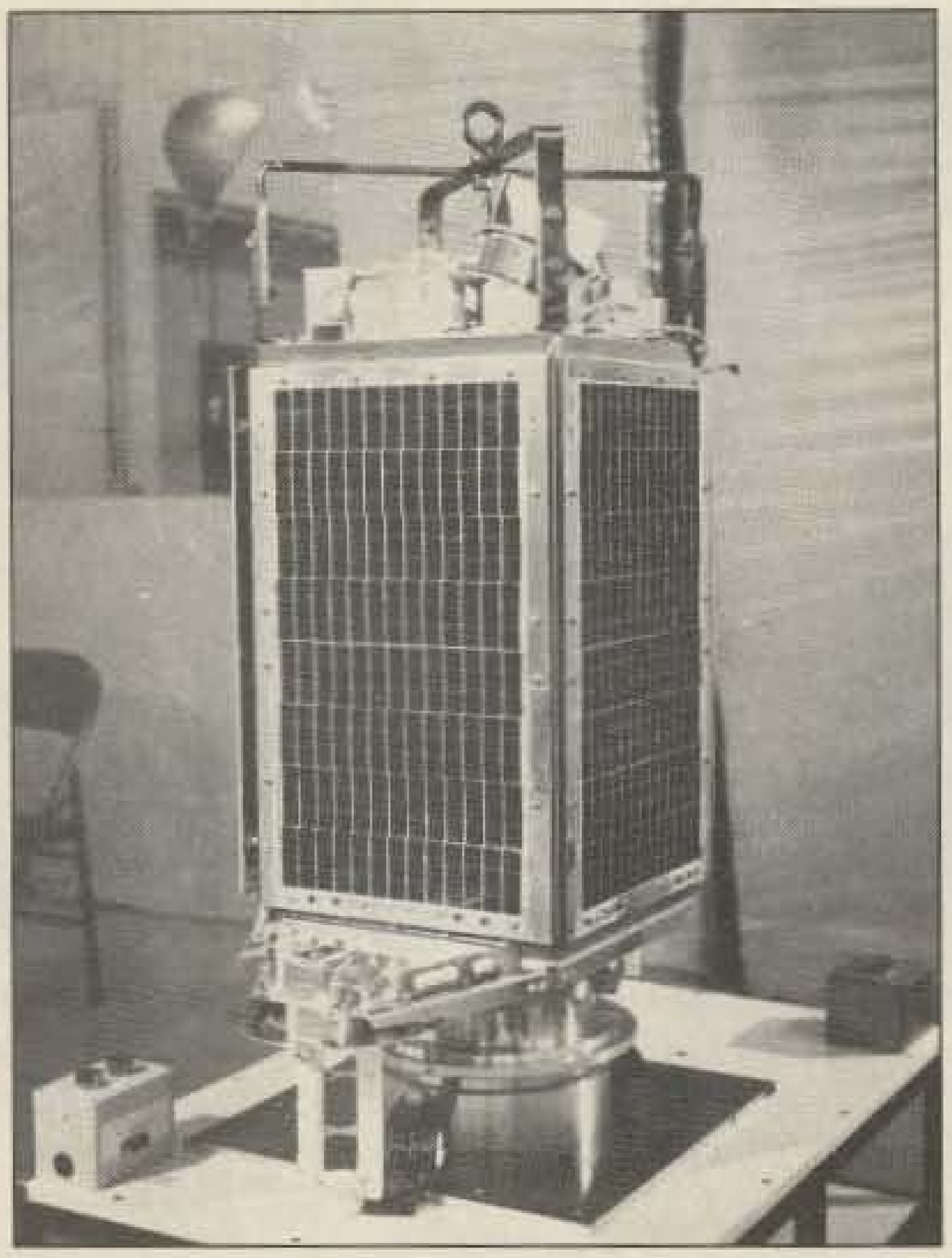


Photo D. UoSAT-OSCAR-11, completed and ready to integrate with the launcher. The bracket on top will be removed before launch. Note the 1.2 GHz antenna in the foreground. Photo by Martin Sweeting G3YJO.

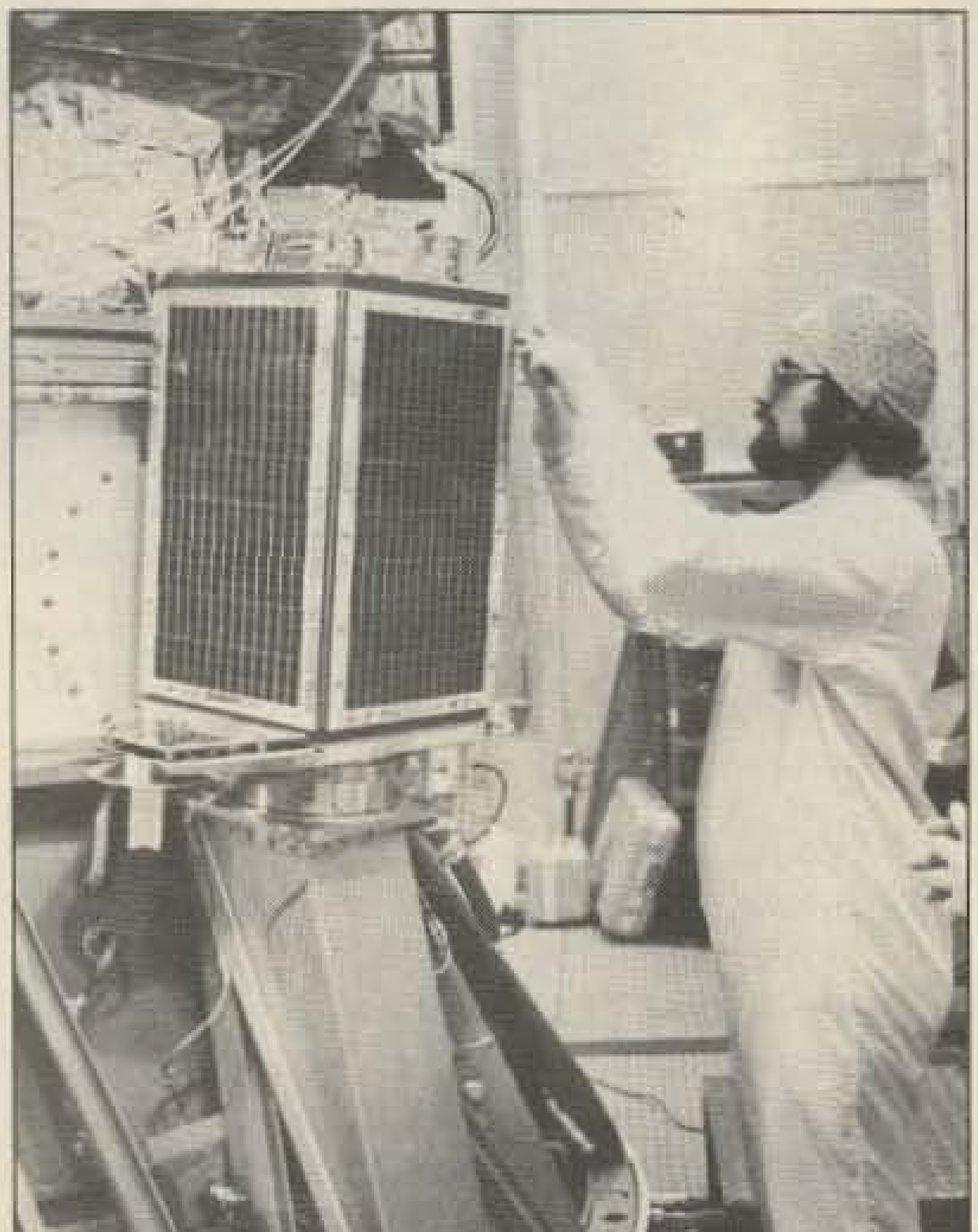


Photo E. Inside the launcher gantry at Vandenberg AFB, California, Ian Ferebee G6BTU places the solar panel on UoSAT-OSCAR-11. The satellite is in its final position, just below the main payload. Photo by Martin Sweeting G3YJO.

The New UoSATS

Technology has advanced since the launch of UoSAT-OSCAR-11; faster, smaller, lower-power computers are available to support more complex on-board experiments. A new group of radio amateurs and student engineers at the University of Surrey is ready to test its ideas in orbit.

Two new UoSAT-OSCAR satellites, designated UoSAT-D and UoSAT-E until launch, are under construction at UoS. (What happened to UoSAT-C? The UoSAT-C mission is an ongoing project, which will now be launched after UoSAT-D and UoSAT-E.)

Harold Price NK6K and Skip Hansen WB6YMH are working on a multi-tasking computer operating system. Larry Kayser has the Canadian battery testing team in action. The UoSAT team in England is constructing the bus and the payloads.

UoSAT-D and -E will be launched by the European launch agency Arianespace, on an Ariane-4 launcher, into 800-km, sun-synchronous, polar orbits. The primary payload is the French imaging payload SPOT-2, and there are six OSCAR satellites riding piggyback. Besides the two UoSATs, there will be four very small OSCARs called Microsats built by AMSAT-NA and described elsewhere in this issue. This is the first multi-satellite OSCAR launch for western AMSAT organizations, and it will be the first test of the new Ariane Structure for Auxiliary Payloads (ASAP).

Arianespace hopes to use the ASAP on Ariane to provide a continuing supply of low-cost launch opportunities for small educational and experimental satellites. The aerospace industry is learning from radio amateurs that small satellites are useful and cost-effective.

UoSAT-D PACSAT Communications Experiment

UoSAT-D is the first UoSAT satellite with communications as its primary mission. The UoSAT-D PACSAT Communications Experiment (PCE) will be an open-access, Mode-J, store-and-forward PACSAT transponder available to all correctly equipped ground stations. For engineers at Surrey, the PCE continues the communications experiments which started with the UoSAT-OSCAR-11 DCE. Once again, AMSAT is joining the Third World development organization VITA to test low-cost hardware and software appropriate for rural communications. VITA is funding the development of the PCE circuits, while AMSAT-UK is paying for the actual flight hardware.

VITA may have their own link to the transponder on a special FCC-licensed channel. (Rest assured that they won't be using amateur frequencies to access the PCE.)

The UoSAT-D PCE will be an advanced PACSAT transponder, using 9600 bits/s Frequency Shift Keyed (FSK) uplink and downlink. These links are compatible with special modems, such as the G3RUH FSK modem (available from AMSAT-UK), but it will not work with the modems built into existing TNCs.

The access protocols for the PCE will be specially designed for efficient use of the high speed link and the limited periods of satellite visibility. Using standard AX.25 packet radio as a starting point, new methods of chan-

Continued on page 102

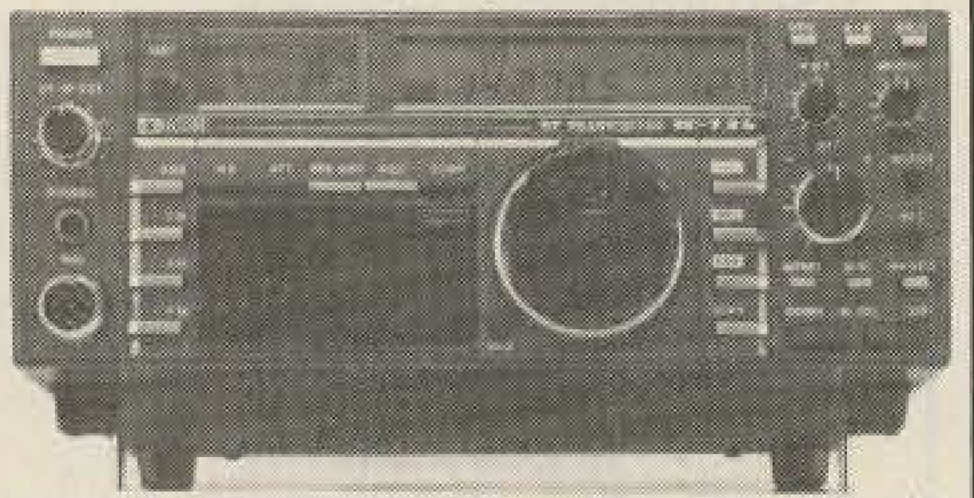
Keyword Index

Issue #344

HF Equipment	Regular	SALE
IC-781 Xcvr/Rcvr/ps/tuner/scope ...	5995.00	Call

IC-761 Xcvr/Rcvr/ps/tuner	2699.00	2369
HM-36 Scanning hand microphone	47.00	
SP-20 Ext. speaker w/audio filter ..	149.00	139^{95}
FL-101 250 Hz 1st IF CW filter	73.50	
FL-53A 250 Hz 2nd IF CW filter	115.00	109^{95}
FL-102 6 kHz AM filter	59.00	
EX-310 Voice synthesizer	59.00	

IC-751A 9-band xcvr/.1-30 MHz rcvr	1699.00	1469
PS-35 Internal power supply	219.00	199^{95}
FL-63A 250 Hz CW filter (1st IF)....	59.00	
FL-52A 500 Hz CW filter (2nd IF)...	115.00	109^{95}
FL-53A 250 Hz CW filter (2nd IF)...	115.00	109^{95}
FL-33 AM filter	49.00	
FL-70 2.8 kHz wide SSB filter	59.00	
RC-10 External frequency controller	49.00	



IC-735 HF transceiver/SW rcvr/mic	1099.00	989^{95}
PS-55 External power supply	219.00	199^{95}
AT-150 Automatic antenna tuner ...	445.00	369^{95}
FL-32A 500 Hz CW filter	69.00	
EX-243 Electronic keyer unit	64.50	
UT-30 Tone encoder	18.50	
IC-725 Ultra compact HF xcvr/SW rcvr	949.00	849^{95}

Other Accessories	Regular	SALE
IC-2KL 160-15m solid state amp w/ps	1999.00	1699
EX-627 HF automatic antenna selector	315.00	279^{95}
PS-15 20A external power supply	175.00	159^{95}
PS-30 Systems p/s w/cord, 6-pin plug	349.00	319^{95}
MB Mobile mount, 735/751A/761A...	25.99	
SP-3 External speaker	65.00	
SP-7 Small external speaker	51.99	
CR-64 High stab. ref. xtal for 751A....	79.00	
PP-1 Speaker/patch	179.00	164^{95}
SM-6 Desk microphone	47.95	
SM-8 Desk mic - two cables, Scan.....	89.00	
SM-10 Compressor/graph EQ, 8 pin mic	149.00	139^{95}
AT-100 100W 8-band auto. ant. tuner...	445.00	389^{95}
AT-500 500W 9-band auto. ant. tuner...	589.00	519^{95}
AH-2 8-band tuner w/mount & whip....	659.00	589^{95}
AH-2A Antenna tuner system, only......	519.00	449^{95}
GC-5 World clock	91.95	79^{95}

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VHF/UHF base multi-modes	Regular	SALE
IC-275A 25W 2m FM/SSB/CW w/ps	1299.00	1099
IC-275H 100W 2m FM/SSB/CW	1399.00	1199
IC-375A 25W 220 FM/SSB/CW (c/o)	1399.00	799^{95}
IC-475A 25W 440 FM/SSB/CW w/ps	1399.00	1199
IC-475H 75W 440 FM/SSB/CW	1599.00	1369
IC-575A 25W 6/10m xcvr w/ps	1399.00	1129
IC-575H 100W 6/10m xcvr	1699.00	1499

VHF/UHF/1.2 GHz Mobiles	Regular	SALE
IC-37A 25w 220 FM/TTP mic... (c/o)	499.00	329^{95}
IC-47A 25w 440 FM/TTP mic... (c/o)	549.00	369^{95}
PS-45 Compact 8A power supply ...	145.00	134^{95}
UT-16/EX-388 Voice synthesizer ...	34.99	
SP-10 Slim-line external speaker ...	35.99	
IC-28A 25W 2m FM, TTP mic	469.00	409^{95}
IC-28H 45W 2m FM, TTP mic	499.00	439^{95}
IC-38A 25W 220 FM, TTP mic	489.00	349^{95}
IC-48A 25W 440-450 FM, TTP mic....	509.00	449^{95}
HM-14 Extra TTP microphone	59.00	
UT-28 Digital code squelch	39.50	
UT-29 Tone squelch decoder	46.00	
HM-16 Speaker/microphone	34.00	
IC-228A 25W 2m FM/TTP scan mic...	509.00	449^{95}
IC-228H 45W 2m FM/TTP scan mic...	539.00	479^{95}
IC-448A 25W 440 FM/TTP mic	509.00	449^{95}
UT-40 Pocket beep function	45.00	
IC-900A Transceiver controller	639.00	569^{95}

★ Package Special . . .
IC-900A Transceiver controller with UX-29H 2m/45W and UX-39A 220/25W band units.
$969^{95}

UX-19A 10m 10W band unit	299.00	269^{95}
UX-29A 2m 25W band unit.........	299.00	269^{95}
UX-29H 2m 45W band unit.........	349.00	319^{95}
UX-39A 220MHz 25W band unit....	349.00	299^{95}
UX-49A 440MHz 25W band unit....	349.00	319^{95}
UX-59A 6m 10W unit	349.00	319^{95}
UX-129A 1.2GHz 10W band unit ...	549.00	499^{95}
IC-1200A 10W 1.2GHz FM Mobile.....	699.00	599^{95}
IC-1271A 10W 1.2GHz SSB/FM xcvr	1269.00	1099
IC-3200A 25W 2m/440 FM/TTP (c/o)	695.00	469^{95}
UT-23 Voice synthesizer............	34.99	
IC-3210A 25w 2m/440 FM/TTP	739.00	649^{95}
AH-32 2m/440 Dual Band antenna ...	39.00	
AHB-32 Trunk-lip mount	35.00	
Larsen PO-K Roof mount	20.00	
Larsen PO-TLM Trunk-lip mount....	22.00	
Larsen PO-MM Magnetic mount	22.00	
RP-1210 1.2GHz 10W 99 ch FM xcvr	1529.00	1349
RP-2210 220MHz 25W repeater	1649.00	1399
RP-3010 440MHz 10W FM repeater...	1299.00	1149

★ Closeout Special . . .
IC-120 1.2GHz FM mobile xcvr
Regular $579 - **Closeout $349^{95}**

Due to the size of the ICOM product line, some accessory items are not listed. If you have a question, please call. All prices shown are subject to change without notice.

MasterCard VISA

Hand-helds	Regular	SALE
IC-2A 2-meters........	289.00	259^{95}
IC-2AT with TTP.......	319.00	279^{95}
IC-3AT 220/TTP (c/o)	349.00	269^{95}
IC-4AT 440 MHz, TTP	349.00	299^{95}
IC-02AT/High Power	409.00	349^{95}
IC-03AT for 220 MHz	449.00	289^{95}
IC-04AT for 440 MHz	449.00	389^{95}
IC-u2AT for 2m w/TTP	329.00	279^{95}
IC-u4AT 440 MHz, TTP	369.00	289^{95}
IC-2GAT for 2m, TTP	429.00	379^{95}
IC-4GAT 440MHz, TTP	449.00	399^{95}
IC-32AT 2m/440MHz	629.00	559^{95}

FREE Battery! . . .
BP-23 600ma/8.4V • No Charge with purchase of IC-u2AT or IC-u4AT

Aircraft band handhelds	Regular	SALE
IC-12AT 1W 1.2GHz FM HT/batt/cgr/TTP	473.00	369^{95}
A-2 5W PEP synth. aircraft HT..........	525.00	479^{95}
A-20 Synth. aircraft HT w/VOR.........	625.00	569^{95}

Accessories for all except micros	Regular
BP-7 425mah/13.2V Nicad Pak - use BC-35	79.00
BP-8 800mah/8.4V Nicad Pak - use BC-35...	79.00
BC-35 Drop in desk charger for all batteries	79.00
BC-16U Wall charger for BP7/BP8............	21.25
LC-11 Vinyl case for Dlx using BP-3	20.50
LC-14 Vinyl case for Dlx using BP-7/8	20.50
LC-02AT Leather case for Dlx models w/BP-7/8	54.50

Accessories for IC and IC-O series	Regular
BP-2 425mah/7.2V Nicad Pak - use BC35....	49.00
BP-3 Extra Std. 250 mah/8.4V Nicad Pak	39.50
BP-4 Alkaline battery case..................	16.00
BP-5 425mah/10.8V Nicad Pak - use BC35	65.00
CA-5 5/8-wave telescoping 2m antenna	19.95
CP-1 Cig. lighter plug/cord for BP3 or Dlx....	13.65
CP-10 Battery separation cable w/clip........	22.50
DC-1 DC operation pak for standard models	24.50
MB-16D Mobile mtg. bkt for all HTs............	25.99
LC-2AT Leather case for standard models.....	54.50
RB-1 Vinyl waterproof radio bag................	35.95
HM-9 Speaker microphone.....................	47.00
HS-10 Boom microphone/headset.............	24.50
HS-10SA Vox unit for HS-10 & Deluxe only	24.50
HS-10SB PTT unit for HS-10.................	24.50
SS-32SMP Commspec 32-tone encoder	27.95

For other HT Accessories not listed please CALL

Receivers	Regular	SALE
R-71A 100kHz to 30MHz receiver......	$999.00	869^{95}
RC-11 Infrared remote controller....	70.99	
FL-32A 500 Hz CW filter	69.00	
FL-63A 250 Hz CW filter (1st IF)	59.00	
FL-44A SSB filter (2nd IF)............	178.00	159^{95}
EX-257 FM unit........................	49.00	
EX-310 Voice synthesizer	59.00	
CR-64 High stability oscillator xtal	79.00	
SP-3 External speaker................	65.00	
CK-70 (EX-299) 12V DC option......	12.99	
MB-12 Mobile mount	25.99	
R-7000 25MHz to 2GHz scan rcvr	1199.00	1029
RC-12 Infrared remote controller....	70.99	
EX-310 Voice synthesizer	59.00	
TV-R7000 ATV unit.....................	139.00	129^{95}
AH-7000 Radiating antenna	99.00	

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Outside Ohio 1-800-321-3594	Outside Florida 1-800-327-1917	No Nationwide WATS	Outside Nevada 1-800-634-6227	Outside Illinois 1-800-621-5802

73 Review by Cornell Drentea WB3JZO

The Ampire 146-OS Low Noise Preamp

Ampire Inc.
10240 Nathan Lane
Maple Grove MN 55369
Price Class: Models 146, 146-OS: $180
Model 440: $190

A low-noise narrow band VHF/UHF preamp with *good IMD prevention.*

The science of low noise amplifiers has been a misunderstood one for many years, and for good reasons. To most of us, amplifiers seem simple to design and implement. There has been an abundance of available products on the market since the beginning of the tube, and since bipolar days. With the advent of the GaAsFET technology, the trend has been toward even lower noise figures at ever higher frequencies. Many Japanese (and fewer American) companies have, over the years, inundated this market with various products. While this trend continues today at VHF, UHF, and microwave frequencies, few companies have concentrated on providing preamplifiers expressly designed to reject potential out-of-band signals which can cause intermodulation distortion (IMD).

One such exception is an American company, Ampire Inc., with its new line of GaAsFET preamplifier products designed to be installed right at the antenna for an improved noise figure for any remotely located VHF/UHF transceiver operating in the 144–148 MHz and 440 MHz bands. The Ampire preamplifiers' unique narrowband design provides a low noise figure with improved immunity to strong adjacent signals. Their main feature is their ability to reject out-of-band signals before they get into follow-up receivers and result in image-related or other intermodulation distortion products. They do this with the help of a very linear GaAsFET amplifier stage, followed by a narrowband passive helical filter.

These preamps automatically switch from receive to transmit by sensing the RF energy going into the antenna for the duration of a transmission. Although no gain is realized in transmit, approximately 160 Watts of RF can be switched and passed reliably through the device.

I recently had a chance to evaluate the Ampire 146-OS, a product which is intended for channelized 2 meter communications, and particularly for OSCAR operation.

Electrical Specs and Performance Tests

The 146-OS is the factory adjustable, narrowband version of the Ampire line. In other words, the company will tune the product to your specified frequency for no additional cost. The sample unit came adjusted for OSCAR operation at 145.8 MHz.

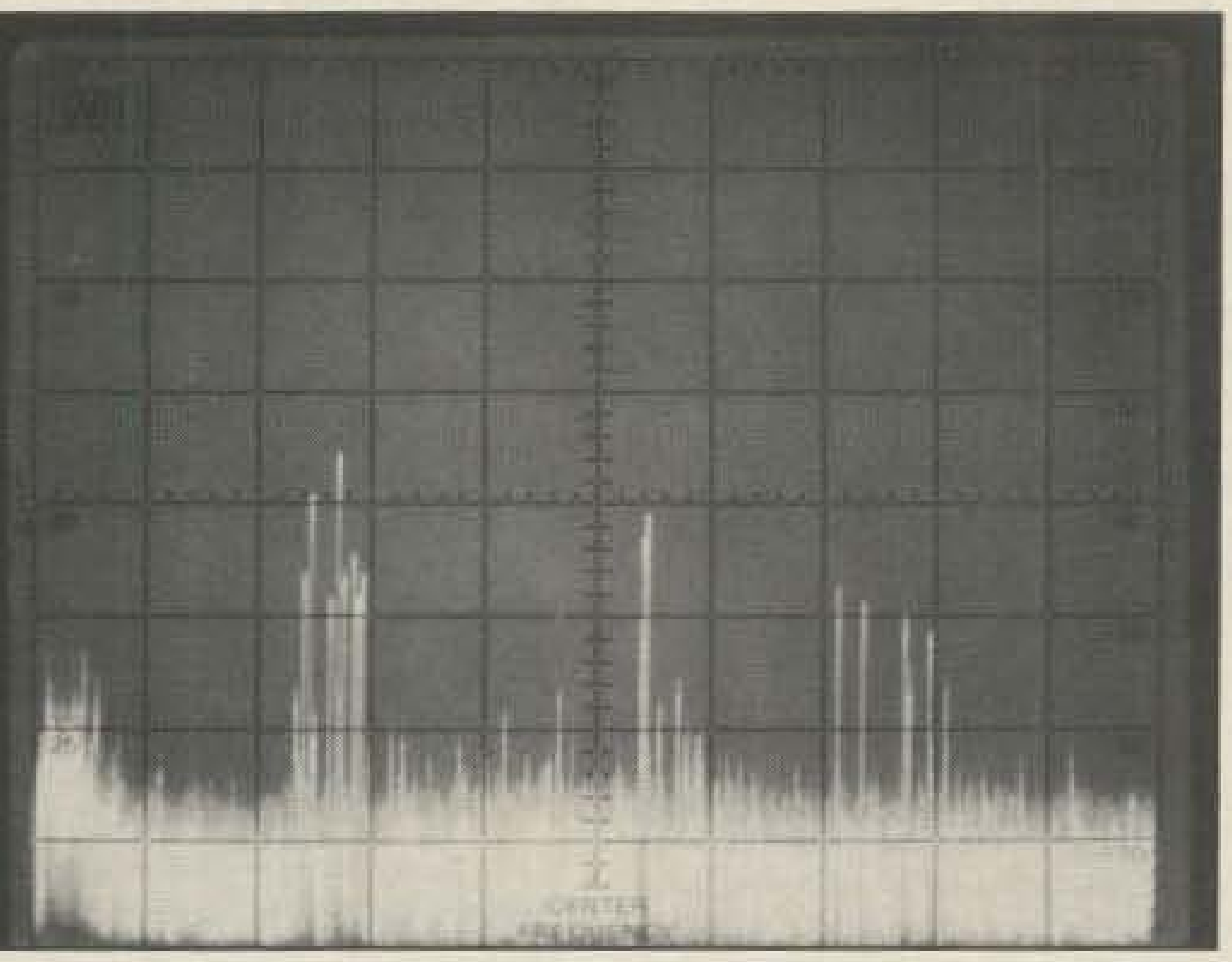


Photo A. Spectrum analyzer results show how many intermodulation distortion-causing signals are present at the antenna.

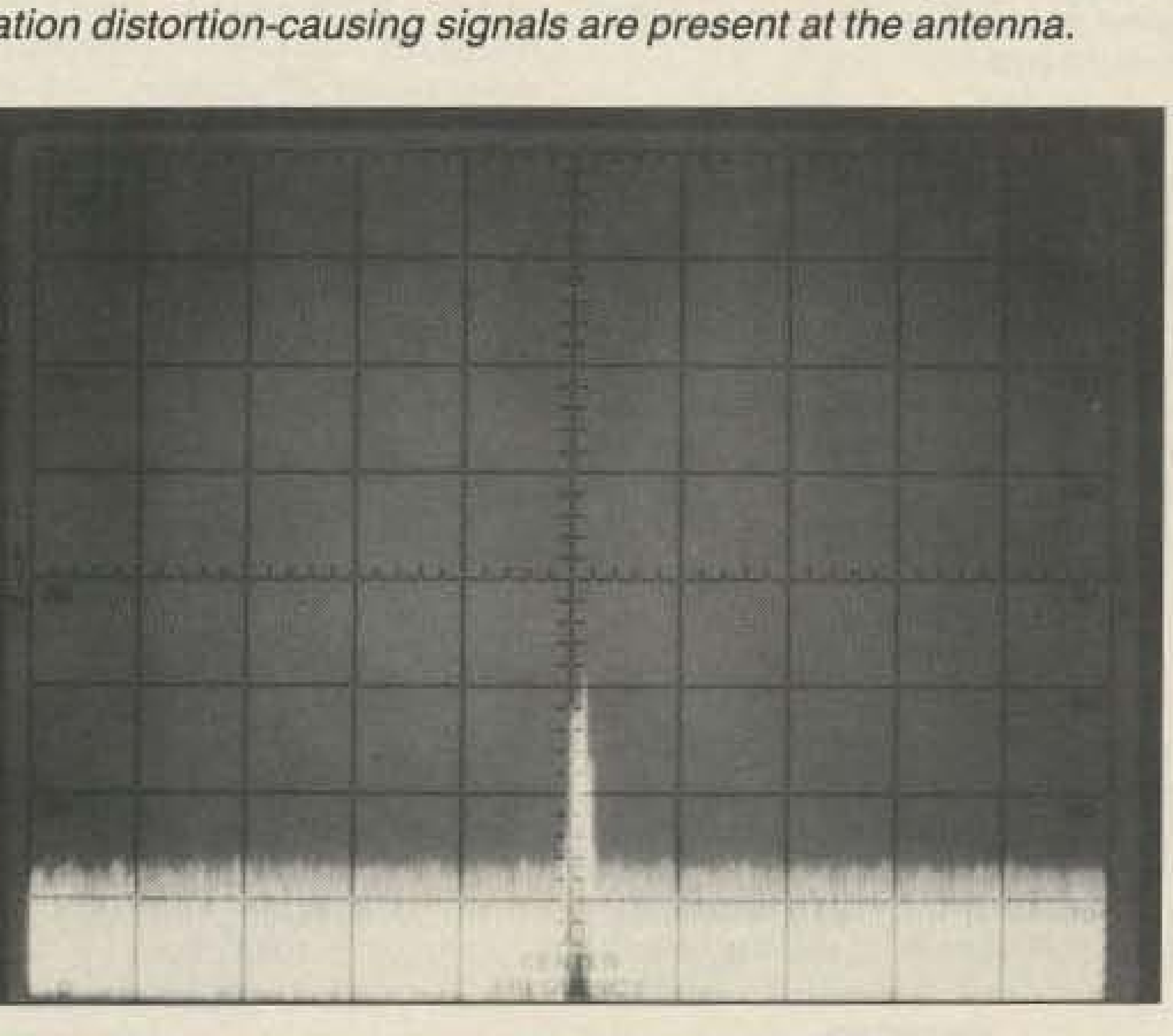


Photo B. Distortion is reduced substantially when the Ampire 146-OS product is switched in. Only the desired signal is passed by the unit with improved signal-to-noise ratio (NF=0.75 dB) and 20 dB of gain.

Laboratory measurements showed a 1.4 MHz bandwidth at the 3 dB points (all other models exhibit a wider bandwidth). At this frequency, out-of-the-2-meter band signals were rejected by at least 15 dB and 20 dB respectively at the edges of the band. Further out, the rejection improved progressively to about −55 dB or better. (See Figure 1.) We measured the in-band noise figure at 0.75 dB, with a gain of 20 dB.

We performed a spectrum analyzer test of the Minneapolis area "EMI" scenario from 46 MHz to 246 MHz, first with the amplifier off, and then with the amplifier switched in, showing definite rejection of possible intermodulation-causing signals over the spectrum of interest. (See Photos A and B.)

The preamp performed unconditionally. We didn't observe any signs of oscillation during a twenty-four hour test involving switching between 100 Watts of transmitted RF power into a dummy load, and receive. The power handling specification of the 146-OS unit exceeds the specifications of most other similar products on the market today, which are usually rated at about 30 Watts.

In addition, the Ampire 146-OS product can switch up to 160 Watts of RF into a 50Ω load. The minimum RF power required to activate the automatic T/R switching detector was 150 milliwatts, quite adequate for many of the low power settings on today's handhelds.

The automatic R-to-T transition of the unit happened at 10 milliseconds (a function of the RF relay mechanics), and the T-to-R transition was at 0.750 seconds. This is the standard delay provided by Ampire and it's intended for SSB operation. You can order other timing options at no additional cost.

We also performed a temperature chamber test, with good results. The

continued on page 102

Number 19 on your Feedback card

SPECIAL EVENTS

Ham Doings Around the World

LOUISVILLE KY
MAY 1–6

Special Event Station KB4DCG will operate on the above dates to celebrate the 115th running of the Kentucky Derby. Suggested frequencies: 7.237, 21.337, and 28.437. For certificate, send QSL and two units postage to *KB4DCG, 641 Camp St., Louisville KY 40203.*

S. SIOUX CITY NB
MAY 5–6

The 3900 Club, in conjunction with the Sooland ARA, is sponsoring its Hamboree #11. Seminars include beginning and advanced packet, QRP, satellite, ARRL Forum, FCC, QCWA luncheon, MARS, and more. Reserve flea market tables through *WØPEX, Al Smith, 3529 Doughlas Street, Sioux City, IA 51104.* For reservations and information, contact *WØFZO, Dick Pitner, 2931 Pierce Street, Sioux City IA 51104.*

SIERRA VISTA AZ
MAY 5–7

The Cochise Amateur Radio Association (CARA) will hold its Annual Hamfest at the club training facility five miles east of town and 2 miles south on Moson Road. No charge for tailgaters. VE exans, overnight RV camping (no hookups). Talk-in on 146.52 or 146.76 (−0.6). Handicap facilities. Contact *N7INK, (602) 378-3155 after 6 PM* or write *CARA, PO Box 1855, Sierra Vista AZ 85636.*

BIRMINGHAM AL
MAY 5–7

The BirmingHamfest '89 will be at the Birmingham-Jefferson Civic Center on the main floor of the Exhibition Hall. Admission $5 per adult; booth reservation entitles you and employees for free admission. Flea market, forums, testing, awards, non-ham activities. *Exhibitor Chairman: Dan Morgan KB4MDI, (205) 822-5242. BirmingHamfest '89, PO Box 26073, Birmingham AL 35226.*

CEDARBURG WI
MAY 6

The Ozaukee Radio Club presents its Eleventh Annual Swapfest at the Circle B Recreation Center. Admission, $3 at the door, $2 in advance. Tables, $3. Hourly prize drawings. Talk-in on 146.37/.97 and 146.52. To pre-register, send postcard with callsign and license exam desired to *Badger Examiners, %Gary Sharbuno WA9UJK, 5119 W. Willow Road, Brown Deer WI 53223. (414) 466-5379.* For more information and reservations, contact *Joe Bauer W9WQ at (414) 692-2329* or write *O.R.C. Swapfest Committee, N5415 Crystal Springs Ct., Fredonia WI 53021.*

BEMIDJI MN
MAY 6

The Paul Bunyan Radio Club will hold its annual hamfest on Saturday at the new V.F.W. Club. Talk-in on 146.13/.73. Dealers, exams, and flea market. Write *Robert W. Bitz KAØKTB, 401 Roosevelt Manor, Bemidji MN 56601. (218) 751-8748.*

BREWSTER NY
MAY 6

The Putnam Emergency Amateur and Radio League will have their PEARLfest at the John F. Kennedy Elementary School. It will feature ham gear and VE exams. Admission, $3; tables, $8; tailgating, $5. Talk-in on 145.135 down 600-KG1O/Repeat. For registration, contact *Terri Cullum N2GWF, 40 Mile Hill Road, Highland NY 12528 or Jim Morgan KA2FIQ, 39 Overlook Road, Ossining NY 10562.*

GREENVILLE SC
MAY 6–7

The Blue Ridge Amateur Radio Society is sponsoring the 50th Annual Greenville Hamfest and Electronic Flea Market at the American Legion Fairgrounds. It features walk-in exams, indoor dealer displays, indoor/outdoor electronic and computer flea market, free parking, camping, and prizes. Admission, $4 in advance; $5 at gate. For information or tickets, send SASE to *Blue Ridge Amateur Radio Society, PO Box 6751, Greenville SC 29606.*

SANDWICH IL
MAY 7

The Kishwaukee Amateur Radio Club is sponsoring their 34th annual hamfest at the Sandwich Fairgrounds. Overnight camping, no hookups. Reserved tables, $5 in advance. Tickets, $3 in advance, $4 at the door. Talk-in on 1373. Contact *Howard Newquist, PO Box 264, Sycamore IL 60178.*

PARAMUS NJ
MAY 7

The Bergen Amateur Radio Association (B.A.R.A.) will sponsor its annual spring hamfest at the Community College. Buyers, free admission; sellers, $5 per space. Amateur testing, walk-in only, Novice through Extra. Free parking. Talk-in on 146.19/.79. Contact *Jim Joyce K2ZO, 286 Ridgewood Blvd., No. Westwood, NJ 07675. (201) 664-6725.* For testing information, contact *Pete Adely K2MHP, 13-30 Edward St., Fairlawn NJ 07410. (201) 796-6622.*

PROMONTORY UT
MAY 10

The Odgen Amateur Radio Club will operate W7STB from Promontory Summit to commemorate the 120th year of the driving of the Golden Spike. Time: from 0001Z to 2100Z. Frequency, one of: 3.970, 7.270, 14.280, 21.375, or 28.415 MHz. Send QSL and SASE to *Ogden Amateur Radio Club, PO Box 3353, Ogden UT 84409.*

FAIRFIELD CT
MAY 13

The Greater Fairfield ARA, Inc., will operate a special event station during the 54th annual Dogwood Festival from 1300Z–2200Z. Suggested frequencies: 3.975, 7.235, 14.330, 21.420, and 28.310 MHz. For a 9x11-inch certificate, send QSL and large SASE to *FARA Dogwood, PO Box 486, Southport CT 06490-0486.*

BELLEVUE WA
MAY 13

Crooked Stick and Rats Nest QSO Party, sponsored by the Issaquah ARC, encourages new Novices, the handicapped, and all other hams, to participate. Bonus points for photos and information about your contest operation. For details, write *Martha Stedman N7IVX, 15423 SE 7th Pl., Bellevue WA 98007.*

PIERRE SD
MAY 13–14

The Pierre ARC will operate WØHVY from 1100Z to 2300Z the 13th and from 1500Z to 2300Z the 14th to commemorate 100 years of statehood. Suggested frequencies are: 28.400, 21.287, and 14.287 kHz USB; and 7.267 kHz LSB. For certificate, send QSL and 9x12 SASE to *Gary Wallace KAØAHI, POB 1261, Pierre SD. 57501-1261.* Deadline June 10, 1989.

LAS VEGAS NV
MAY 13–14

1989 Nevada QSO Party, sponsored by the Frontier Amateur Radio Society, an ARRL Special Service Club. From 0000Z the 13th to 0600Z the 14th. 6–160 meters, CW/SSB/FM/RTTY/PACKET/SSTV. No cross-mode or repeater QSOs. Suggested frequencies: CW 15 up from bottom of general bands; phone −25 up from bottom; Novice and Tech portion of bands.

Exchange: Nevada-RS(T) and county; others-RS(T) and state/province/DXCC country. One point for each contact per mode. Multiply points by number of NV counties worked. Certificates to top scores in each category. Mail logs by June 1 to *Jim Frye NW7O, 4120 Oakhill Ave., Las Vegas NV 89121.*

ATHENS OH
MAY 14

The Athens County Amateur Radio Association (ACARA) will hold its 10th annual hamfest at the City Recreation Center. Large flea market, door prizes. Tailgaters. Talk-in on the club repeater at 145.15/.55 MHz. Indoor space available only by pre-registration. Contact *Rod Holley KA8NDC, 15267 S. Canaan Rd., Athens OH 45701. (614) 593-8177.* To register for license exams, mail completed FCC Form 610 and $4.75 payable to ARRL/VEC to *John Cornwell NC8V, 101 Coventry Lane, Athens OH 45701.* Walk-ins accepted. For general information, contact *Carl J. Denbow KA8JXG, 63 Morris Ave., Athens OH 45701.*

CADILLAC MI
MAY 20

The annual Swap and Shop of the Wexaukee ARA will be at the Cadillac Middle School. Admission, $3; tables, $6. Talk-in on 146.37/.97 repeater. Contact *John Craddock KX8Z, (616) 797-5491* or write *Wexaukee ARA, PO Box 163, Cadillac MI 49601.*

KNOXVILLE TN
MAY 20

The Radio Amateur Club of Knoxville presents the 1989 ARRL Tennessee State Convention and the 23rd Annual Knoxville Hamfest and Computer Fair at the Kerbela Shrine Temple. ARRL forums, Joe Fairclough WB2JKJ on using ham radio to teach, packet demonstration, DXpeditions, VEC exams, prizes, and flea market. For reservations, contact *Joe Meighan KB4REC, Rt. 26, Central Avenue Pike, Knoxville TN 37919. (615) 558-8487.* For exam registration, contact *Ray Adams N4BAQ, WCARS/VEC, 4325 Felty Drive, Knoxville TN 37918. (615) 687-5410.*

ABILENE TX
MAY 20

The Key City ARC will hold its Fourth Annual Armed Forces Day Ham Fest at the Civic Center. Pre-registration, by May 18, is $5; at door, $6. Tables, $2 each. VE exams, walk-ins OK. Large arts/craft show same building. *Bill Jones N5DOX, (915) 698-4606/7290 days, 3935 nights; or WB5EKW-3 Gateway 7096/145.01 or AE5I Autoforward BBS via DBL, BRD, WIN, or ALB.*

SEVERNA PARK MD
MAY 20

The Maryland Mobileers ARC will operate WA3PJQ aboard the submarine *USS Torsk* (SS-423) from 1400Z to 2100Z to honor the submarine service. Frequencies, ± QRM will be: SSB-7240, 14240, 21340, 28340 kHz, and FM 146.805 (repeater output). For certificate, send a legal-size SASE to *MMARC, PO Box 784, Severna Park MD 21146.*

GODFREY IL
MAY 20

The 3rd Annual Lewis & Clark Radio Club Hamfest and Electronic Flea Market will be at the Lewis & Clark Community College. Prizes, display (packet, satellite, ATV, WEFAX, AMTOR), commercial vendors, ARRL booth, giant flea market with no charge for space, exams, and free parking. Advance, 7 for $5; $1 each at door. Talk-in on Club 2 meter net (Monday at 8 PM) on 145.23 repeater. *Lewis & Clark Radio Club, PO Box 553, Godfrey IL 62035. (618) 466-1909.*

SPRINGDALE AK
MAY 20

The Northwest Arkansas ARC will hold its Ozark Hamboree at the Rodeo Community Center. Plenty of parking. Flea tables, $5. Retailers will show all new ham gear. Door prizes, programs, VE exams on a walk-in basis. No charge for attendance. Contact *Randall Spear WA5QGH at (501) 846-3210.*

DULUTH MN
MAY 20

The Arrowhead ARC presents SWAPFEST '89, held at the First United Methodist Church. Hourly drawings, main door prize. Admission, $4; 4-foot tables, $5. Talk-in on 146.34/.94 MHz. Contact *Duane Flynn KB/0LC, 4907 Peabody St., Duluth MN 55801. (218) 525-4580.* Pre-register for exams with *John Crow KAØSYN, 1365 Roland Road, Cloquet MN 55720. (218) 879-5356.*

COLORADO SPRINGS CO
MAY 20

The Pikes Peak Radio Amateur Association will hold its Swapfest at the Rustic Hills Mall. Admission free. Tables, $8 in advance, $10 at door. Talk-in on 146.37/.97. Contact *Al NØCMW, (719) 473-1660* or write *PPRAA Swapfest, PO Box 16521, Colorado Springs CO 80935.*

MILLINGTON TN
MAY 20

In recognition of the 40th Annual Armed Forces Day Celebration, Amateur Radio Station W4ODR will operate from 1300Z to 2300Z. SSB 7.230, 14.280, and 21.3780 MHz (±10 kHz). CW on 21.145 and 28.145 MHz. 2 meters on 146.52 simplex. For details, contact *Lieutenant Robert D. Alley WA4WFJ (901) 873-5306; AX2 David A. Holding KB5BXJ (901) 873-5134; Sergeant Major Jim Moffatt WD4SMW (901) 363-0778; and Military Club Station W4ODR/Navy-Marine Corps, MARS Station NNNØNIF, Bldg. N-100, NAS Memphis TN (901) 873-5134.*

OAK PARK MI
MAY 20–21

The 1989 Michigan QSO Party will be sponsored by the Oak Park Amateur Radio Club. Phone and CW are combined into one contest. Michigan stations can work Michigan counties for multipliers. A station may be contacted once on each band/mode. Portable/mobiles may be counted as new contacts each time the county changes. For exchange, scoring, awards, and log requirements, write *Mark Shaw K8ED, 27600 Franklin Rd., Apt. 516, Southfield MI 48034.*

ROCHESTER NY
MAY 20–21

The Rochester Hamfest and Computer Show, in conjunction with the New York State ARRL Convention, will be at the Monroe County Fairgrounds. Dealers, exhibitors, booths, tables, contests, prizes, and noncommercial flea market. For more information, contact *Rochester Amateur Radio Association, Rochester Hamfest, 300 White Spruce Blvd., Rochester NY 14623. (716) 424-7184.*

ANDERSON SC
MAY 20–21

The Lake Hartwell 10th annual Hamfest is sponsored by Toccoa, Hartwell, Georgia; and Anderson, South Carolina; ARCs at the Hartwell Group Camp south of Anderson. Talk-in on 146.295 + 600, 146.19/.79, 147.93/.33. Free flea market space. For tickets and information, write or call *M.A. Counsell W1BNS, 215 Nottingham Way, Anderson SC 29621. (803) 261–7018.*

YAKIMA WA
MAY 20–21

The Yakima Amateur Radio Club W7AQ announces its Hamfest '89, which will be held at the State Fairgrounds in Yakima. VE exams, commercial exhibits, swap and shop tables, and lectures. Admission, $5; tables, $5. Talk-in on 146.66/.06, 146.84/.24. Contact *Dick Umberger N7HHU, (509) 453–8632, days; (509) 453–3580, evenings* or write *Yakima ARC W7AQ, PO Box 9211, Yakima WA 98909.*

ST CHARLES MO
MAY 20–21

The St. Charles ARC will operate WB0HSI from 1400Z to 2200Z as part of the Lewis and Clark Rendezvous. This special event station will transmit near 7250, 14325, 21350, 28410, and 146.67 as propagation and QRM permit. For certificates, send a large SASE to *St. Charles ARC, PO Box 1429, St. Charles MO 63302-1429.*

FOLSOM CA
MAY 21

The North Hills Radio Club is sponsoring its HAMSWAP at the Folsom Community Clubhouse. Free admission. Auction, tables ($6 each), tailgating, free parking, park with rides for kids. Talk-in on 145.19 and 224.78. Contact *NHRC, PO Box 41635, Sacramento CA 95841* or call *Bob WA6ULL at (916) 983–2776.*

CHICAGO IL
MAY 21

The Chicago Amateur Radio Club will hold its annual Mini-Hamfest at the North Park Village. Indoor area. Admission, $2. Contact *CARC, 5631 W. Irving Park Road, Chicago IL 60634. (312) 545–3622.*

WABASH IN
MAY 21

The 21st Annual WCARC Hamfest will be held at the Wabash County 4-H Fairgrounds. Admission, $3.50 in advance, $4 at door. Inside tables, $10. Prizes, large outdoor flea market, free parking and overnight camping, and examinations for Tech to Extra. Talk-in on 147.63/.03, 146.52/.52, and 146.94/.94. For ticket information, send SASE to *Don Spangler W9HNO, 235 Southwood Dr., Wabash IN 46992. (219) 563–5564.*

KNOXVILLE IL
MAY 21

The Knox County Radio Club, Inc., will hold its annual Knox County Hamfest at the County Fairgrounds. Large commercial display building and acres of outside flea market space at no charge. The Knox County Pork Producers will be serving their Butterfly pork chops. VE testing nearby. Talk-in on 147.00/146.40. For table reservations, pre-registration of testing, and advance tickets, write *Keith L. Watson WB9KHL, 119 South Cherry Street #3, Galesburg IL 61401-4527* or call *(309) 342–3885 evenings.*

ADENA OH
MAY 21

The Triple States Radio Amateur Club will hold its 11th annual Wheeling Hamfest/Computer Fair at Wheeling Park. Roofed area for dealers, six acres of flea market. Children 14 and under free. Admission, $4 in advance, $4 at door. Contact *TSRAC, Box 240, RD 1, Adena OH 43901. (614) 546–3930.*

WRIGHTSTOWN PA
MAY 21

The Warminster ARC is sponsoring their 15th annual Hamfest at the Middletown Grange Fairgrounds. Admission, $4 (XYLs and children free). 80 indoor spaces with 8-ft. tables, $5 space. New equipment vendors, large flea market, amusements for children. Talk-in on 146.52 simplex and 147.09/.69, 223.76/222.16, 52.04/53.04 repeaters. For information or pre-registration, contact *Bill Cusick W3GJC, Apt. 804 Garner House, Hatboro PA 19040. (215) 441–8048.*

DALTON MA
MAY 21 (& AUG 13)

Ham Radio Flea Markets, sponsored by the Northern Berkshire ARC, will be at the Dalton American Legion. Talk-in on 146.91. Admission, $1. Free tailgating space. Contact *Dick WB1HIH at (413) 458–8267/8452.*

NAMAO ALBERTA
MAY 26–28

The Northern Alberta Radio Club is sponsoring a Ham Fest and Flea Market on the above days. Dealers, demonstrations (SSTV, packet, SWL, RTTY, satellite, computers, radio museum), awards. Students 18 and under, free. Adults, $5 at door. $4 pre-registered. Banquet, breakfast, RV parking. No hookups. Send SASE to register to *Northern Alberta Radio Club, 9628–69A St., Edmonton, Alta CANADA T6W 1W3. (403) 438–9205.*

PETAL MS
MAY 26–JULY 18

The Amateurs of Petal and Hattiesburg will be operating on the above dates to celebrate the International Checkers Tournament. Operation will be in the lower general portions of all bands and the Novice SSB portion of 10. Send QSL and large SASE to *KA5UBL, PO Box 2131, Hattiesburg MS 39403-2131.*

DURHAM NC
MAY 27

The Durham FM Association will hold its 10th annual "DURHAMFEST 1989" at the South Square Mall. Vendors and plenty of free tailgating space, table rental, and AC power for testing equipment. FCC exams by pre-registration. Contact *Pete Goolsby KY4Y, 120 Radcliff Circle, Durham NC 27713.* Talk-in on 147.825/.225, the Friendly Repeater WA4WTX/R. *Mick Rankin W4ZUS, 1001 Wedgewood Lane, Durham NC 27712.*

HAMILTON SCOTLAND
MAY 27–28

The Scottish Tourist Board (Amateur Radio) Expedition Group operates a special events station at various times of the year. In May GB2RB the focus will be Robert Burns, Scotland's famous poet, at the Burns House Museum, Mauchline, Ayrshire. The group issues two certificates, both in color. For details, write the above group at *PO Box 59, HAMILTON, SCOTLAND ML36QB.*

NASHVILLE TN
MAY 27–29

The Nashville Amateur Radio Club K4CPO will operate, during daylight hours only, in various sections of the phone band, a special events station aboard the General Jackson stern-wheeler as she cruises the Cumberland River on Memorial Day weekend. Full-color QSL card of the General Jackson for your card and SASE to *K4CPO Nashville ARC; see call book.*

WEST FRIENDSHIP MD
MAY 28

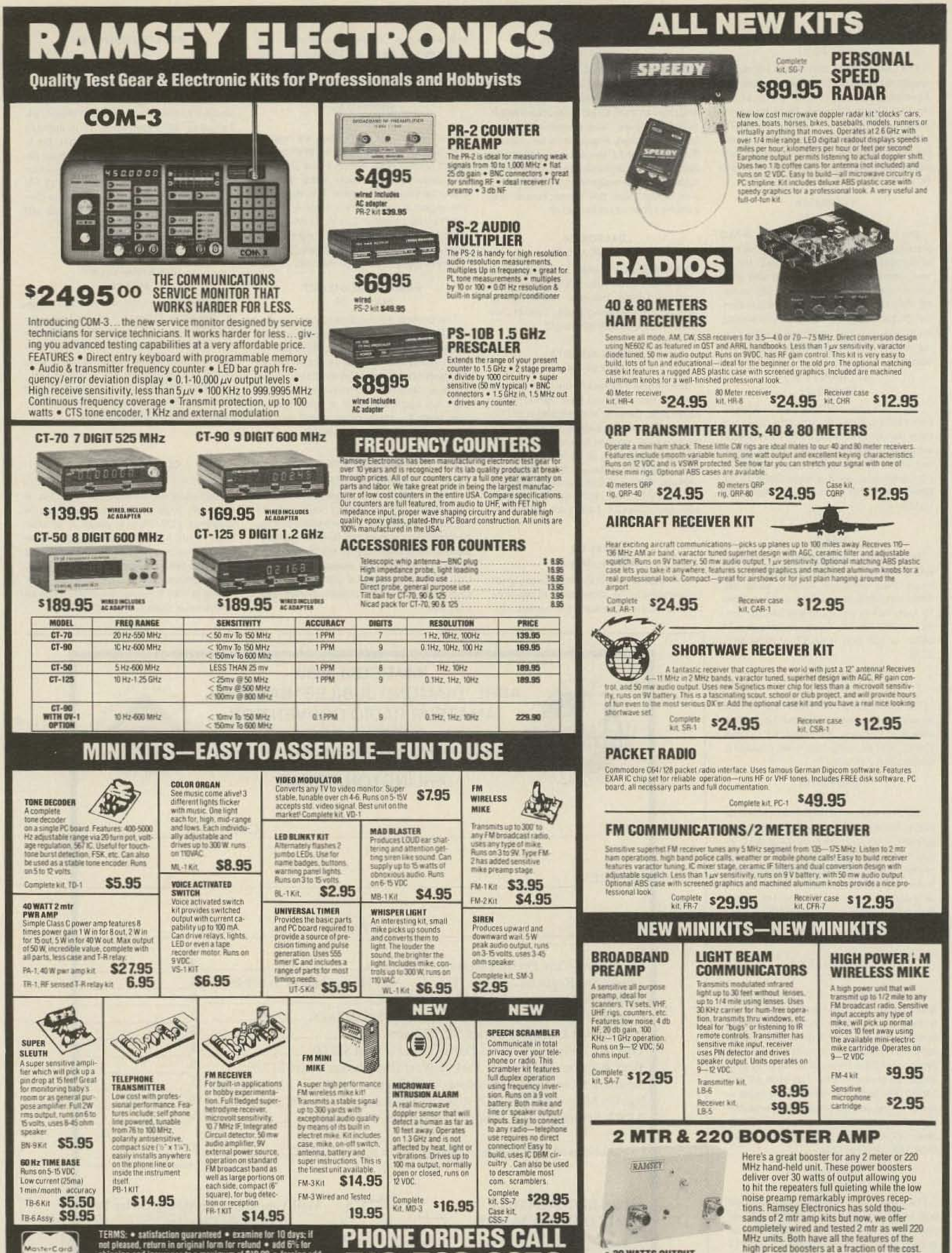
The Maryland FM Association, Inc., presents its annual Memorial Day Hamfest at the Howard County Fairgrounds with commercial displays and ample parking. Admission, $4. Tailgating, $3. Table rental, $7 in advance and $10 at the Hamfest, if available. For license exam reservations, contact *Steve Silberman K3RMX, (301) 578–8527.* Talk-in on WA3DZD/Repeater (146.16/.76, 222.16/223.76, and 449.1/444.1). Contact *Mike Cresap, 1294 Dorothy Road, Crownsville MD 21032. (301) 923–3829.*

BUCKHANNON WV
MAY 28

The Buckhannon ARC and the West Virginia Wesleyan College ARC will operate W8WVM from 1400Z to 2200Z to celebrate the 48th Annual West Virginia Strawberry Festival. Suggested frequencies: 7.250, 14.250, 18.150, 28.350. For a special QSL, send your QSL and SASE to *West Virginia Strawberry Special Event, PO Box 65, Buckhannon, West Virginia 26201-0065.*

COLLEGE PARK MD
PRIOR MAY 31

The Foundation for Amateur Radio, Inc., a non-profit organization headquartered in Washington DC, plans to award 32 scholarships during 1989–90. If you plan a full-time course of university studies and are enrolled in or have been accepted in a university, college, or technical school, request more information at *FAR Scholarships, 6903 Rhode Island Avenue, College Park MD 20740.*



CIRCLE 34 ON READER SERVICE CARD

1269 MHz Helix Array

Wind your way to higher gain.

by Ralph E. Herzler WA8WBP

Soon after finally taking the big step—assembling a successful Mode L system of no less than 35 Watts to a 12-turn helix antenna for an uplink—I began to think about upgrading it. Increased RF power was not an attractive option because I was heterodyning a 2 meter signal to 23 cm at the antenna, and amplifying to the limit of available solid state equipment. However, my first helix offered such an attractive gain (16 dBi) for such a small space that the helix idea seemed logical.

Searching for a Worthwhile Gain

From my research of the RSGB *VHF/UHF Manual*, I found that one way to upgrade was to lengthen the helix to 20 turns, for an increase of 17 dBi. My 35 Watts equates to 15.4 dBw, so I could expect this combination to result in a 32.4 dBw EIRP (1.7 kW). Not enough! The opportunity to gain another 3 dB is very tempting. Furthermore, I have heard from a number of hams, including John Hogan KC7GY, who have done this successfully. If I could make this work, I might achieve an antenna gain of 20 dBi! That could net 35.4 dBw EIRP (3.47 kW), a worthwhile gain!

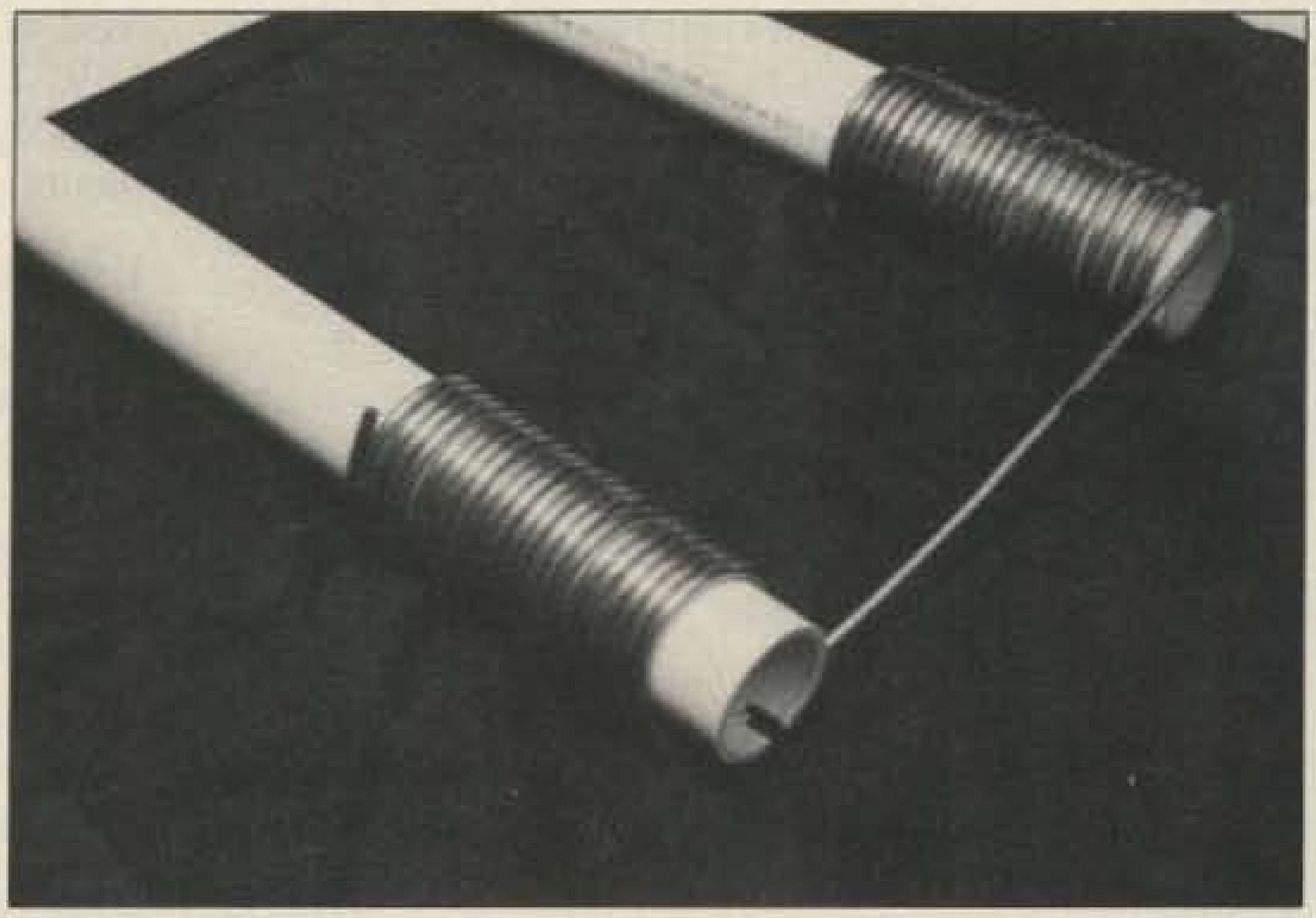


Photo A. A 50-foot coil of ¼" copper refrigeration tubing, wound 46 turns over a piece of 2" PVC pipe, is the beginning of the helix array. It's important to wind the helix as a right-hand thread.

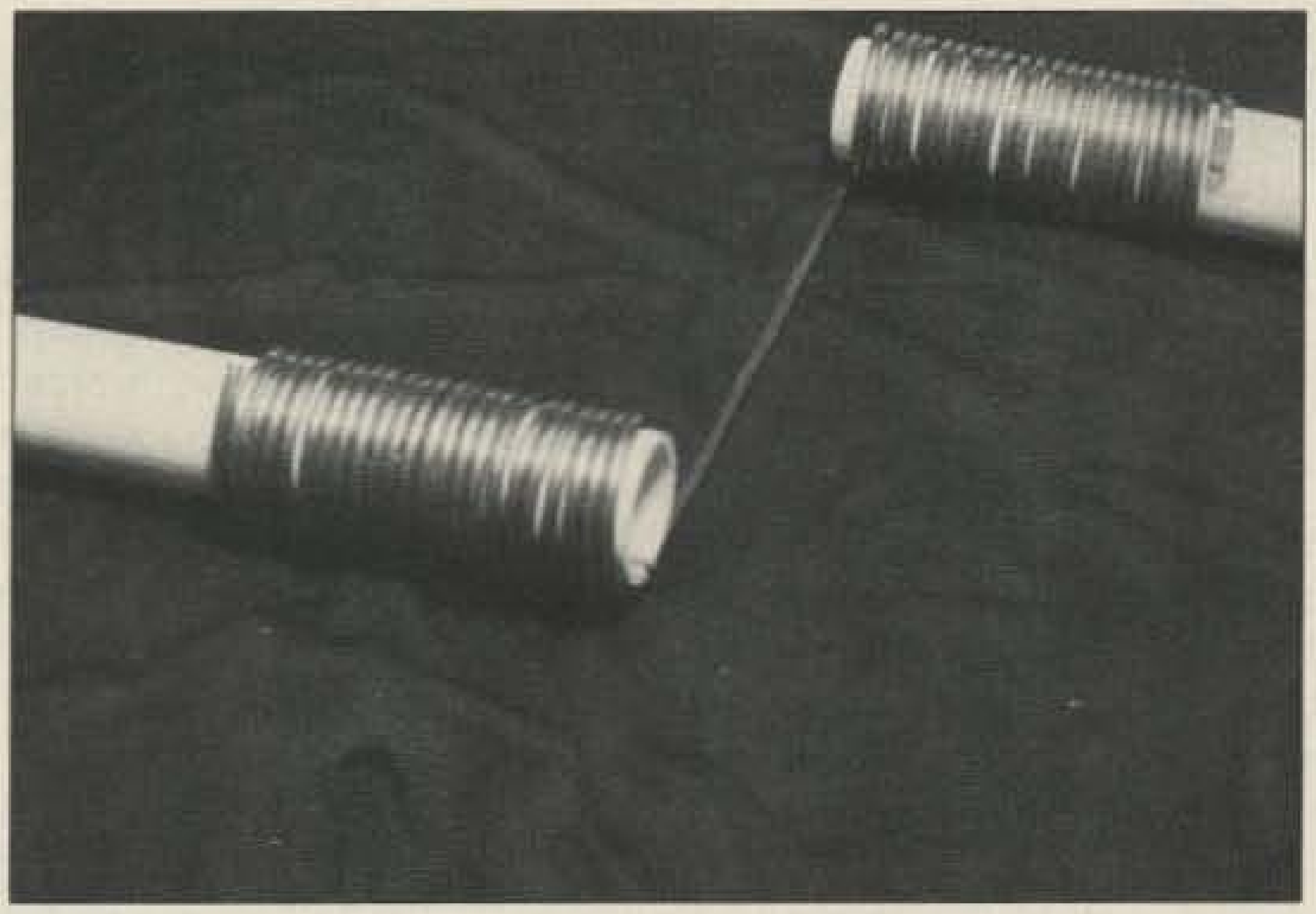


Photo B. After finding the mid-point of the helix, unwind enough tubing from each side to space the closest helix turns 24 cm apart. Then twist the two coils 180 degrees to form two parallel helices.

Unfortunately, my one contact with KC7GY took place when his multiple helices were covered with ice and snow, late in the Mode L segment of the orbit. However, I did learn that he was using conventional helices with a commercial power divider. What I didn't learn was the spacing used to stack the antennas. Shortly thereafter, when I might have been able to get back with John, Mode L was coming to life in the early hours here in Michigan, and even earlier in White Salmon, Washington. In my anxiety to develop a more effective system, I took off on my own theory.

Since power dividers introduce some amount of loss, I designed an array of two 20-turn helix antennas on a common back plate to use without a power divider. I figured that if a single helix had a characteristic impedance of 140Ω, then two helices in parallel would have a combined impedance of 70Ω.

I further planned to space the helices one wavelength apart, hopefully to feed them in phase. I would use the same material that formed the antennas, crossing diagonally over the reflector and tapped at the midpoint for coaxial feed. My reasoning was to keep the cross-over reasonably close (about ½") to the reflector so that I could add capacitive plates to improve the impedance match, if necessary.

New Use for Refrigerator Tubing

I bought a 50-foot coil of ¼" copper refrigeration tubing, and wound 46 turns over a piece of 2" PVC pipe (see Photo A). Two-inch pipe is actually 2.375" OD, so the final helix would have an outside diameter close to three inches. A small notch in one end of the plastic pipe, and a sharp bend in the tubing to fit the notch, make this job much easier. It is important to wind the helix as a right-hand thread.

Then I found the midpoint of the helix, and unwound enough tubing from each side of this point to space the closest helix turns 24 cm apart. The two coils can then be twisted

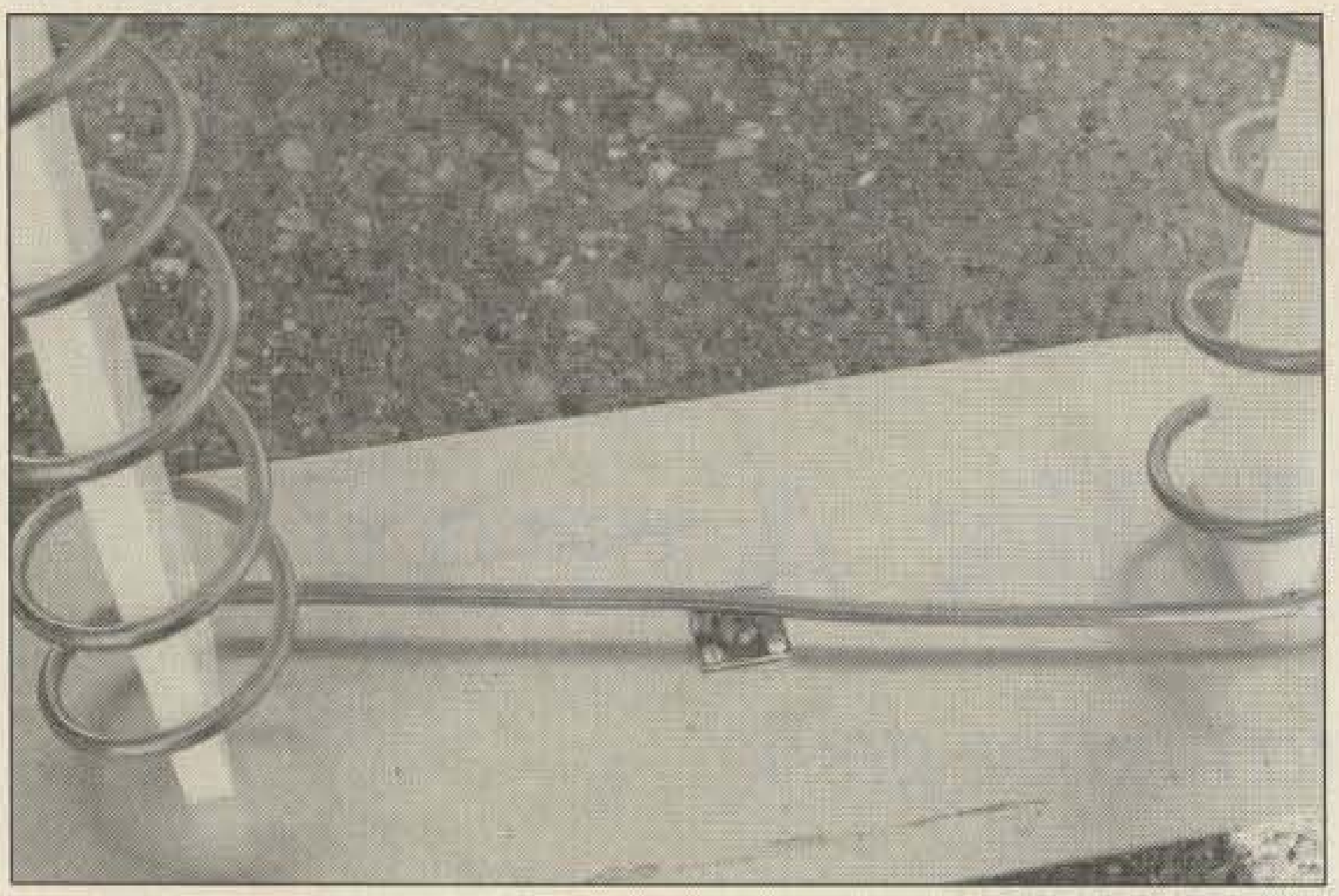


Photo C. The crossover should nearly meet the chassis connector, and they should be carefully and securely soldered together at that point.

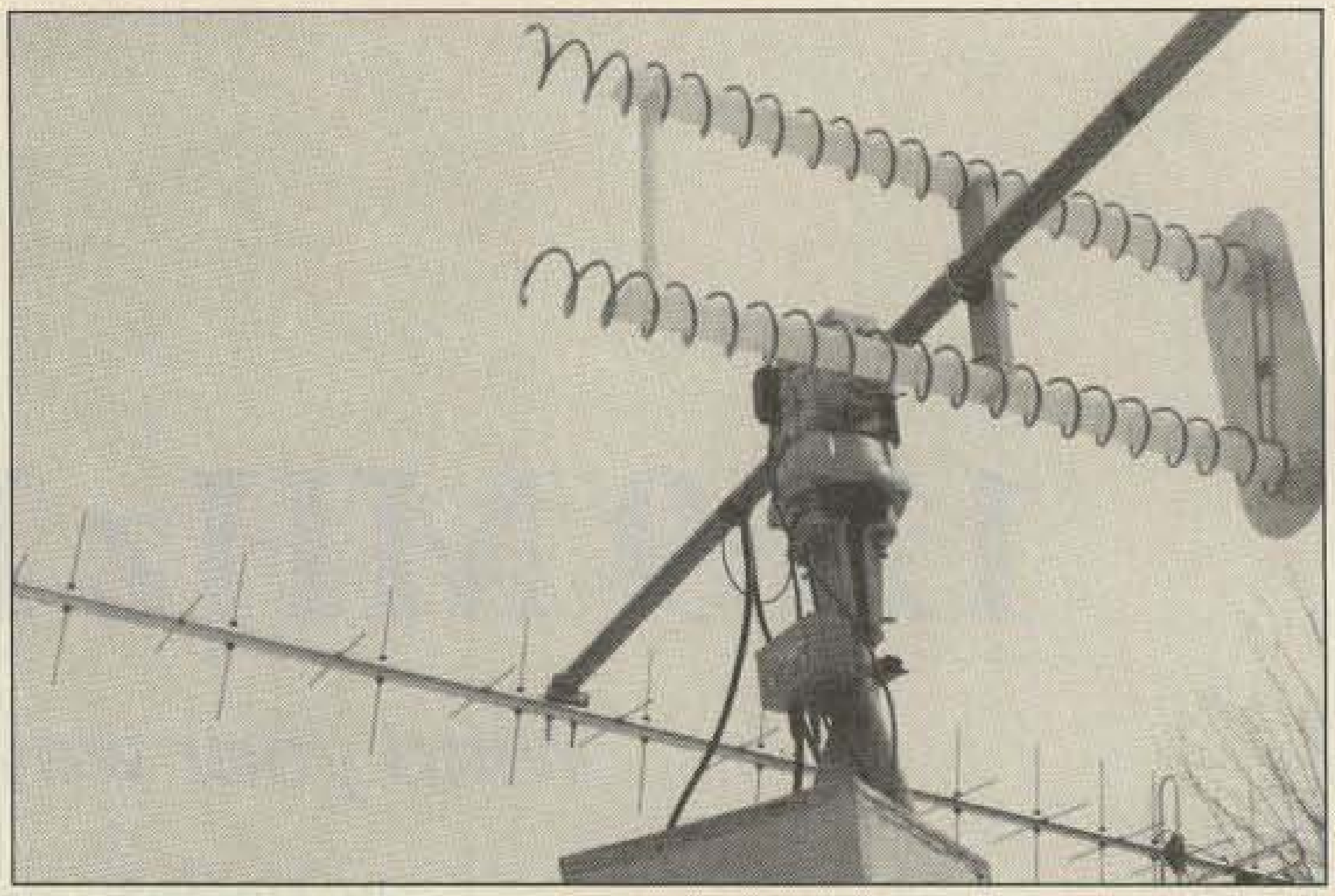


Photo E. The finished 1269 MHz Helix Array, balanced and cross-braced.

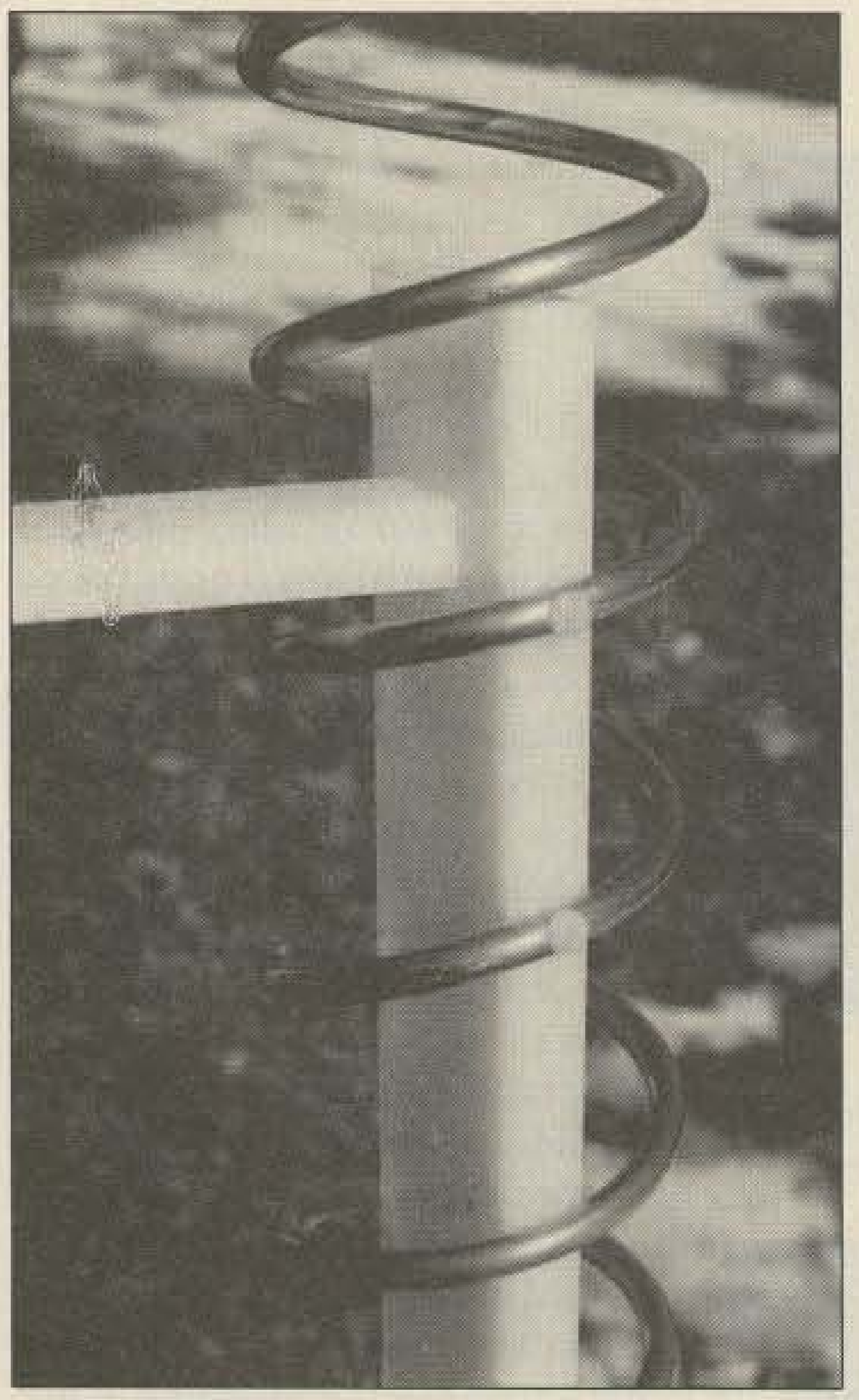


Photo D. Trim the coils to allow only 20 turns of helix to extend from the reflector. Note the ¼-20 nylon bolts.

180 degrees to form two parallel helices (see Photo B).

Prowling through my nearest Cadillac Plastics warehouse, I found a 6-foot long piece of polyethylene, ½″ thick by 3¼″ wide. Because of its awkward size, they gave it to me without cost. After sawing it into two 36″ lengths for easy handling, I cut two 2¼″-wide strips to serve as supports for the coils.

I drilled one small end of each plastic support strip and tapped it for ¼-20 nylon bolts with which I would attach the reflector (see Photo C). Next I drilled one edge of each support and tapped for 6-32 nylon bolts which would secure the tubing at the proper 2″ pitch. I found that with the first hole drilled ½″ from the bottom of the support, holes every four inches secured every other turn of the helix quite adequately (see Photo D).

You must stretch the tightly-wound copper coils carefully to match the mounting holes, and drill them to clear the 6-32 bolts. I used steel bolts to establish the pitch, then replaced them later with nylon.

I made the reflector from a 19½″ x 7″ piece of 0.072″ aluminum by rounding the ends on a 3½″ radius. Since the antenna won't be mounted at the rear, the thickness of the reflector is not critical. Drill ¼″ holes at the centers of the end radii to mount the polyethylene supports, and a ⅝″ hole at the center of the reflector to mount a type N chassis connector (see Photo C). After mounting the connector, you can partially assemble the antenna.

". . . two helices in parallel would have a combined impedance of 70Ω."

A several-turn portion of each coil will protrude beyond the end of the plastic supports. You should trim this back (diagonal cutters work well) to allow only 20 turns of helix from the reflector (see Photo D). The crossover should nearly meet the chassis connector, and they should be carefully and securely soldered together at that point. I added a cross brace near the outboard end of the helices, using a piece of the polyethylene trim from the forming of the supports. After drilling and tapping the support, I used ¼-20 nylon bolts.

Because of the weight of this antenna, I decided to center-mount it for better rotational balance. For the support, I used a piece of 2¼″ wide, 1″ thick oak, fitted to the balance point of the assembly so that no part of the wood touched any point of the helix (see Photo E). I drilled each end of the oak support and fitted them with two brass adapters for ¼-20 bolts to wood. The coil supports were drilled to clear the nylon bolts used to join them to the oak cross member. Last, I drilled suitable holes in the wooden support to accommodate the normal U-bolt mount.

Does It Work?

I can't believe that I mounted and tested this contraption on a twenty-degree, snowy day in Michigan, but I did. The needle of a Bird wattmeter with a 25 Watt slug for this frequency pegged on forward power. I wasn't really too surprised because my PA had been tested with full 10 Watts 1269 input, and showed in excess of its 35 Watt rating. The reflected power measured only 3 Watts, for a calculated SWR of 1.8:1. Not bad for an unsophisticated design! Someday I may try for a better match, but I know it won't change the performance.

As if testing my design in winter weather weren't enough, I interrupted my night's sleep at 3:30 a.m. to catch a Mode L schedule. Egon DL9GZ gave me a good report. It wasn't a barn burner, but it showed significant improvement. Time will tell the rest of the story. I had the fun of building it for $29.07 (see the Table).

Material/Part	Source	Cost ($)
Copper Tube	Coast to Coast Hardware	17.95
Brass Inserts	Coast to Coast Hardware	1.60
1/4-20 Nylon Bolts	Coast to Coast Hardware	1.20
U-bolt	Coast to Coast Hardware	.79
Aluminum Sheet	NW Welding, Sturgis MI	4.68
6-32 Nylon Bolts	Hosfelt Electronic, Steubenville OH	1.60
N Chassis Connector	Hosfelt	1.25
	Total	$29.07

Space Education Network

Hams, spaceniks meet on A-O-13!

by K.O. Learner, II K9PVW and Greg Barr

Over the past few months, the AMSAT Space Education Network (SEN) has been bringing news, educational material, and tutorials on the activities of the world's space research organizations to satellite users within the OSCAR 13 footprint. For approximately 60 minutes each week, the scripts and voices of volunteers across the United States are beamed into space and retransmitted by a satellite built and prepared for launch by volunteers from around the world.

This unique activity shows how a common interest in space and communications is bringing together people of diverse backgrounds into a network of active contributors. Their goals are: to improve individual skills in the art of space communications; to link the amateur radio community and people interested in space science and technology; and to create a weekly network of amateur radio stations via an amateur radio communications satellite to discuss material of interest to the amateur space community.

Genesis of SEN

The creation of this network began over two years ago when AMSAT Vice President Dr. John Champa encouraged us to formalize and present the idea to the AMSAT General Meeting in November 1987. We picked topics for possible inclusion in each weekly bulletin. The most obvious of these is the transmission of news about world space programs from trade magazines and specialty publications. Following the news, we proposed that volunteers develop topics of interest, such as improvements in space transportation, the development of a joint US-Soviet space mission, NASA's plans for a Mars mission, and similar in-depth feature material. During the first half of the net session, we allowed time for retrospective features and thoughtful comments.

We followed the news and feature segments with one or more tutorials ranging over a broad area of technical and scientific issues. Examples of possible tutorials include a description of how the amateur radio communications satellite, being used for the SEN, operates; how it was launched into orbit; and how its operational characteristics were determined. We expected tutorials to range from orbital mechanics to astronomical observations.

The neatest aspect of the SEN through the hamsat is the possibility for interactive discussion, during which those who produced the material would be present to answer questions from the audience. This interactive participation would make it possible for the network to reach into the classroom through interested amateur radio operators who seek to interest young people in radio communications, as well as to excite them about participating in the development of space.

"With over 1000 OSCAR stations in the US, with many of these capable of providing an input to a local repeater, the SEN could be available at nearly any location."

With over 1000 OSCAR stations in the US, with many of these capable of providing an input to a local repeater, allowing reception over a large area with a handheld radio, the SEN could not only reach classrooms, but be available at nearly any location.

SEN's First Session

The Space Education Network became a reality with the launch of AMSAT's Phase IIIC spacecraft from the Kourou, French Guiana space facility by the first Ariane IV vehicle. The first session of the SEN was held on AMSAT-OSCAR-13 (A-O-13) during Labor Day weekend, September 3, 1988. The downlink frequencies were (and will continue to be) 145.960 MHz, Mode B and 435.900 MHz, Mode L.

Mars was the major topic of discussion, since it would pass particularly close to Earth later in the month, and it would be well-placed in the evening sky (for the northern hemisphere). Greg Barr reported on the Russian Phobos missions to Mars and to its moon, Phobos. These spacecraft promised to make the first close approach to Phobos and remotely analyze its composition for future investigations. Various astronomy publications provided information to aid observers in enjoying the magnificent view of Mars, whether visually, as a bright red spot in the sky, or through a telescope. Also in the first bulletin, Martin Pfefferkorn, Jr., reported on other items of space news from various journals.

The NASA Pathfinder Project

A typical feature is the ongoing series about the recently funded NASA Pathfinder Project. To coordinate and develop the technologies necessary to sustain humans in space, NASA has created a program that will use these technologies on missions. With the documentation available, it was easy to research the Pathfinder Project and rewrite the documentation summary to reduce technical jargon. An interview with Dr. John Mankins, the project manager, supplemented the material NASA provided.

We edited the material into segments of under 10 minutes each, to allow for station identification, then we used these segments as scripts for a live recording on a high quality cassette recorder and microphone. We used a filter to reduce frequencies below 500 Hz which decrease audio clarity in radio transmissions.

The NASA Pathfinder Project feature illustrates the AMSAT Space Education Network's ability to transmit up-to-the-minute information that would not normally be available through other media for many months, if at all. Even the trade magazines don't cover this topic in depth, since it isn't relevant to the commercial interests of their readers. The SEN Pathfinder series shows how information about the cutting edge of technology can be brought directly into the community. It is especially fitting that communities all across the country are accomplishing this task.

Plans for Future Sessions

In October 1988, the SEN added Retrospective segments written by William Wilson

Goodson, Jr., and narrated by Martin Pfefferkorn, Jr. Each Retrospective brings back a moment of history in the exploration of space. Many of these memories are exciting, joyous occasions of human triumph; but, as we all remember, some are not. William helps us to remember those who have already given so much to space exploration. Retrospective is a part of each session of the SEN.

The SEN has reported on the development and flight of two weather balloon ATV experiments by WB8ELK and W9PRD. More flights of this nature are planned, and information on how you can participate in these very interesting experiments will appear on the SEN.

Recently, William Black K4BSN, publisher and editor of *The Radio Meteor Review,* shared his publication of radio meteor research and data collection with the SEN. We are planning to have tutorial sessions on observing meteors via enhancement of signal strength over a radio path and topics in amateur radio astronomy.

Visual Augmentation

In future sessions, the SEN will be presenting information on diverse projects, such as solar sailing, amateur lunar orbit operations, future ham-in-space missions on the space shuttle and space station, and receiving pictures from weather satellites. Sometime in the future, you can request an amateur ground telescope to electronically photograph an interesting configuration of Jupiter's moons, or get a good view of a comet visible only in the opposite hemisphere!

Tutorial sessions can show a line drawing of the topic under discussion, such as a diagram of the A-O-13 orbit around the Earth. Photographs of a spacecraft or any of its systems can be shown to reinforce the description. Imagine the terrific views that will, in the very near future, come from the Hubble Space Telescope, or which one day may come from an amateur space telescope.

At present, we are using slow scan TV (SSTV) to show pictures during the SEN. SSTV is transmitted on 145.965 MHz. We have been experimenting with SSTV since November 1988, and we've received good quality, 8.5-second frames with signal strengths about equal to the A-O-13 beacon strength. SSTV reception reports have come from England and Japan, but as yet, very few have come from US stations.

With the advent of the digitized TV frames the WEBERSAT (MICROSAT-D) project will initiate, amateur radio will have a new, high quality, TV transmission standard. The WEBERSAT technique is to digitize the picture and transmit it by packet radio. AMSAT will provide the software for recreating the pictures in your station. Watch for this exciting development on the SEN.

Get in Touch!

Listen to the SEN on Saturdays on 145.960 MHz, Mode B and 435.900 MHz, Mode L. Join the fun by checking into the net and inviting friends who are interested in space activities to your station, or provide a gateway operation so that repeater users may join in. Remember, those friends might just become interested in amateur radio, too. The SEN wishes to thank these gentlemen who have served as NCS: Pete K1PXE, John K8OCL, and RIP WA2LQQ.

The AMSAT Space Education Network is a growing operation which needs your support. If you can help in any capacity, from writing, reading, serving as a net control station (NCS), to operating a repeater in your area, you will contribute to the growth of a substantial community educational service. Not everyone has the desire to read their own scripts or has adequate equipment for quality recordings. One of the network volunteer functions includes receiving and recording scripts from researchers and writers.

For further information, please contact the authors at the following addresses: *Greg Barr, 1412 Potomac Ave SE, Washington, DC 20003.* (Gregg Barr is the former Administrator of the L5 Society, and Deputy Executive Director of the National Space Society. Currently, he is the Director of Development at Action on Smoking and Health.)

K.O. Learner, II K9PVW, PO Box 5006, Kokomo IN 46904-5006 and by packet radio on KD9QB. (K.O. Learner is Senior Engineer, Systems Integration, Delco Electronics Corp., GM-Hughes Electronics, manager of the Learner Farms, and an AMSAT volunteer as AMSAT SEN project manager.) 73

Radio Links to Phase III-D

Satellite operation with a handheld in the near future?

by Dr. Karl Meinzer DJ4ZC
(translated by Don Moe DJØHC/KE6MN)
and updated by Peter Guelzow DB2OS)

AMSAT-DL proposes that the next generation of Phase III satellites be termed Phase III D. For the radio amateur, the most important characteristic of these new satellites will be the significantly improved signal strengths. The relatively involved antenna installations as currently needed for OSCAR-10 and OSCAR-13 operation will then be unnecessary. In fact, the radio links can be improved to such an extent that mobile or even hand-held operation will be possible.

The P-III-D and Phase IV Project

The P-III-D design specifies an elliptical orbit so that worldwide activity is possible with just one satellite. In this case, the technology also remains fundamentally comprehensible, especially since the orientation control system in OSCAR-10/13 and the antenna geometry can be duplicated. The parameters for the elliptical orbit would be set more precisely, however, so that of the two daily eight-hour access intervals at our latitude, at least one interval would conceivably occur during local evening hours.

Recently, in the United States, the "Phase IV Project," a system of several geostationary satellites, has been under discussion. Since a continuous access of 24 hours daily has the highest priority there, they are willing to sacrifice the possibility of worldwide communications and to accept reductions in the achievable signal strengths. From the European point of view, it is more sensible to stay with satellites using the Phase-III orbit and gradually supplement them with geostationary satellites. In the long run, this results in a communications system which would permit worldwide contacts at any time.

A frequently mentioned advantage of the geostationary orbit is that antenna tracking is no longer necessary, and the operator can achieve relatively large antenna gains economically. In amateur practice this argument is only partially valid, since generally the antennas are also used for other types of operation, and rotors are required. The actual problem is that many amateurs are restricted from building large antennas, with or without rotors. P-III-D offers a solution from the other side: when the radio links are so good that even very small low-gain antennas are adequate, tracking is unnecessary. AMSAT-DL hopes that this philosophy will attract a larger number of people to satellite communications.

Later I will discuss why better signal strengths are possible in the P-III orbit than in a geostationary orbit, but now I will only mention that in a geostationary orbit, the main lobe of the antennas has to lie diagonal to the spin axis of the satellite. As a consequence, either a mechanically counter-rotating antenna, or a three-axis stabilized satellite, is required. In regards to our current launch opportunities, the bulkiness of the first solution reduces the gain by more than 8 to 10 dBi. The second solution involves such a complicated mounting and deployment mechanism for the solar generator that we dread to think of the development and risks.

The P-III satellites are relatively simple and well adapted to our launch opportunities; the main radiation lobe is along the direction of the spin axis, and we readily achieve antenna gains of up to 15 dBi. This argument could possibly change in the future, however, if the electrical power were increased over that planned for P-III-D. In this case, three-axis stabilized satellites are cheaper because the cost of the solar generator could be reduced by half.

The improvement of the radio characteristics of P-III-D compared to OSCAR-10 is achieved mainly through higher antenna gain at the satellite and higher transponder power. Both aspects presuppose a bigger satellite. The large number of users (100 simultaneous channels) requires a bandwidth that is only achievable on Mode-L. The nominal power generation was designed so that activity restrictions would only rarely be required. Current planning centers around a satellite with the specifications given in the Table.

Can You Reach the Bird?

In earlier satellites, the radio link to the satellite had virtually no influence on the achievable system performance. In the case of Mode L this is no longer correct, and under certain circumstances, this link can be more limiting than the satellite-Earth link. Is it therefore even possible to operate through P-III-D using simple stations? The path loss at 1269 MHz and 37,500 km distance amounts to 186 dBii. For the 300°K system noise temperature in the satellite, the noise power in the SSB bandwidth (2.4 kHz) corresponds to −170 dBW. To overcome the path loss with a 20 dB (PEP) noise margin, you need 36 dBW (PEP) minus antenna gains at both ends.

When an antenna gain of 15 dBi is assumed at the satellite end, the transmitter power on the ground must be 21 dBWi (PEP), or 126 Watts PEP into an isotropic antenna. It is in fact enough if, for example, a mobile station radiates in the direction of the sky with a minimal elevation angle of 20 or 30 degrees. An antenna gain of approximately 5 dBi results from that, so that a transmitter power of 40 Watts PEP suffices, which is relatively easily generated nowadays using transistors.

Alternatively, a small helix antenna for a handheld could easily provide 11 dBi, thus requiring a transmitter power of only 10 Watts PEP. From these numbers, we see that we can achieve a 20 dB noise margin on the upward link to the satellite. Considering that P-III-D is planned for the last decade of this century, it is entirely probable that manufacturers will offer appropriate equipment and antennas costing no more than the present 2 meter or 70 cm SSB equipment.

Frequently, on the uplink, the operator uses too much transmitter power, which causes the transponder to reduce its gain. This in turn forces all stations to increase their power unnecessarily. We can assume that incompetence, indifference, and poor receiving installations are the primary reasons operators do not observe AMSAT's power recommendations. We have therefore come to the opinion that it is imperative to add certain technical features to the transponder in order to foster better understanding of satellite operation. As a reminder, the transponder in OSCAR-10 is almost always reduced in gain by approximately 15 dB; even on the QRP days, the limiter voltage is scarcely any less.

In other words, if all stations would reduce their power by a factor of 30, their strength would not change one whit. Weaker stations would then also have a chance to use the satellite. In our experience, it appears that appeals to self-discipline are quite futile.

LEILA

Back during the time of OSCAR-7, a concept was already being discussed at AMSAT-DL which we named LEILA, for "LEIstungsLimit Anzeige" (Power Limit Indicator). This is a type of spectrum analyzer which searches out the strongest station in the pass band of the transponder and then, when the limiter voltage exceeds a prescribed value, inserts a special CW marker signal over this station. Today, with the onboard computer, it's relatively easy to implement this concept. In fact, it is possible to go beyond merely marking an excessively strong station by actually attenuating it immediately with a tunable notch, to prevent degradation to other signals.

In practice LEILA will operate as follows: when an inordinately strong signal appears in the transponder, it will be covered with a characteristic CW pulse. The station should then reduce power until the CW pulse disappears, resulting in the optimal power level. If a station is too strong, the notch filter quickly reduces power.

Due to the characteristics of the notch filter, the signal will sound "odd," in addition to having the marking pulse. In this case a reduction in power by a factor of at least 20 is warranted.

Since LEILA's spectrum analyzer is controlled by the onboard computer, several stations can be managed simultaneously. Suitable software can doubtless be created such that limiting in the transponder can be virtually eliminated. We have therefore definitely decided to include LEILA as a component of P-III-D. This measure along with the high antenna gain should assure that the satellite is truly accessible on a continual basis, even for QRP stations. One other point that needs to be mentioned is that through computer control, special frequencies may be allocated a higher power level, thus providing preferential channels with exceptionally strong signals for emergency communications under difficult circumstances, without degrading the remaining communications to any significant extent. We hope that all users of the satellite will profit from LEILA. (The losers will be the manufacturers of superfluous amplifiers.)

The Satellite-Earth Radio Link

While the noise margin on the upward link is determined by the effective radiated PEP power of the ground station, the satellite's average power per user is the appropriate measure on the downward link. When the average output power of the transponder is 50 Watts, this means that each of 100 active channels has 0.5 Watts available.

For SSB, the peak power (PEP) is approximately 10 times higher, i.e., the transponder provides nearly 5 Watts peak power per channel. Although this adds up to 500 Watts for the 100 channels, and the transponder is capable of 200 Watts PEP maximum, this is no problem since not all channels require the peak power simultaneously. Even for as few as 10 channels, the fluctuations average out to the extent that the transponder can provide practically any peak power level to a single channel.

At 435 MHz and 37,500 km distance, the path loss amounts to 177 dBii. With an antenna gain of 15 dBi at the satellite and 0.5 Watts of power per channel, the effective radiated power of the satellite is 12 dBWi, resulting in levels of −165 dBWi or −160 dBW into a 5 dBi antenna on the ground. The noise power in the receiver is again assumed to be −170 dBW.

This results in a 10 dB average noise margin, or 20 dB S/N PEP. The links to and from the satellite thus provide the same 20 dB noise margin for the minimal station setup assumed. Even considering that both noise magnitudes accumulate, and that small additional losses are unavoidable, the PEP noise margin should not fall under 15 dB; thus easily readable signals are available to the amateurs.

In practice the two links will always differ by a few dB. For anything more than the minimal investment on the receiving side, the upward link will nearly always be the poorer one. The system therefore works at a level where an even larger satellite could no longer boost the achievable noise margin.

Special Aspects of the P-III-D Satellite

The Orbit: Because of the low inclination angle of OSCAR-10, a completely false impression of the capabilities of an elliptical orbit has unfortunately developed in many minds. When the orbital plane is inclined approximately 60 degrees, both orbits are accessible at our latitude during a single day. In addition to the commonly known pass in a southerly direction until overhead, the second daily pass is heard in the northerly direction. In a manner of speaking, one looks past the North Pole to the other side of the Earth. Consequently there are only two brief interruptions of operation daily, while the satellite passes through perigee.

Long-Term Orbit Corrections

In P-III-D an electrically powered thruster will be incorporated which will permit alterations in the orbit even after operation commences. The orbital period can thereby be set to exactly 12 hours, so that the orbit is exactly repeated day after day. Unfortunately, the East-West drift of the ascending node remains unaffected, resulting in the geometry of visibility changing during the course of a year. Alternatively, there is also the possibility of positioning the longitude of the ascending node, which, however, precludes the orbit from remaining synchronized with the clock. At this time it is still uncertain whether these two measures can be combined; there will surely be a few surprises when we tweak the orbit. The orbital control presupposes an electrical thruster, as mentioned.

The Antennas

The original P-III-D design implements antennas with approximately 10 dBi of gain. At apogee, the furthest distance away from the Earth, these antennas are directed optimally at Earth; at other points along the orbit, the antenna squints past the Earth. As a result, the distance to the Earth decreases, the field strength remains nearly constant over a large portion of the orbit.

Theoretically, it is possible to increase the antenna gain to around 18 dBi. Higher gains are not possible since the main lobe becomes too narrow and no longer encompasses the entire globe. As a consequence of such a high gain, signals rapidly fall off in strength away from apogee, and only a fraction of the orbit is useful. When an antenna gain of 15 dBi is selected, the conditions improve, but a large unusable portion of the orbit remains.

Since P-III-D is rather large, the opportunity arises to synthesize the antenna patterns such that the radiation pattern can be changed during orbit, providing optimal gain at any given point. Note that all patterns must always be rotationally symmetrical about the Z axis in order to avoid spin modulation. The switchable patterns make it possible for an antenna gain of 5 to 10 dB more than the original P-III antennas.

P-III-D Power Supply

Under ideal circumstances, the solar generator of P-III-D can supply approximately 300 Watts

Target Parameters of P-III-D

Communication	
Transponder Mode JL:	
Uplink	145 MHz and 1,269 MHz bands
Downlink	435 MHz Band
Transponder power consumption (nominal)	150 W
Average RF output power of transponder	50 W PEP
Output power of transponder	200 W
Antenna gain (70cm & 24cm each)	15 dBi
Bandwidth of transponder	500 kHz
System noise temperature of 24cm RX	300°K
Spacecraft	
Diameter	3 m
Height without antennas	1 m
Mass at launch	400 kg
Available electrical power (nominal)	175 W
Lifetime (nominal)	8 years
Orbit	
Molnija-Orbit with 12 hour period:	
Inclination	63.4 deg
Perigee height	1,500 km
Apogee height	35,000 km

from its 6 square meters of cell area. When you consider a 20% reduction due to aging from radiation and a sunlight angle of 30 degrees, the available power is reduced to a bit under 200 Watts on the 28 V bus. Of that, the satellite consumes 25 Watts for propulsion, position control, and onboard systems, so that at least 150 Watts remain for the transponder. Using this conservative calculation, no limitations on communications should be necessary during most of the satellite's life.

To permit uninterrupted operation during eclipses, the battery should have enough capacity to supply the power of the solar generator for at least three hours. In OSCAR-10, this condition is partially met. In the case of P-III-D, this means that 750 Watt-hours must be stored. We are uncertain whether it is really prudent to provide such a large battery, weighing nearly 40 kg. It is probably more reasonable to select the battery based on the needs of the propulsion system, nearly 400 Watt-hours, and to accept interruptions to communications or reductions in power during the eclipses. On the other hand, there is no longer the capability of storing enough energy during perigee to enable full operation during the remainder of the orbit despite unfavorable sun angles.

Conclusion

As described, stations having only limited antenna gain will be able to use the satellite fully, based on the current design parameters for P-III-D. This will establish satellite communications on a dramatically broader base, since the antenna expense for the first generation of P-III satellites has been the main deterrent to this mode of operation. For the first time, station design for worldwide DX communications via P-III-D will be significantly cheaper than their shortwave counterparts. The modest requirements for antennas will make the satellite attractive to those who cannot erect outside antennas. The transmissions on 23 cm will cause few TVI problems at the relatively low power levels.

The link improvements of at least 10 dB compared to OSCAR-10 and OSCAR-13 are achieved through the size of the satellite and its high transmit power of over 200 Watts PEP.

Additionally, the new antenna concept for switchable radiation patterns and the electronic notch to prevent misuse by strong stations contribute considerably to this design.

After the successful launch and commissioning of the AMSAT OSCAR-13 (P3C) spacecraft, work is now concentrating on this new P3-D project. Final design review is expected this year, including concepts for high speed digital communication, HF beacons, and other services.

Originally AMSAT had expected to receive financial assistance for this development during 1986 from the German Federal Ministry for Research and Technology, but various bureaucratic hindrances have prevented this from happening. We are now hoping to receive this assistance during 1989 so that the work may begin. 73

Number 23 on your Feedback card

NEW PRODUCTS

Compiled by Rebecca Niemela

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ACE Systems' full-featured, compact 5"x5¼"x1½" OPTO Iambic keyer is light enough to take with you anywhere. It contains 7 CMOS devices for high noise immunity and low power consumption. An opto isolator accomplishes keying. Speed and weight controls are adjustable.

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KENWOOD CORP.

The new Kenwood TS-790A covers 144/450/1200 MHz with enhancements such as Doppler shift compensation for the VHF, UHF, and satellite operator. Automatic Lock Tuning on 1200 MHz eliminates frequency drift. Power output is 45 Watts on 144 MHz, 40 Watts on 450 MHz, and 10 Watts on 12 MHz. For DXpeditions, the TS-790A operates on 13.8 volts DC.

The TS-790A has temperature compensated crystal oscillator circuits, frequency stability of ±3 PPM, 59 multi-function memory channels, multiple scanning and scan stop functions, built-in 500 Hz CW filter, a 10 dB RF attenuator on 2 meters, noise blanker, IF shift, selectable AGC, and all-mode squelch. It also features a packet terminal, CTCSS encoder, dual watch, and voice synthesizer. The TSU-5 and computer control are options. Suggested retail price is $2000. *Kenwood USA Corporation, Communications & Test Equipment Group, 2201 E. Dominguez Street, Long Beach CA 90810. (213) 639–4200. FAX: (213) 604–4487.*

OPTOELECTRONICS, INC.

The 2210 hand-held frequency counter from Optoelectronics features a dual crystal oscillator and dual input amplifier design. The low frequency range, down to 10 Hz, has a FET input, high impedance circuit; the microwave range, up to 2.2 GHz, uses miniature integrated circuit amplifiers.

Input sensitivity is less than 10µV, with 3µV typical in the above range. Accuracy is 1 PPM with temperature compensated crystal oscillators. The 2210's size is 3.9"Hx3.5"Wx1"D, and its weight is 9 ounces. Resolution is 1 Hz below and 100 Hz above 12 MHz. The Model 2210 sells for $189, complete with NiCd batteries and charger. A full line of accessories is available. The Model TA-100S Telescoping Whip Antenna is $12. *Optoelectronics, Inc., 5821 NE 14th Avenue, Fort Lauderdale FL 33334. (800) 327–5912 or (305) 771–2051.* Circle Reader Service number 201.

ELENCO ELECTRONICS, INC.

The Elenco electronic temperature control soldering station incorporates a sophisticated electronic circuit which enables the user to change the temperature of the tip from 300°F to 900°F without changing the tip or the heating element.

With a sensor near the tip, the temperature is maintained within 10°F of its preset temperature. The tip is isolated from the AC line by a transformer. Low voltage (24 volts) powers the heating element. Electronic switching protects voltage and current sensitive components against any spikes caused by other units. The electronic soldering station incorporates a linear LED array readout which displays the temperature of the tip. Price, $169. *Elenco Electronics, Inc., 150 W. Carpenter Ave., Wheeling IL 60090.* Circle Reader Service number 205.

MFJ ENTERPRISES, INC.

MFJ announces several new modes and enhancements for the MFJ-1278 Multi-mode Data Controller. Navtex receiving and AMTOR transmit and receive have been added to packet, RTTY, WeFAX, SSTV, CW, ASCII, and Contest Keyer Modes. Two features, Easy Mail™ and a new KISS Interface for TCP/IP compatibility, have been added to the packet mode. The price for the MFJ-1278 is $250.

The MFJ-1278 Starter Pack with software for the Macintosh and interface cable with instructions, sells for $20. Existing programs for the IBM (MFJ-1284) and Commodore (MFJ-1282 disk/MFJ-1283 tape) with cable and instructions remain available for $20 each. *MFJ Enterprises, Inc., PO Box 494, Mississippi State MS 39762. (601) 323–5869. FAX: (601) 323–6551. Telex: 53 4590 MFJ STKV. (800) 647–1800.* Circle Reader Service number 203.

TIME DOMAIN SYSTEMS

The VOICE-ID™ reproduces voice and sound effect messages in any language, without sounding robotic. Voice messages are safely stored in a nonvolatile EPROM. Microcomputer technology combines with voice compression algorithms for quality reproduction. Small, field installable, and virtually maintenance free.

Other specifications: Audio output 0.5 Watt, 8 ohms; low level. Bandwidth approximately 2–4 kHz. Voice duration 15–25 seconds. Input/output 7 TTL level, normally open. Repeater controller interface, 5 wires. Message combinations, 5 pins to trigger 5 different messages with programmable delays. Circuit board size is 3.5"x5". Powered by 9–12 volts DC at 300 mA, or independently by battery.

The VOICE-ID was designed for repeater identification, security systems, annunciators, monitoring systems, computer terminals, paging systems, robots, talking signs, and video game sound effects. Price, $150. Shipping/Handling, $5. UPS ground, FOB Davis, California. Prices and specifications subject to change without notice. *Time Domain Systems, Electronic Speech Products, 5003 Cowell Blvd., Davis CA 95616. (916)75-VOICE. (916) 758-6423.* Circle Reader Service number 207.

ICOM AMERICA, INC.

ICOM's compact IC-725 HF transceiver measures 9"Wx3.7"H x9.4"D. It receives and transmits on USB/LSB/CW, and also receives on AM. It has 26 tunable memories with Band Stacking Registers, two-memory channels, and memory for split operation. The three scanning systems are programmable scan, memory scan, and selected mode scan.

The IC-725 has a built-in AH-3 controller, priority watch monitor, 105 dB range receiver, and low-noise Direct Digital Synthesizer (DDS) switching. Operation ranges from 160 through 10 meters, with shortwave reception from 30 kHz to 33 MHz.

Other features include panel selectable RF preamp and attenuator, dual VFOs, noise blanker, RIT, semi-break in CW, and selectable AGC. Options available. Suggested retail price, $949.

The new AH-3 HF automatic antenna tuner is an option for the IC-725. The AH-3 adjusts immediately to the minimum SWR; it has eight memories for quick retuning. It emits 300 mW during tune-up, eliminating interference to other stations. The housing is durable acrylic sealed with rubber gaskets. No adjustments, no assembly; just connect the cables. Suggested retail price, $489. *ICOM America, Inc., Corporate Headquarters, 2380 116th Ave. NE, PO Box C-90029, Bellevue WA 98009-9029. (206) 454-8155. Service: (206) 454-7619. Telex: 152210. FAX: (206) 454-1509.* Circle Reader Service number 204.

The AMSAT-NA Microsats

Four new miniature hamsats.

by Courtney Duncan N5BF

When the European Space Agency launches the SPOT-2 mission this summer, six new amateur radio satellites will be on board. They will all fit on a newly developed mounting ring around the base of the Ariane payload area. This is the largest group of amateur satellites on the same launcher since 1981 when Radio Sputnik's 3 through 8 were put up by a single rocket.

Operators whose experience dates back to the days of OSCAR 8 and the RS-3–8 salvo will recognize certain features of the intended missions and orbits. These six new satellites are, however, state-of-the-art and up-to-date in every way.

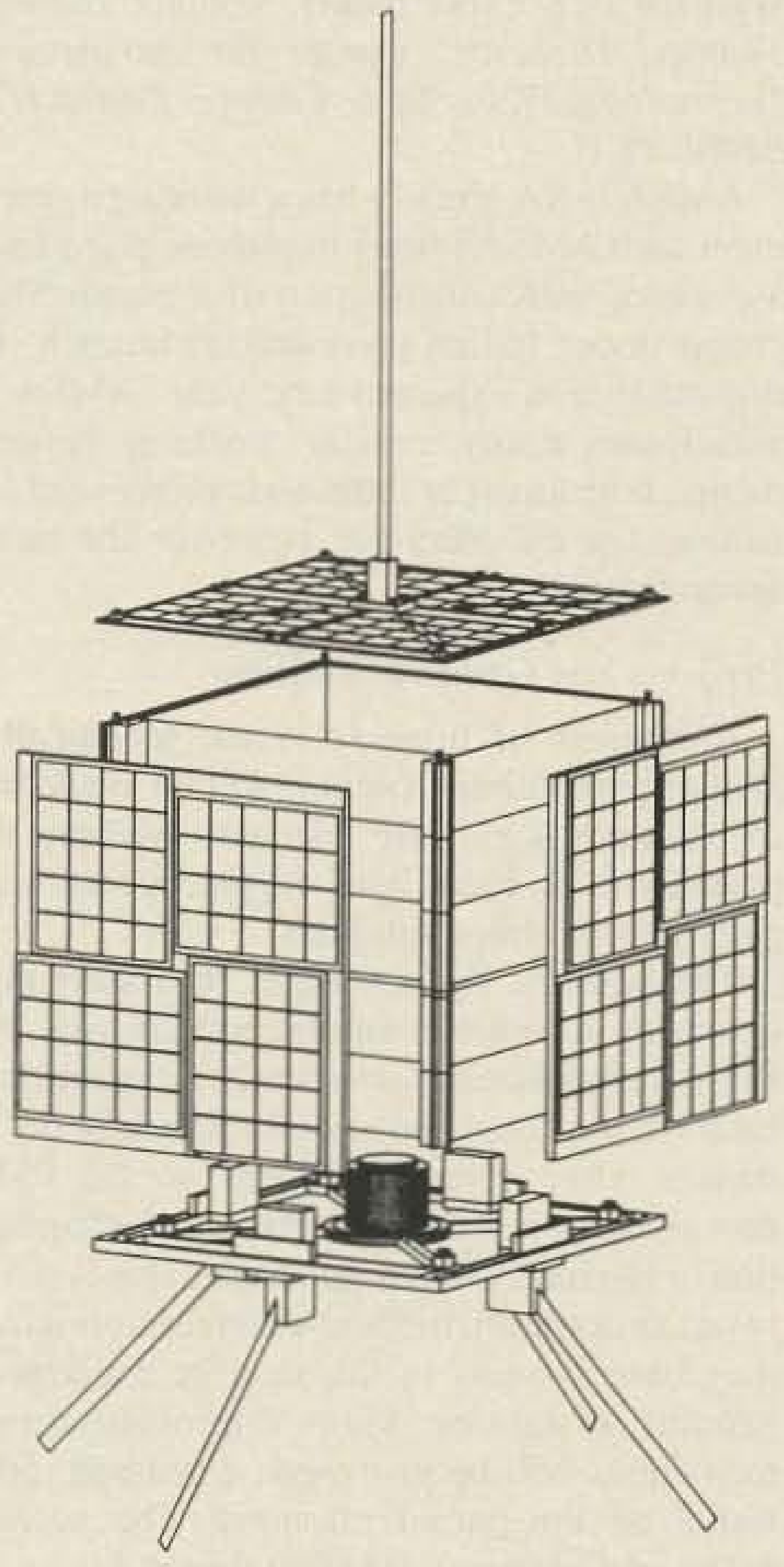
The University of Surrey, the builders and operators of UoSAT-OSCAR 9 and UoSAT-OSCAR 11, is providing two of the new satellites. UoSAT-D and UoSAT-E continue the tradition of low-end scientific research using amateur radio in orbit. These missions are covered extensively in other articles in this publication.

The other four are the first of a new series of spacecraft designed and produced by AMSAT-NA and built around a common bus called Microsat. This standard bus consists of five modules stacked up like cafeteria trays and bolted together. Four of the modules are standard equipment on each satellite: transmitter, receiver, flight computer, and power system. The fifth module is reserved for special "customer" payload applications and is known affectionately by the handle "TSFR" or "This Space For Rent."

Each Microsat stack is a cube about nine inches on a side with solar cells on all six faces. A canted turnstile for the transmitter is mounted around the "bottom." A whip for the receiver sticks out the "top" (see Figure). The power budget allows for a maximum transmitter power of four Watts which will allow easy, adequate reception by ground stations using simple, fixed antennas.

Each flight computer consists of a V-40 and can contain up to 10 Megabytes of memory (in the initial incarnation). These computers will run a multi-tasking operating system that emulates MS-DOS. This approach is intended to simplify software development, maintenance, and simulation on readily available personal computers. Due to a number of clever and creative hardware design decisions, several hundred telemetry and other spacecraft operating parameters will be available to command and monitoring stations.

For more information on the spacecraft monitoring and operating team, contact



Exploded view of a microsat. Note the five tray frame stack. The receiver module is in the top-most tray, and the transmitter module is in the bottom-most. The three inner trays are power module, computer and "TSFR."

Cylindrical section at bottom is the spring housing, which contains the spring to eject the microsat from the launcher and into orbit. The arrangement is different on DOVE and WEBERSAT.

Ralph Wallio W0RPK, 1240 Highway G24, Indianola IA 50125.

Orbit Access Times

The orbit for the SPOT-2 mission is specified as sun-synchronous polar (inclination 97 degrees) with an altitude of 822 kilometers, period of about 101 minutes (similar to the orbit of OSCAR-8), and ascending node around 2230 local time. (Note that local time is solar time at a given longitude which may be up to an hour different from local time, or two hours during daylight savings.)

This means that for each satellite, overhead passes will last 15 to 20 minutes. At temperate and equatorial latitudes, there will be two to four passes each morning and two to four each evening in a three to four hour window centered around 10:30 AM or PM. Passes before 10:30 occur to the east, after 10:30 occur to the west, and near 10:30 are near overhead.

Stations at higher latitudes will have more access to the satellites. Because the orbit is polar, each orbit (and there are 14 per day) takes each satellite near each pole.

Although each of the six satellites are placed into the same orbit, they are each deployed in slightly different directions from the launcher body. The resulting slight difference in actual velocity will cause them to spread out all around the orbit circle in just a few days, as happened with the RS 3-8 satellites.

To visualize this, imagine a ring around the earth going from pole to pole and crossing the equator over a place where the local time is 10:30. Six satellites are spread out at random along the ring. As was observed with the RS 3-8 satellites, an operator under the ring of the orbit (that is, where it is late in the morning or evening) will not have to wait long for a satellite. As the six satellites drift around with respect to each other, they will appear individually or in groups of two or three, changing patterns from day to day. When one sets, another will be up, or will be about to rise. In between nodes (several hours around 4:30 AM or PM local time), passes are not possible for any of the group.

A Co-operative Effort

The AMSAT-NA team is not building the Microsats on their own, nor will they be operated solely by and for North Americans. To the contrary; several groups are participating in the development of the Microsat bus and will separately (but co-operatively) own, license, and operate them. These groups and their leaders are:

AMSAT-NA; Doug Loughmiller; PACSAT
Weber State College, Ogden, Utah; Robert Twiggs; WEBERSAT
BRAMSAT; Jr. DeCastro; Project DOVE (Digital Orbiting Voice Encoder)
AMSAT-LU; Carlos Huertas; LUSAT

AMSAT-NA is the Amateur Radio Satellite Corporation, North America. BRAMSAT is the AMSAT of Brazil and AMSAT-LU is the AMSAT organization of Argentina. Also, The American Radio Relay League (ARRL) and Tucson Amateur Packet Radio Corporation (TAPR) are each providing considerable assistance with development.

Nominal Operating Frequencies

Mission	Downlink	Uplinks
PACSAT	437.050 MHz	145.900, 145.920, 145.940, 145.960 MHz
LUSAT	437.150 MHz	145.900, 145.880, 145.860, 145.840 MHz
WEBERSAT	437.100 MHz	
DOVE	145.970 MHz	

PACSAT and LUSAT are orbiting packet radio mailboxes. These build on and significantly expand the Fuji-OSCAR 12 mode JD (digital) mailbox tradition. They will not function as digipeaters. The intention for these missions is to allow worldwide access to packet mail messages, to bring the amateur digital and satellite communities closer together, and to improve the response of the packet mail forwarding system. Access will be via the exact equipment that has been used to access Fuji-OSCAR-12, a packet radio TNC (terminal node controller) and associated computer terminal, a 2 meter FM radio for transmitting, and a 435–438 MHz sideband receiver connected with a phase shift keying demodulator for reception.

Since packet radio functions are computer-intensive, a powerful computer is included with each Microsat as standard equipment. That is the only payload. The TSFR module is flown empty on the pacsats, or will contain additional digital transmittals and receivers.

The Digital Orbiting Voice Encoder (DOVE) will continuously transmit stored digital voice messages on 2 meter FM as it orbits. This operation will be similar to that of the digitalkers on UoSAT-OSCAR-11 which aided the recent Skitrek polar expedition by providing navigational information for the group moving across the ice, and for educational listeners around the world. Ground operator equipment for DOVE consists of only a 2 meter FM receiver or scanner with a simple antenna.

The payload module on DOVE contains all the special equipment for producing audio for the FM transmitter. There are three audio sources, a digital synthesizer, digital-to-analog converters so that any sampled sounds can be played back, and Bell 202 standard modem tones for limited telemetry transmission.

DOVE is considered largely educational, to provide inexpensive and simple access to satellite communications and science, technology, sociology, geography, languages, and other subject matter. High school students worldwide are submitting messages for DOVE. For more information and teacher's kits, contact *Richard Ensign N8IWJ, 421 North Military, Dearborn MI 48124.*

The WEBERSAT also uses packet radio and frequencies similar to those on the pacsats, but its mission is somewhat different. The WEBERSAT payload module contains scientific experiments and a color TV camera! TV pictures will be digitized and compressed, then broadcast as binary files on packet "unproto" beacon frames. These may then be collected and reassembled by monitoring stations on the ground. WEBERSAT will also contain a spectrometer and an L-band wideband receiver for direct uplink into memory of fast scan TV pictures.

For more information on participation in WEBERSAT experiments, contact *Robert Twiggs, Director, Center for Aerospace Technology, Weber State College, Ogden UT 84408-1805.*

AMSAT-NA already has a working agreement with AMSAT-Italy to provide plans and assistance with construction of a pacsat Microsat under Italian jurisdiction. Launch of this mission is expected next year. AMSAT anticipates many similar working agreements, both amateur radio and commercial in nature, for the Microsat bus over the next several years.

Projects For Ground Stations

A number of projects, some technically challenging, others routine, will be available to amateurs and UHF listeners wishing to participate at some level in the operational programs for these satellites.

The pacsats, for example, will start out operating in a mode similar to that used by FO-12. Stations will randomly compete for each of the four FM uplink channels on 2 meters while everyone listens on the PSK downlink for responses, traffic, and information or telemetry beacon packets. This is really not an optimum method when the uplinking user base in view of the satellite exceeds a handful of stations. Many improved access techniques will be proposed, discussed, and tested on the pacsat missions. The access protocol dialogue is far from finished.

Techniques for using the pacsats for packet mail forwarding and improvement of the forwarding network are also under consideration. Mail forwarding protocol changes implemented for pacsat operation will also help the terrestrial forwarding circuits.

Each Microsat using packet radio will have the ability to select between 1200 and 4800 baud on any combination of uplink and downlink channels. Assembling and operating a ground station for 4800 baud operation will be a challenging project worthy of the best operators in the AMSAT tradition. Functioning stations will also provide much needed gateway, linking, or high speed forwarding resources, if desired.

Digitized video is a popular topic in amateur radio recently, and WEBERSAT will be a strong participant in testing and developing standards both in space and in diverse ground stations.

Rod Magnet Stabilizing

Spacecraft stabilization is an interesting area of investigation. The Microsats are each stabilized by rod magnets mounted parallel to the Z axis of the spacecraft. These magnets try to align themselves with the earth's magnetic field as the spacecraft orbits, so the spacecraft's Z axis rotates twice per orbit. Photon impacts on the canted turnstyle causes the satellite to rotate about its Z axis with a rotation period of minutes. The turnstile antenna blades, which are painted black on one side and white on the other, generate torque. Lossy ferrous material mounted in the X-Y plane damps rotation.

The Z axis magnets, by the way, are being mounted in PACSAT and LUSAT in opposite senses so that if there is any favoritism between hemispheres in this stabilization approach, one pacsat will favor the northern hemisphere, and the other the southern hemisphere.

Although this stabilization technique is well understood and was used very successfully on AMSAT-OSCARs 7 and 8, it has not been thoroughly analyzed and quantified. An understanding of the spacecraft's attitude can help users understand and predict antenna patterns, thermal activity, and solar cell illumination. A predictive model of spacecraft attitude is particularly useful for WEBERSAT, so that users can know when to take pictures with the camera! Conversely, you can use the camera to confirm WEBERSAT's attitude and to refine the predictive model.

We can do much to collect data on the demographic peculiarities of the Microsat missions. The pacsats can collect part of this data automatically by tabulating successful interactive packet exchanges. Reception reports from all Microsat listeners will provide complementary information for optimizing future plans.

We can use experiments to determine ionospheric and other propagation effects on the digital uplink and downlink signals to determine an optimum set of AX.25 parameters for each link and data rate.

These experiments are interesting and educational and help fill out AMSAT's understanding of its own projects. Some are crucial to mission success. In most cases, all or nearly all of the equipment necessary for participation, is already present in an OSCAR station equipped for mode JD, as described above. Of course, the orbiting packet mailboxes can handle the announcements, bulletins, and electronic-mail correspondence among participants.

Exact orbital information and mission status will be available from AMSAT after launch.

This article has presented a brief overview of the imminent Microsat missions and challenging experimental programs. The list is by no means complete, but is merely a sample of the exciting opportunities about to become available.

Join AMSAT

For further general information, or for more information on operational projects, join AMSAT and contact *Courtney Duncan, Vice President, Operations, AMSAT, PO Box 27, Washington, DC 20044.* AMSAT publications cover the technical issues surrounding the amateur satellites and their use in great depth. Members also receive periodic progress reports. We encourage your AMSAT membership and participation!

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Continued from page 18

There should be eight holes per leg, totaling 64 holes. These holes will help you to attach the screen wire to the spokes with pop-rivets.

Cut eight pie-shaped pieces of screen wire so that they overlap each section of the dish by at least three inches. Then attach the metal screen wire to the spokes with ⅛-inch pop-rivets. If you've never used pop-rivets, don't be afraid; they're cheap and easy to use. It's a good idea to place a small CAD washer under each rivet to increase the holding area. Start by securing the edges of two screen pieces to the first spoke in an "overlapping leaf" technique (sort of like placing two pieces of a pie next to each other). Then, moving one section to the right, secure the previous screen section and the next to the second spoke. Repeat the process until all eight sections are attached.

There will be some leftover screen hanging over the perimeter. Fold this over the 16 gauge wire and then cover it with eight pieces of very thin sheet aluminum angle stock (sold at hardware stores for covering sheetrock when it is joined together in outside corners). This thin right angle stock comes in 8-foot sections and sells for under one dollar.

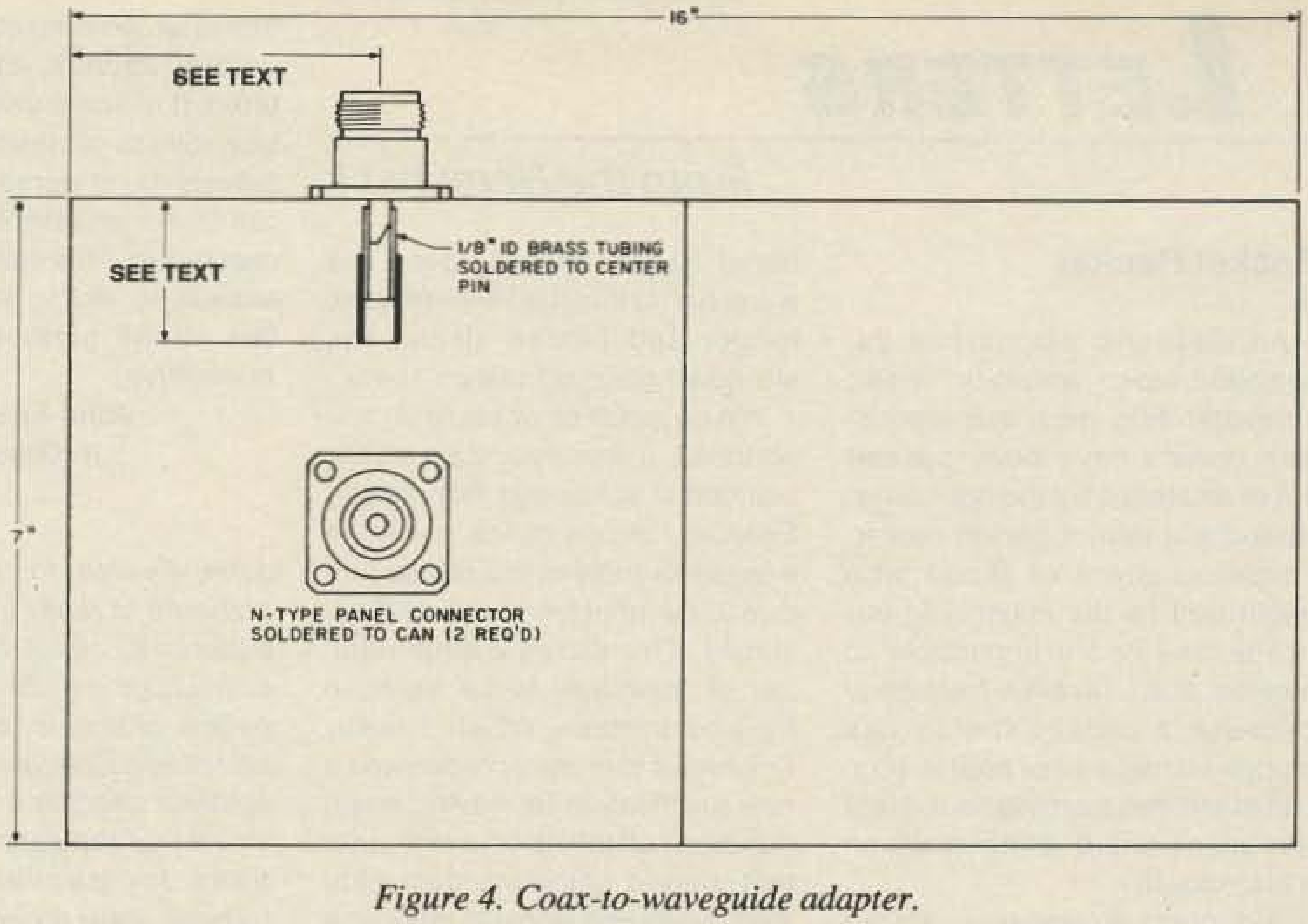

Figure 4. Coax-to-waveguide adapter.

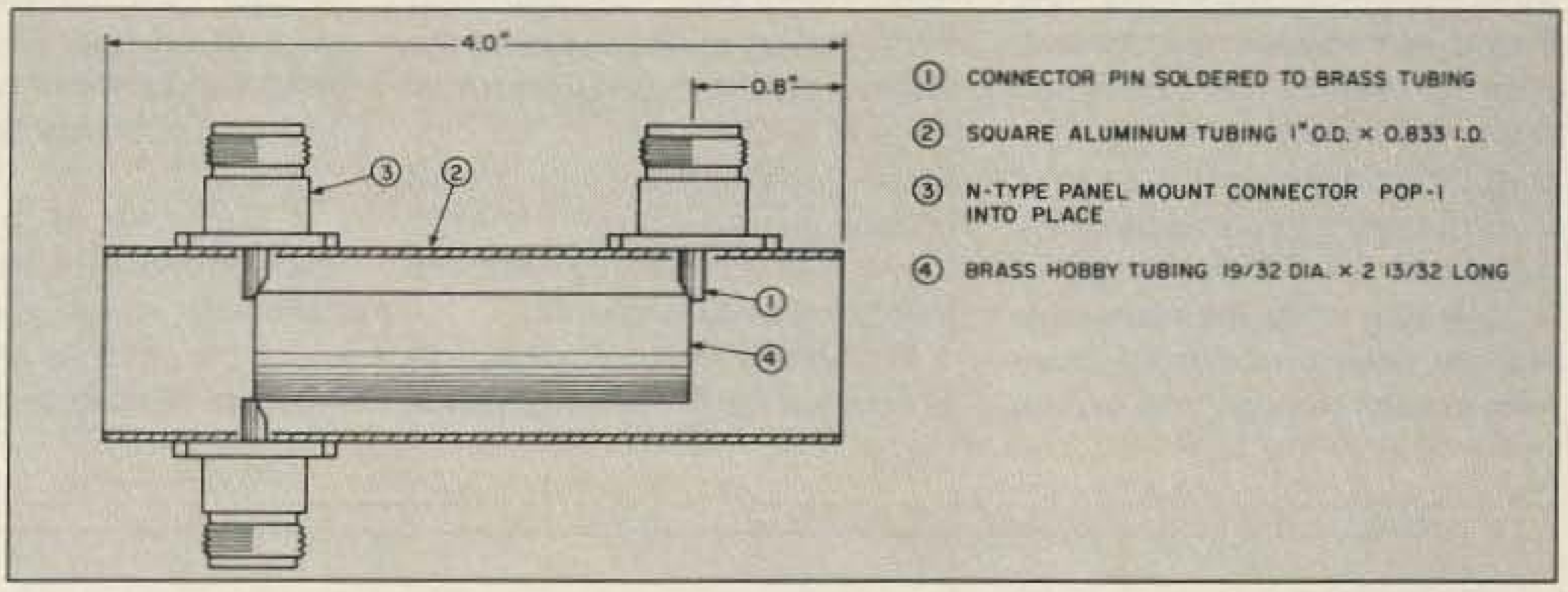

Figure 5. Power divider.

"For OSCAR-13 work you will need right-hand circular polarization (RHCP)."

The Feed

The best parabolic reflector in the world would be useless if it weren't fed properly. The feed I chose boils down to a big coax-to-waveguide adapter (see Figure 4). The waveguide consists of two 7-inch diameter cans that I found in a craft shop. (I think they were originally meant to hold flour.) I used a can opener to remove the bottom of one can, and then soldered the two cans together to produce one big can. Next, at the correct point from the rear wall, I soldered two N-type panel connectors to the outside of the can, 90 degrees apart. Then I attached a small one-inch long piece of ⅛-inch I.D. brass hobby tubing to the center conductor of each connector, and slid a 1.5-inch piece of the next size up brass hobby tubing over the former piece to allow tuning. I tuned each feed individually with a Bird wattmeter to get a 1:1 SWR. Once you have determined the correct length, you can solder the outer tube into place. I was amazed at how easy it was to tune the antenna, and how broadbanded it was.

If you don't want to use this method, you could solder a single piece of large diameter copper wire to the N connector, and prune it to the correct length for best SWR. This should work acceptably, at the expense of some bandwidth.

For OSCAR-13 work you will need right-hand circular polarization (RHCP), so make two feeds into the same waveguide. If you feed one probe 90 degrees out of phase to the other, you will generate circular polarization. When a signal from the feed antenna hits the parabolic surface, the polarization will be reversed. So, in order to generate RHCP, you must first produce LHCP. The power divider shown in Figure 5 will accomplish this. This power divider is nothing more than a ¼ wavelength piece of 35.7Ω coax that transforms 50Ω down to 25Ω. You want 25Ω because that is what results when the two 50Ω feed antennas are hooked up in parallel. Add an extra ¼ wavelength of 50Ω feedline to the left-most feed (as looking from the backside of the can) to produce LHCP. Be sure and take into account the velocity factor of the cable when measuring this.

Mounting The Feed Horn

Attach the feed horn to a two foot piece of wood 2 x 2, which is in turn bolted to a one foot piece of ½-inch O.D. pipe (Figure 5). Offset this whole arrangement from the center 3.5 inches by using right angle pipe joints. The feed horn should end up directly over the center of the dish and two feet above the surface (corresponding to a 0.4 F/D). Use wood to minimize the interaction of the feed antenna with the mounting hardware.

Installation

The 1-inch floor flange on the backside of the dish is placed there to accommodate a piece of one-inch pipe. The length of this pipe will depend on how you want to mount your antenna and how much you need to counterbalance it. Each installation will be different, so good luck!

Test and Results

As of yet, I have not permanently mounted the antenna next to the other OSCAR antennas. I've only manually pointed it "Field Day" style. I think that I'm going to have to get a bigger elevation rotor. With 10 Watts to the antenna I can consistently hear my own signal close to the beacon in strength, and on-the-air reports from others are favorable.

This article was written to show how I built this antenna cheaply with the materials at hand. I'm sure that I could have done things differently as I know you may choose to do, depending on the availability of materials in your area. Be innovative and use construction materials that are probably all around you now.

My thanks to K5SXK who patiently explained antenna theory to me and answered questions whose answers I should already know. See you on the satellites!

LETTERS

From the Hamshack

Packet Racket

An electronic plague has descended upon amateur radio. Long-standing nets and discussion groups have been pushed out of existence by the agonizing, screeching tide of packet racket. Large numbers of those who might well be the majority in our hobby now find it impossible to monitor their favorite frequency because a packet station has plopped down on it or near it. Who can stand that piercing sound that has been likened to fingernails on a blackboard?

A typical example is found when monitoring 144.9 MHz. This frequency has been used for fast-scan TV liaison for over thirty years. It is important for signal reports, homing-in antennas, and guiding transmitter/modulator adjustments. An S-9 packet signal on 144.905, while not even moving the meter on adjacent channels, breaks through and can be heard 10 kHz up and down. The worst part is that the RF burst lasts longer and blocks all but the strongest voice signals on 144.9.

When packet was first announced, it was described as the ultimate in space age technology. Economy in use of the spectrum was the keynote in this discussion due to its inherent speed and accuracy. This allows a large number of operators to be serviced by one system. What it really amounted to in many cases was a new justification for having spent hundreds of dollars on a computer that started gathering dust after the novelty had worn off. Although most hams can talk well, and many can even chew gum at the same time, this great store of wit and wisdom had to be digitized, dehumanized, and stored in libraries called bulletin boards. I guess it goes along with the inability to listen and write.

In any case, the basic pleasures of amateur radio—hearing a voice from afar, sensing its emotions, its unique sounds, are being bittered. It is bad enough to lose frequencies to commercial interests, but it is much worse to have them rendered unlistenable by your own group. This could be the final assault in which amateur radio, like all the great empires, falls from within.

John Shelley WA1IAO
N. Granby CT 06060

John, it's clear to me you haven't bothered to really check out what packet's all about. First, the packet invasion on 2m is really 5–7 packet channels, taking up 100 kHz of bandspace—2.5 percent of amateur allocation on that band. You'll find the same modest subband for packet on the HF bands—there are again 5–7 channels on 20m, for example, that take up around 15 kHz of the band—about 4% of our allocation on 20m. This hardly constitutes an "assault."

A single AM voice signal—the voice mode with the minimum bandwidth where you can really sense the richness of nuance and emotion in another op's voice—takes up half the total packet subband on 20m!

Packet is indeed a frequency economical mode—and it rose in part out of a desperate need to economize band space. Most bands—in HF especially—are now jammed with activity, most of which is still voice and CW. The basic pleasures of amateur radio about which you speak—the voices from afar, the emotions, the sounds—are more and more our agonies; the voices of weary DX stations dealing with obnoxious pile-ups, exasperation, and constant mutual QRM. A clear voice channel on 20m nowadays is truly unique!

One of the things that made amateur radio a great empire was that hams were at one time on the leading edge of radio communications development. We embraced new modes such as FM and SSB when they came along. Who then balked about the monotonal quality of SSB as compared to AM?—the important thing was that it allowed a greater range and cut signal bandwidth in half!

The introduction of new modes to amateur radio, and the low-cost R&D performed on them by thousands of hams, is a blessing. This is a continuing justification of our existence to the government. Packet, too, does an unparalleled job with another one of our raisons d'etre*—traffic handling. What other mode do you know that can handle traffic, error-free and unattended, at many times the rate of CW, or even voice? Visit a VHF packeteer's shack some time late at night and watch the stream of automatically routed NTS traffic scrolling across the monitor—keeping a band active that is often times nearly dead in the late hours.*

If amateur radio falls from within, a large part will be from our overriding nostalgia preventing us from learning new modes.

. . . de NS1B

Sorry, Wayne

Sorry to inform you I have upgraded to Tech and have been working on teaching a new Novice who is almost ready for the test. So you don't get to rip up my license for failure to upgrade myself and promote amateur radio to others!

If every ham would work with one student each year, we could avoid discouraging people.

Keith Martin
Lewiston ME 04240

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73 INTERNATIONAL

edited by C.C.C.

Notes from FN42

The feature item this month is the finalized 73 **[Best Regards] *International Universal Permit Application*,** *printed on a separate page. It isn't really finalized, of course—it never can be that, but so long as Hambassadors keep us posted on changes of requirements in their countries, we can keep it reasonably up to date. In its present form it has now been officially accepted by the authorities of* **The Republic of South Africa** *(see under "Roundup," below).*

And speaking of Hambassadors: They come and they go, and in recent months more Hambassadors have been going than coming. How long can "73 International" do its job without wide coverage of the ham world?

What IS that job? Broadly speaking, we see it as keeping strong and bold the **S** *in* **A**mateur **S**ervice. *One of the major conditions of receiving a ham license is the obligation placed upon license-holders to be of* **S**ervice *to their nations and, since radio waves have no national boundaries, this really means service to the ham world.*

We of the editorial staff who all together make up the fictional editor of this column, Chauncey Charles Cuthbraith (the all-CCC-ing C.C.C.), view our job to be of **S**ervice *to you. Like working for a universal permit application form. For you. But this, and by far most of the information brought you here each month, would never appear on these pages without Hambassadors.*

We hope the change in policy had nothing to do with the drop-off (cash payments of $40 for each of four long reports a year have been replaced with a first-class airmail subscription to the magazine for three brief reports each year). There was no way we could expand our world coverage from the initial 38 countries to the current more than 75 and continue under the old policy. Work out for yourself the increased cost to us of up to 225 reports per year, many of which, with a maximum of four pages to use, we would have had to cut in length or not used at all!

And the 75-country coverage is being reduced to only theory right now. It has been too long since we have heard from some countries, and it hurts a little that this includes some with Hambassadors whose subscriptions continue and will continue through 1989. . . If you have to resign, OK, we know how situations can change for anyone. But please let us know so we can recruit your replacement. Remember: Hambassadors are providing **S**ervice *to each other and the world, and "73 International" provides the space for you.*

(We hope all subscription problems were solved by late last year—we fired the company that had hashed up addresses badly. As an example: one overseas address had been computer-mangled into a name, a street address, and a nation. We DO think our Hambassadors are notable, but an address without mentioning the name of a city is asking too much of a postal system!)

Hambassador or not, let us know of changes needed for the universal permit application form to make it acceptable in your country. Hambassadors, please submit the form printed in this issue for an official approval by your country's authorities.

The kind of wording used by the government of South Africa (see box) should be satisfactory.

And now the calendar for May: On the 1st it is May Day (Fete du travail, Tag der Arbeit, etc.) for China, France, Germany, and the USSR (National Labor Day is on the 22nd for Jamaica); 2—King's Birthday, Lesotho; 3—Constitution Day, Japan (17th for Norway); 5—Bataan Day, Philippines; 7—National Day, Chad (Cameroon on the 20th, Tanzania on the 26th); 8—Victory Day, France; Queen's Birthday, Australia; 9—Liberation Day, Czechoslovakia; Independence Day, Israel (Paraguay on the 14th, Jordan on the 25th); 14—Mother's Day (Muttertag, Dia de las Madre, Fete des Meres) USA, Germany, Guatemala (on the 28th for the Central African Republic); Unification Day, Liberia; Joan of Arc Day, France; 15—Victoria Day, Canada; 16—Discovery Day, Cayman Islands; 18—Prayer Day, Denmark; 20—Navy Day, Chile; 22—National Heroes Day, Sri Lanka; Spring Bank Holiday, Great Britain; 24—Bermuda Day, Bermuda; 25—Revolution Day, Argentina; 29—Memorial Day, USA; 31—National Holiday, South Africa.

Roundup

Australia. K.D. (Ken) Gott VK3AJU writes: "My delay in answering [your letter asking if I had notified the WIA of my volunteering to be the Australian Hambassador] was due to my vacation on Erith Island, an unpopulated spot in Bass Strait, 147° 20 E, 39° 30 S, where the fishing is great and the abalone and lobsters are free. (However, the DX is not so great.) The VK news should start to buzz around a lot faster. . . the WIA office holds files of 73 which I have already consulted. So before long you may expect some dispatches from me. . ." [*We look forward to them—and a picture of you, please. (Any Hambassador who has not yet sent us a picture: please send!—CCC*]

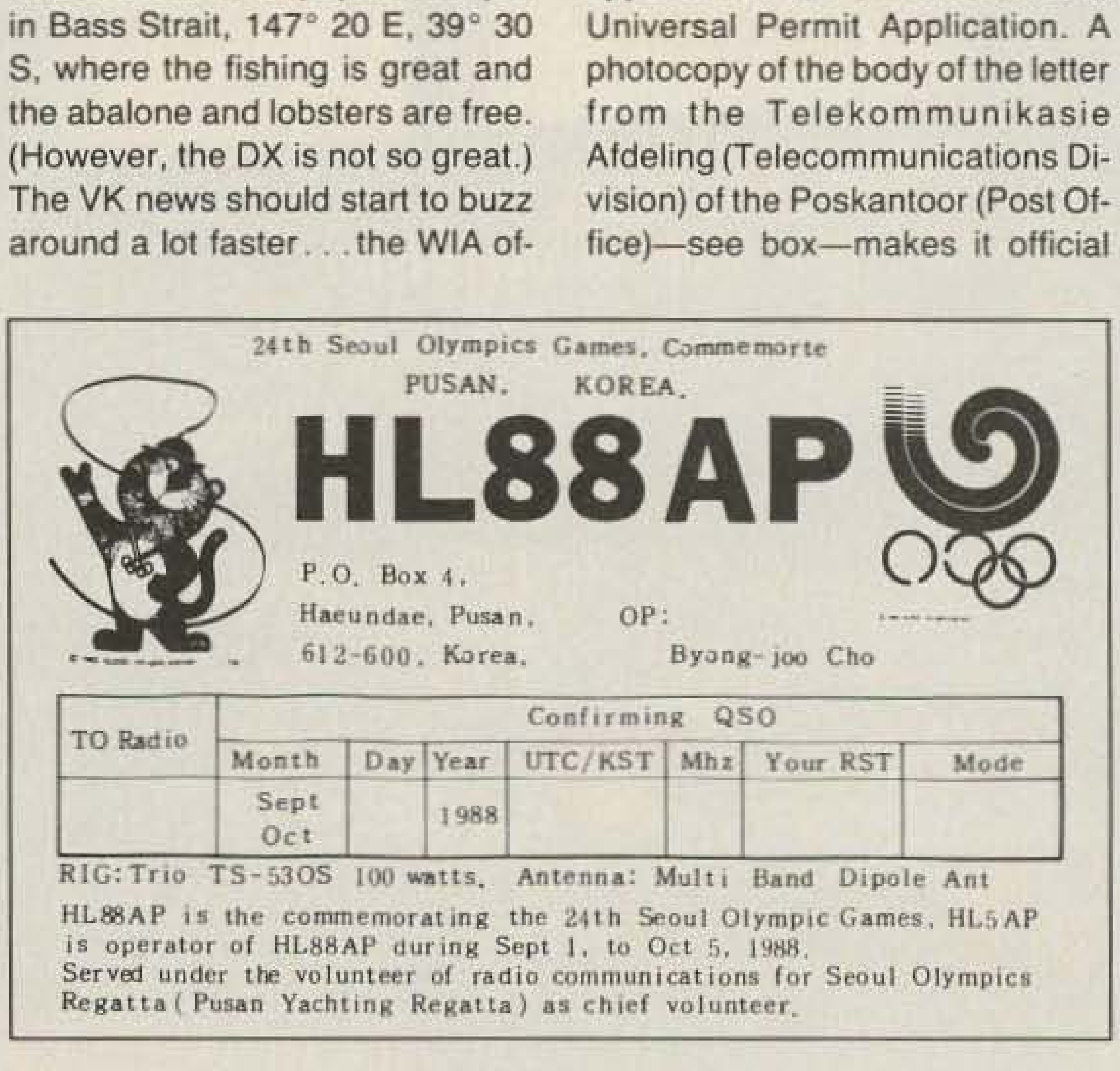
Korea. Byong-Joo Cho HL5AP/HL88AP sends Christmas and New Year's greetings:

더욱 알찬 결실을 맺는
새해가 되시길 기원합니다.

He promises reports in 1989 when construction of "our new home and offices" is finished and he has "set up a new antenna tower and beam." He also sends his and the KARL Olympics stations' (HL88AP and 6K88BYC) QSL cards.

Netherlands. Radio Netherlands program information is available electronically. Dial your international access code, then (31) 35 45395 for the IBM host computer, which will work at 300/1200/2400 baud. It uses the standard 8-N-1 (eight data bits, no parity, one stop bit) format and both CCITT and BELL tones. Alternative methods: In the USA: ANARC (Association of North American Radio Clubs) bulletin board in Peoria IL, (309) 688-0604, or the Pinelands board (Tom Sundstrom) in Vincentown NJ, (609) 859-1910; both use BELL tones and the same format and baud rates as above. If you run a BB and want an electronic feed of Radio Netherlands news, get in touch.

Republic of South Africa. Our Hambassador Peter Strauss ZS6ET sends us the first official approval of the 73 International Universal Permit Application. A photocopy of the body of the letter from the Telekommunikasie Afdeling (Telecommunications Division) of the Poskantoor (Post Office)—see box—makes it official



24th Seoul Olympics Games, Commemorte
PUSAN. KOREA.

HL88AP

P.O. Box 4,
Haeundae, Pusan,
612-600, Korea.

OP:
Byong-joo Cho

TO Radio	Confirming QSO						
	Month	Day	Year	UTC/KST	Mhz	Your RST	Mode
	Sept Oct		1988				

RIG: Trio TS-530S 100 watts, Antenna: Multi Band Dipole Ant

HL88AP is the commemorating the 24th Seoul Olympic Games, HL5AP is operator of HL88AP during Sept 1, to Oct 5, 1988.
Served under the volunteer of radio communications for Seoul Olympics Regatta (Pusan Yachting Regatta) as chief volunteer.

Councillor D Siegel
South African Radio League
Headquarters
PO Box 3911
CAPE TOWN
8000

Dear Mr Siegel

RECIPROCAL AND GUEST AMATEUR RADIO LICENCES

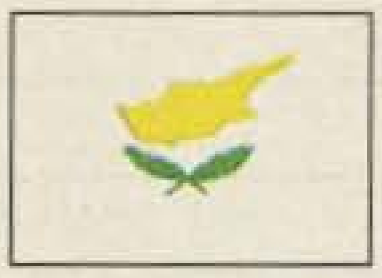
With reference to your letter of 16 November 1988 with enclosure I wish to inform you that the proposed form by 73 Magazine of the USA appears to embody all the details normally required. Consequently we would have no objection to an overseas visitor submitting such a form when applying for one of the above-mentioned licences.

Yours faithfully

POSTMASTER GENERAL

as of December 20, 1988 for use by any ham planning a visit to South Africa.

Sweden. 1988 marked the 50th anniversary for Radio Sweden and the 40th for *Sweden Calling DXers* which published its 2000th issue. On December 5th the new language, Estonian, was added. (From Bulletin #2023, 12/27/88.)



CYPRUS

Aris Kaponides 5B4JE
PO Box 1723
Limassol
Cyprus

News From Cyprus. HF radio amateur activity in Cyprus seems to be stabilized. About a dozen amateurs come regularly on the air on the HF bands, mostly on phone. Two or three are regulars on CW, with Loris 5B4FN leading the group. Very timidly, the first packeteers on HF have made known their presence in this new and exciting mode. OM Costis 5B4TX is pioneering, and 5B4FN, Akis 5B4OA, and George 5B4MDD, in the Nicosia area, are starting to be active. Nicos 5B4CV in the Limassol area is warming up his soldering iron to homebrew the necessary packet TNC and interface.

From the ZC4-side, I can copy only the Akrotiri and Epikopi base areas, and as far as I know from the old ZC4s, Alan ZC4AB is specially active on 10 meters. Bill ZC4WK will be a new station heard from this year, the club station, ZC4EPI will be reactivated, and there are another five or six ZC4 stations on the island but I have no information on their activities.

On the VHF side, CARS has decided to use the private line system on all the Cyprus repeaters to counteract the QRM from the various nonlicensed operators from Lebanon.

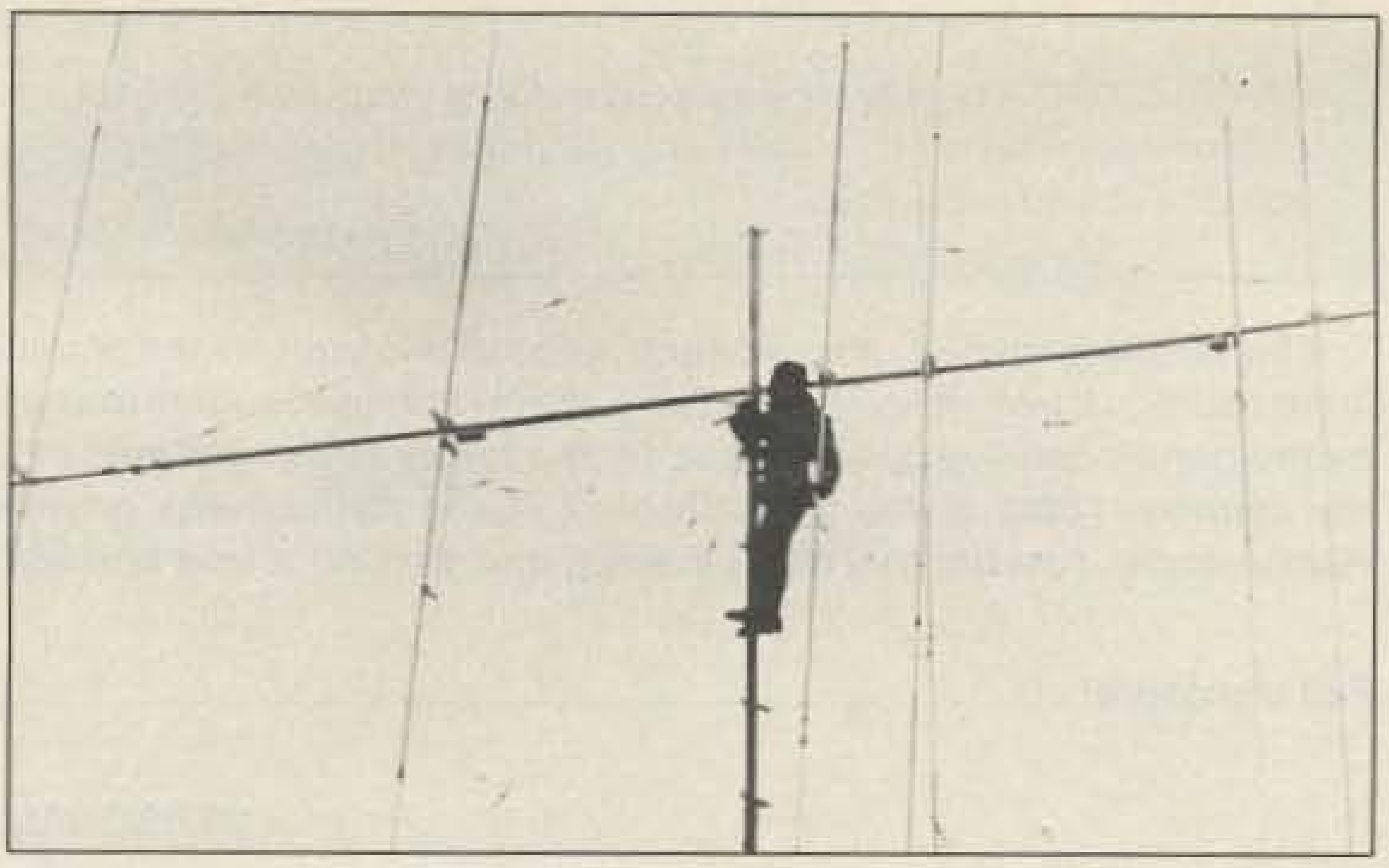
On the social side, a Christmas Dinner Dance was held in Nicosia and amateurs from all over the island gathered there with their families and had a terrific time!

Cyprus is a holiday island, and we do get our fair share of ham visitors. I had in my shack Rudi DJ0MAF and Tony G7ATA, and Michel GJ6WDK and Bjorn SM7ED were here. Last summer I again had my friend Jim GM4HKW and his XYL Hilda. Other 5B4 hams had also foreign ham visitors in most parts of the island. Little Cyprus seems to be doing her best to promote the amateur radio aims and objectives. Hi! *[OK, Hambassador Aris, can you get the new universal permit application form officially approved?!—CCC]*

USSR

From Mike F. Shakirov UA9MI
PO Box 2056
Omsk 644119, USSR
via Ken Carpenter KC4UG
PO Box 586
Vernon, AL 35592

[KC4UG writes that the envelope from UA9MI arrived open and two of the three pictures were missing. He also wrote, "I find the 73 International column very interesting and always read this just after Wayne's editorial." We'd say that in this case being second is as good as being first!—CCC]



UA9MI's fullsize 7-el yagi.

Hello! I'm greeting readers of "73" journal! I'm teacher by profession and have not much free time, but devote good deal of it to ham radio. It is many-sided and therefore has many admirers [everywhere] and in Omsk, too. Equipment and antenna designing is my hobby, only home-made is my principle! Working on the bands I prefer zero degree azimuth beam direction because I find American hams great gentlemen in operating and I like to work with them.

As I write these lines, our country has a disaster—the earthquake in Northern Armenia. Like many other ham radio friends I try to do everything I can in the transmission of the information by ham radio canals [channels]. A group of three from Omsk, including chief - UA9MA, G. Kolmakov, is in Stepanovan now and keeping in official touch. I have many QSOs with special stations from Armenia.

[The missing pictures were of UA9MI and his station, and a 2 kW linear amplifier of his own design. Maybe he can send replacements? About the third photo, he wrote that a maintenance check was being performed here, before the 1987 WW Contest, in −25 C temperature, 40 meters off the ground, with the wind 15 M/S!—CCC] 73

SAMPLE FORM to submit when requesting the authorities for official approval for its use by any visiting amateur wishing to operate in your country.

The 73 International Universal Permit Application

The following-named radio amateur respectfully requests the permission of the government of ________ to operate amateur radio equipment in the country. If permission is granted, I, the undersigned, agree to operate in accordance with ***the rules, regulations and conditions established by the permit-issuing government, by the terms and conditions of the bilateral agreement (if any) between the permit-issuing country and my country, rules of the (ITU) Geneva Radio Regulations governing radio operations, and the rules and regulations of my country. Furthermore, I certify that the following information is true and accurate.***

Full signature: ______________________ **Date:** ______________

PERSONAL INFORMATION

1. Family Name(s) ______________ **2. Given Name(s)** ______________

3. Country of Residence ________ **4. Citizen?** ________ **by Birth?** ________ **Naturalized?** ________

5. Nationality ______________ **6. Place/Date of Birth** ______________

7. Home Address ______________________

8. Personal description (if not included on passport or other official ID attached here—Color hair, eyes;weight, height): ______________

9. Attach photocopies of passport pages showing name, number, other selected data. (If passport not required for entry, attach photocopies of Birth Certificate and official ID showing picture—such as Driver's License.)

10. Occupation (profession) (place of employment) ______________

AMATEUR RADIO INFORMAION

11. Callsign ______________ **12. Operation license number (if any) and class** ______________

13. Expiration date (if none given attach notorized certificate that license is valid) ______________

14. Attach photocopy of license (If Morse speed not shown, indicate here) ______________

INFORMATION ABOUT PLANNED VISIT

15. Arrival/permit to be effective date ______________ **16. Departure/permit end date** ______________

17. Address(es) in permit Country ______________

18. Location(s) of operation(s) ______________

19. Description of equipment (brands, models, XMTR, RCVR, XCVR, power amps, antenna(s), power, bands, and types of emission(s)

____

____

20. Point and manner of entry of operator and equipment into Country ______________

SPECIAL INFORMATION FOR THIS PERMIT-ISSUING COUNTRY (if any)

____

12/20/88. *As of this date* this form has the *official* approval of South Africa and the probable unofficial approval (earlier versions were OKed) of PY1APS, OK3CMZ, SV1IW, 4X1MK, I2MQP, JARL, XE1MKT, ZL2VR, CT4UE, SM0COP, and BV2A/2B, for their countries. As official approvals come in they will be added here; as approvals come in *asking that additional information be supplied*, the back of the form will be used to list the added info needed, by country needing it.

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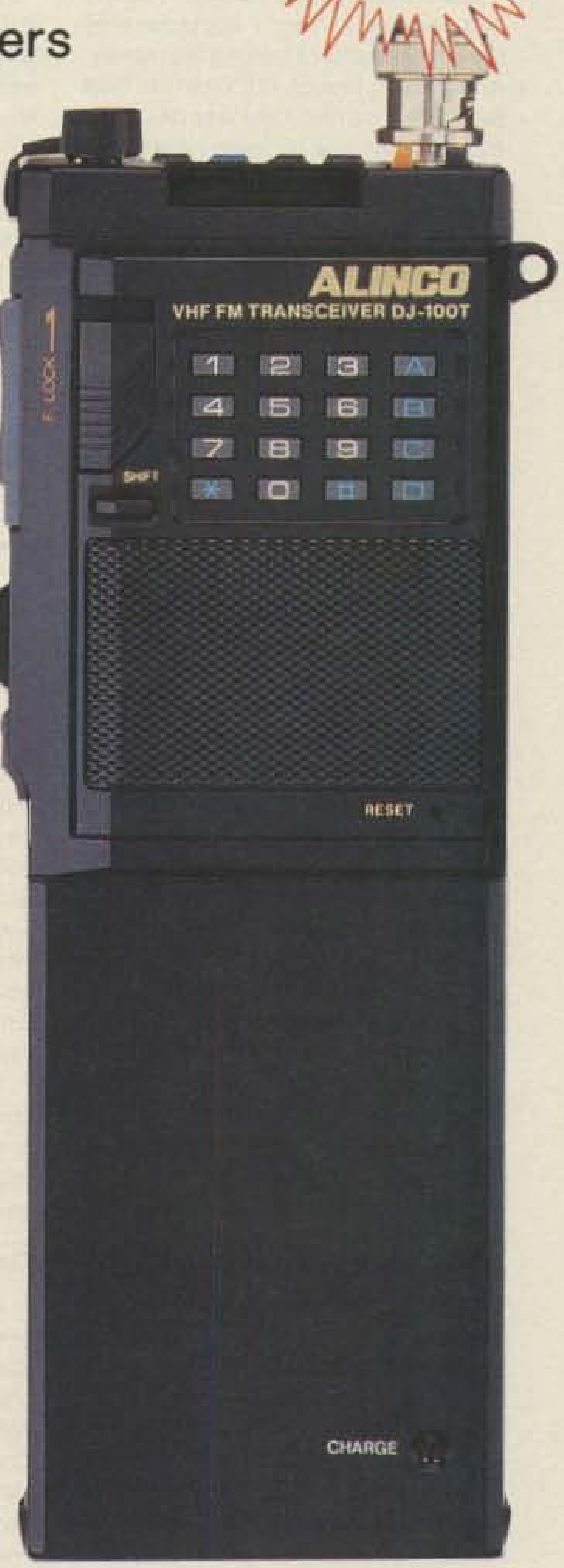
- Standard Battery, EBP-9NAZ Has DC/DC Converter Built In
- Stores Standard Repeater Offsets In Memory
- Full Range of Accessories
- 220 MHz and 440 MHz To Follow Shortly



(Optional EBP-2NAZ Ni-Cd battery)

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AES - Las Vegas, NV
Austin Amateur Radio Supply - Austin, TX
Barry Electronics - New York, NY
Burghardt Amateur Center - Watertown, SD
Colorado Comm Center - Denver, CO
Delaware Amateur Supply - New Castle, DE
Doc's Communications - Rossville, GA
El Original Electronics - Brownsville, TX
EEB - Vienna, VA
EGE, INC. - Woodbridge, VA
EGE, INC. - Salem, NH
Erickson Communications - Chicago, IL
F&M Electronics - Greensboro, NC
Floyd Electronics - Collinsville, IL
The Ham Station - Evensville, IN
The Ham Hut - Amarillo, TX
Hatry Radio - Hartford, CT
Henry Radio - Los Angeles, CA
Hirsch Sales Co. - Williamsville, NY
HR Electronics - Muskegan, MI
HRO- Anaheim, CA
HRO - Atlanta, GA
HRO - Burlingame, CA
HRO - Oakland, CA
HRO - Phoenix, AZ
HRO - San Diego, CA
HRO - Van Nuys, CA
HSC - Santa Clara, CA
HSC - Sacramento, CA
HSC - Sunnyvale, CA
International Radio Systems - Miami, FL
Jun's Electronics - Culver City, CA
Kennedy Associates - San Antonio, TX
KJI Electronics - Houston, TX
Madison Electronics - Houston, TX
Maryland Radio Center - Laurel, MD
Memphis Amateur Electronics - Memphis, TN
Michigan Radio - Mt. Clemens, MI
Mission Consulting - Houston, TX
Missouri Radio Center - Kansas City, MO
N&G Electronics - Miami, FL
Omni Electronics - Laredo, TX
Quement Electronics - San Jose, CA
RF Enterprises - Merrifield, MN
R&L Electronics - Hamilton, OH
Reno Radio, Reno, NV
Rivendell Associates - Derry, NH
Rogus Electronics - Southington, CT
Rosen's Electronics - Williamson, WV
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Texas Towers - Plano, TX
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CANADA:
Canadian Distributor
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Continued from page 6

helped build international friendships? Have you helped us get more newcomers? Or will the only sign that you ever existed be a listing in old *QSTs* in the Brasspounder or DX Honor Rolls? What an ego-starved waste of a hobby which has such an enormous potential. Oh, I enjoy working DX, but I haven't the vaguest idea of how many countries I've worked. I stopped counting at 300 years ago, and even then I never submitted cards for "credit."

Some hams go into business making ham products. Yes, I suppose they have daydreams of making big money. A few have, though not often on ham products. The ham business never did much for anyone by itself—it was the growth into the more commercial markets which brought on real success.

Art Collins WØCXX did well when his ham SSB gear was accepted by the military. Yes, he used amateur radio as his entry into this market, with the help of Don Merten W2UOL. I'd sure like to see the inside story published—fascinating, if rather seamy in places. But that just makes the story more interesting.

Ham History

There's a lot of ham history which needs to be written before all you oldtimers who were there die off. It'll never be published in *QST*, but I'd go for it.

When will someone write a biography of Mort Kahn W2KR? His success with Tempco, which he sold to Otis Elevator for a few million dollars—then his clever bulldozing his way into the job of Hudson Division director, from which spot he got rid of Bud Budlong W1BUD, the League's long time alcoholic and arrogant general manager. He also organized the building of the new HQ building. On the downside, he was deeply involved with the terrible Hallicrafters scandal at the New York World's Fair and, even worse, was the main engineer of the devastating Incentive Licensing disaster.

There must be someone left from that meeting on Mort's yacht on Long Island, in December 1962, where Tom McAnn K2CM came up with the plan for Incentive Licensing—a plan to return amateur radio to its pre-WWII license system and frequency allocations. A plan which has directly caused America to lose over two million scientists, engineers, and technicians so far—and contributed substantially to the loss of all our consumer electronic industries.

Oddly enough, you don't have to be a genius to leave your footprint in history. You do want to remember that genius is 90% perspiration and only 10% inspiration, so even the most brilliant of ideas are unlikely to get anywhere unless you get behind them and push hard.

Just look at the state of the art in amateur radio today. Here we are still fighting QRM on our HF bands. That's crazy. We have the technology available to get rid of 99% of the QRM—all it takes are some pioneers to make it happen.

Sure, we have the beginnings of packet radio. But it's still far too slow and problem-prone. It needs the help of more pioneers. We want to get packet so it's fast and error-free. We have the technology available to speed packet up to 500 pages per second. Yep, two milliseconds for one full page of information! By using a digitizer, we could input text and graphics from books and magazines, so we wouldn't even have to sit and type everything.

How about it? Will your final mention in Silent Keys be the only way we'll remember you? Or will you find some way to improve amateur radio for us all—for future generations, if there are any? What, if anything, are you doing to make sure there is a next generation?

Are you working with your club to get us more Novices? Or are you doing your best to keep the darned kids out of your old-man's club? Are you spending your life pursuing certificates? Why? Is the Honor Roll your main goal in life? Why? Are these things really the best you can do for the world as a person and as a ham? They ain't much.

I told 'em to try again and I'd see what I could do. I explained that my management style was not to dictate, but to advise. Well, I advised and the *73* staffers ignored—claiming the readers would be angry. They're probably right.

Since even the psychiatrists have a lot yet to learn about homosexuality, there's no way most of us are going to put something as charged as this into any reasonable perspective. Gays have, to some extent, come out of the closet, but their welcome hasn't been warm.

One of my problems in getting along with people has always been my refusal to go along with "accepted" ideas unless they made sense to me. That's worked in my favor in some ways—like smoking. Most of my teenage friends took up smoking. Hmm, so I tried it and said ugh, thereby saving myself an incredible amount of money on cigarettes over the last 50 years—plus accumulating fewer serious health problems. Many of the smokers who served with me on the *Drum* during WWII are already long

"We have the technology available to get rid of 99% of the QRM"

If you can help make our ham history more complete by telling us about the heroes and villains you've known, how about writing an article before you, too, are gone? Perhaps, if we had more of a sense of history, we'd have more ham heroes. How much do you really know about Hiram Percy Maxim, the chap who founded the ARRL? Have you read his books? Pity, if not.

The sunspots are coming—we've got Novices on 10 meters—and we've a world of new technologies just waiting for us to get to them. You do it—you write about it—and I'll publish.

Gay Hams

At the end of my talk at Dayton this year a chap came up to explain that he didn't think anyone would ever convince him that we should get rid of the Morse code as a requirement for a ham license, but after my talk he was converted. I think "converted" is the right term—since it's much more a religious matter than one involving intelligent thought. Perhaps I should rebill myself as Reverend Green. As a Doctor of Divinity in two religions, I certainly have the bonafides. Heck, those DDs cost me $20 each around twenty years ago—one of my well-hidden assets. Hallelujah! Say Amen, brother!

Right after the genuflections of the newly converted Code-Satan contingent, I faced a more formidable group: militant gays. Oh, boy! The leader, working his way up to a petulant seethe, was outraged that *73* had refused a classified ad from his ham radio gay/lesbian group, which was looking for members. First I'd heard of it.

gone—and most of 'em were younger than me.

My father, who came from about seven generations of New Hampshire people, was typical of his generation of WASPs—anti-black, Jew, Catholic, and so on. When I started my first business with a sales office in my bedroom at home I hired an assistant. A few days later my father took me aside—my assistant, he was J-e-w-i-s-h, wasn't he? Hmm, guess so, it never crossed my mind one way or the other.

When I was working as a professional psychologist one of my patients was a homosexual. He had some problems with which he needed help, but his sexuality wasn't one of them. Never Say Die, I tried to see what I could do for him. I wish he'd been more interested in finding out where and when it started, but we did go back to his being aware of his sexual feelings for boys when he was three years old, so the psychiatrists are dealing with far more than a behavior problem.

As a straight, the whole concept is repugnant, but that hasn't seemed to interfere with my accepting gays as friends. Indeed, I have never found myself considering that when hiring, or in any decisions on friends. I have some good close friends who I know are gay, though the subject has never come up between us.

So my inclination was to run the ad. It isn't as if a gay/lesbian ham group is going to convert someone to the gay life, so what's the beef? But, I recognize that though in many ways I'm an arch conservative, my liberalism in people could set many older hams off into flights of fury. With the average ham age up around mine, I recognize that in this respect I'm marching to a different drum.

Heck, I hope it won't bug you, but even though I live in New Hampshire, where blacks are almost as rare as wild tigers, I have a good friend who is black. Now that may not sound like much, but when you consider that 99% of my life is spent working, I don't have much time to make and keep friends.

One thing amuses me, speaking of work. I run into people who are suffering burnout. Give me a break! I've worked a schedule few of you could keep up with almost all my life and I'm still not quite burnt out. I've got more plans for new projects than anyone else I know—with modest goals of getting us to over two million US hams, modernizing the American educational system, cutting college costs to virtually zero, ending welfare, and so on.

Yes, I agree my plans are outrageous, but by golly I'm making progress with 'em. Isn't it better for me to have these goals instead of the more normal ones for people my age, such as getting my golf handicap down five points?

So what do you think about our running a classified ad for a ham gay/lesbian special interest group? The whole gay situation is going to be a hot potato for a long time to come. We've seen plays about the shock of parents finding out one of their children is gay. And we know about the jokes around the office about AIDS and gays deserving each other. Many people don't think of gays as being normal—something like being handicapped—maybe like being blind or deaf, but with an even greater element of shame and disgrace.

Amateur radio has always been a friend of the handicapped. I remember the great help Bob Gunderson W2JIO was with his Braille Technical Press for many years. And there was Stan W2ET, another old-time blind ham. Bob Weitbrecht W6NRM was stone deaf, so he helped pioneer radioteletype.

I guess it comes down to how insecure we feel. People who feel inferior make up for it by putting others down. It's called the redneck syndrome, not one of the more endearing American qualities. Indeed, we Americans are rather well known for this. We're known as Ugly Americans in many countries for our surplus of the smug, boorish, and arrogant. Yet here we hams are, speaking over the radio every day as supposed goodwill ambassadors for our country.

Y'no, if we don't clean up our act, we're going to have an awful job getting two million new hams into our ranks. Our overly-ugly contingent will drive 'em away as fast as you get 'em interested in checking out the hobby. And you know who they are. You hear 'em on the repeaters with bad language, bad-mouthing this or that. I've a new flash for you: It's your responsibility to see that hamming is fun. Fun on the air. Fun at club meetings.

That's not the responsibility of an ARRL director, or your club president—it's your job.

Making Ham Radio Fun

What's the most fun you've had in ham radio? When are you going to sit down and write me a letter and tell me what you've found the most fun—what's been the most exciting for you?

I suspect that if we can get newcomers to work DX on 10 meters, they'll have fun. Now, they can do that with a super bandbanger rig, kilowatt amplifier, and six-element full-sized beam on a 100-foot tower. They can also have a ball with a converted CB rig on 10 meters and a dipole. There they'll have the added excitement of converting the rig—getting into the guts of it with a soldering iron.

They're not going to do this unless you do it first and write articles telling 'em how. With CB rigs going so cheap these days, what's stopping you? And you don't need a beam to work out on 10 meters—a simple twinlead dipole does wonders. How long does it take to throw a string up into a tree with a weight on it and hoist a dipole between a tree and your house? Minutes.

You say you believe in CW? Okay, how about putting your word processor where your mouth is? First let's see what you can do to cook up a simple solid-state CW rig—maybe one Watt. Then get on the air and work some stuff. Now write a construction article so a few hundred others can join you. Back before Incentive Licensing in the mid-60s, I was publishing small magazines for VHF (*6-Up*, Jim Kyle, Editor), contesting (*5-7-9*), television (*ATV*), and one for ham club newsletter editors (Marvin Lipton, Editor). Incentive Licensing not only almost destroyed the ham industry, it killed these specialized magazines.

If we are able to get some school radio clubs going we're going to need simple projects like QRP rigs to get the kids excited. I'll find some ham companies to make parts kits available—even the printed circuit boards—so you won't have to pull a strain.

If you'll get some QRP rigs going, I'll see what we can do about setting aside a few kHz for QRPers so they won't get clobbered by the ten gallon heads.

Has your club started with hidden transmitter hunts yet? What do you need? Let's start seeing fox hunts on 2 meters, on 10 meters—hey, why not on 220, the band shouldn't be totally dead?

Then I want to see some articles (with pictures) on your club activities. I want articles on how to build simple transmitters for hunts—hand-held receivers, antennas, the works. Wouldn't it be nice if in a couple of years we had a national fox hunting team we could send to Europe for the international finals?

Getting a ham ticket, buying a rig, and getting on the air to rag-chew doesn't do a young ham a lot of good. It doesn't do our hobby much good, either. Only if we get our newcomers excited about the hobby so they're induced to learn by the fun they're having, will we be worth anything to them.

Thirty years ago when I published theory articles I got good solid feedback from the readers. They wanted more. Today I find that theory articles are virtually invisible. What's happened to the sense of excitement and pleasure in learning? Did that go the way of our educational system, turned into bland pap?

A little quiz. How much do you really know about radio? How long has it been since you made a serious effort to learn more? Could you get up in front of a club and explain how RTTY works? How about packet radio? I'll bet a school radio club would make mincemeat out of you.

What do you know about transistors, ICs, gates? If you wanted to build a rig for 10 GHz, how would you go about it? On what frequencies are the 10 meter FMers working? Have you ever worked 2 meter aurora? How about OSCAR? When are you going to get active on OSCAR? We've had ham satellite communications available for you for years now—what's it going to take to get you off your duff and busy at the workbench? We're not talking big bucks here, just how much of a ham you really are!

If I were able to find someone to write a simplified technical series for *73*, would you even bother to read it? This is supposed to be a technical hobby, unfortunately for about 99% of us, and I may be being kind even at that, it's just an operating hobby, with us showing little interest in the technical side.

If you're an engineer, why should you bother with ICs? Modern rigs are too complicated to fix, so what's the use? It takes thousands of dollars in test equipment and a Master's degree to fix a synthesized transceiver, right? Well, perhaps, either that or a motivated youngster with a VOM.

If I could get some articles for you on how to fix your ham gear, would you read'em? Sigh, I was afraid not. Well, if I can't get you off the couch and away from your TV to learn more technically, how about getting you busy with your local ham club? How about you as a spark plug to get your club into putting on hidden transmitter hunts on weekends? How about Novice classes? Providing communications for local events, such as sports car rallies, walkathons, marathons, helping local TV stations with fund raisers, putting on ham demos at shopping malls and in schools. How about club picnics, flea markets, auctions? Eat prunes and get things moving.

Your Ham Activity Score

Have you ever worked:

_ SSTV?
_ RTTY?
_ AMTOR?
_ High speed CW?
_ FAX?
_ 100 countries?
_ 200 countries?
_ 300 countries?
_ 50 countries on 75/80m?
_ 50 MHz?
_ Putting up your own repeater?
_ 220 MHz?
_ 450 MHz?
_ 900 MHz?
_ 1.2 GHz?
_ 2.3 GHz?
_ 3.3 GHz?
_ 10 GHz?
_ Via Packet?
_ Via OSCAR?
_ VHF contests?
_ DX contests?
_ Sweepstakes contests?
_ From a rare country?
_ As a QSL manager?
_ As an officer in your local radio club?
_ As an Elmer?
_ To put on a hidden transmitter hunt?
_ To provide communications for a civic event?
_ To demonstrate ham radio publicly?
_ To build a Heathkit?
_ From a mountaintop on VHF?
_ To provide real emergency communications?
_ At giving talks about ham radio to local civic groups?
_ At talking up ham radio over local radio or TV stations?
_ Aurora DX?
_ Moonbounce?
_ 50 MHz DX?
_ On your club newsletter?
_ To write an article for a ham magazine?
_ To provide PR for your local club?
_ QRP?
_ To build a QRP rig?
_ With your club for Field Day?
_ All states in one weekend?
_ 100 countries in one weekend?
_ All continents in one hour?
_ To run a service net?
_ Over 100 Novices since getting your higher class ticket?
_ To keep up with the technology?

You get two points each, so what's your total? Mine's 84, but then I wrote the quiz, so it could be slightly biased.

"Ignorance, like alcoholism and drug dependency, tends to protect itself."

Oh yes, getting back to the gay hams, if you were in my spot, would you overrule the wiser and more conservative heads at *73* and run their classified ad? And if we open the gates to special groups, will we next be asked to run ads for other groups looking to organize such as Mensans, Irish, Polish, Lithuanians, Latvians, Estonians, Scots, Brits, Hispanics, Blacks, Catholics, Protestants, Methodists, Shiites, Hedonists, Bon Vivants, Episcopalians, Congos, Commies, Demmies, Socialists, Capitalist Pigs, Nazis, Lutherans, Mormons, Scientologists, Moonies, Lions, Kiwanians, Nerds, AMers, Scatologists, Philatelists, Numismatists, Herbologists, Philologists, UFOlogists, Occultists, Satanists, Feminists, Ecologists, Conservationists, ex-submariners, ex-cops, ex-CIA agents, ex-FBI agents, ex-Secret Service agents, ex-Mafia, XIRS agents, XT-Men...hey, this could be a major source of classified income!

I don't know if we have enough frequencies for every group to have a net. They may have to time-share. And what do we do about conflicts where a lesbian Nazi feminist wants to meet all three groups at the same time on different frequencies? Hey, don't shoot the messenger? I just want to get everyone sorted out so they can have the most fun.

By the way, I put no stock whatever in the old saw that the left-leaning of America is responsible for the fruits and nuts settling in California. Since a ham ticket is the closest thing we have to a registration card certifying us as nuts, we're not in a position to throw stones.

Psychic Communications

A recent scientific study of identical twins separated at birth and raised separately astounded the scientists, bolstering the hereditary behavior school and discouraging the environmental school.

Each time we see the results of these scientific studies we're faced with trying to explain how twins who have never met each other manage to have wives with the same names, second wives with the same names, children with the same names, dogs with the same names, smoke the same brand of cigarette, and dozens of other coincidences which are far beyond the laws of chance.

The hereditary school says ha, it's genetic. You see, a fantastic amount of our behavior is controlled by our genes. The environmental school mopes.

My own take on this is that neither should put much stock in the results of these studies. I'll bet they'll find that identical twins have a higher than average ability to psychically communicate. Don't snicker and say, "There goes Wayne again." You can put me down if it makes you feel superior, but if you ever get a chance to talk with me personally—or have the guts to write and snicker in writing—you'll find that I have done my homework.

In this case we're talking a few dozen books, who knows how many magazine articles, many scientific conferences, and so on. Perhaps you recall the early work of Dr. Rhine at Duke

University. One of his scientists was a close friend of mine—I participated in many early experiments on psi and have kept up with the research it the field ever since—some fifty years now.

Psychic communication is very well-documented. Scientists have a serious problem with it in that no repeatable experiments have yet been devised—therefore they can't accept it as real. How do you scientifically measure something which just happens now and then—seemingly at random?

My own experience, which I've probably written about before, was several years back. I was in the middle of a most upsetting emotional experience when the phone rang. It was my mother. She said she sensed something was terribly wrong. She sure was right. This was the only time in my life she ever called like that—and her call came at the very peak of my anxiety—over something she had no way of knowing about. Coincidence? Baloney!

So if my mother could sense my anxiety, how much more in communication, on whatever level this is, may identical twins be? The next question is, how can we study this mechanism and perhaps develop it? Will we someday be able to sit back in a chair, relax, and call CQ with our mind?

In the meanwhile, let's be skeptical of the scientists who attach too much importance to heredity. I do believe time will show that IQ and many personality traits are genetic, but that these are modifiable to a great degree by the environment. Having a high IQ is very much like having a higher capacity computer available than others. The operation of the system still depends much on the programming and the data acquired. Lousy programming will screw up both the computer and the data. Bad data or a lack of data will keep even the best computer from being effective.

Ignorance, like alcoholism and drug dependency, tends to protect itself. The alcoholic refuses to accept the problem. Ditto the drug addict. Ditto the ignorant. Yet none of these conditions are curable until the person is able to admit to himself there really is a problem.

It's odd about scientists. There's no stigma attached to research in the hard sciences—and we've seen constant progress: the Big Bang concept, the isolation of the strong and weak nuclear forces, the new short-range gravity force, recombined DNA, plate tectonics, ovonics, ever smaller microchips—yet we've seen dismayingly little progress in psychology, psi phenomena, understanding death, and other such soft sciences.

Education might be called a soft science. While there have been many experiments in education, there is little in the way of research, so there's no way to develop the science of education. I'd like to see a university take on the challenge of improving education. They could do this by seeking out and investigating experimental educational systems. The ones with promise should be tested further, with the results made generally available.

The one thing that might help education more than anything else would be a magazine dedicated to the science of education. This would act as a networking communications medium for those interested. It would also help newcomers to the field come up to speed on the state of the art. Thirdly, it would provide a marketing medium for entrepreneurs to start businesses offering educational systems—hardware, software, and information products. Indeed, it is almost impossible to get a new field to grow without a dedicated publication.

Nova recently did a marvelous program on the advances in Ovonics—particularly showing the new ovonic solar cell system. The inventor, Ovshinski, has been frustrated trying for years to get his inventions accepted. Obviously no one has explained to him the critical importance of publishing. If there were a dedicated publication for this new field of amorphous crystals, I believe it would quickly take off and soon be accepted.

If I'm taking your mind off more important things like Monday Night Football or holding you from getting out there for golf, apologies—I just thought you might be interested—or need something to grouse about on the air.

Well, what do you think?

Good Works

A letter from a ham in Florida who's retired and trying to live on Social Security, has serious medical problems and an equally sick wife, said he didn't have enough money to subscribe to *73*. Worse, his rig broke and he doesn't have enough money to fix it, so he was hoping maybe I could find a ham to donate a rig to him so he could get back on the air.

Judging from the average age of the ham population and the relatively low income of the average ham before retirement, there must be thousands of hams who are in similar desperate straits. I think something should be done to help these old-timers get back on the air, don't you?

One of the worst aspects of old age is the loss of friends—the loneliness. Many kids don't want to be bothered with their old parents, so it's often a terribly lonely life. Many old people can no longer see well enough to drive, so they're isolated. Ham radio is a wonderful way for these old-timers to keep in touch—to have friends.

We had one such chap who spent his declining years on the Derry (NH) .85 repeater. He was on there ten to twelve hours a day since he didn't have anything else to do. He had enormous medical problems which he shared with us 85ers. I think we all enjoyed this lonely little cantankerous old man.

There's a need, I think, for a retired ham or even a ham club to form a nonprofit Old-Timer Ham Assistance League with the purpose of finding old ham gear, making sure it's repaired and working, and getting it to unexpired hams who need it. Lord Knows we need the activity on our bands.

Tens of thousands of us have old ham gear lying around unused. So why not put it to some really good use? And, if we can get a nonprofit organization going, we'd even be able to get a tax credit for our donation! That might even do better for us than foisting it off on someone at a flea market, swap meet, or ham auction.

I'll be surprised if there aren't some groups already doing this, but doing it without a lot of fanfare. Even so, we could use more—perhaps groups in our major retirement areas where they could not only help the old hams get the gear they need to get on the air, but would be able to help them repair it when they mistune a final and blow the tubes. We'd want groups in Southern California, Arizona, Texas, and Florida, at a minimum.

Wouldn't it be wonderful if we could use this reservoir of ham experience to help hold some of our endangered bands? The lack of activity on 50, 220, 1200, 2300, and 3300 MHz could easily lose them for us in the near future. Have you any ideas on how we could get equipment built for these bands and into the hands of retired hams who have little else to do?

Bill Hoisington K1CLL, when he was in his 70s, designed many extremely simple and inexpensive-to-make rigs for these bands. If you have some old issues of *73* you can look 'em up. He showed how to make gear for the microwave bands on the kitchen table using very low cost parts.

So what do you think? Can your ham club look around for some impecunious old-timers or otherwise handicapped hams to help get on the air? They need rigs, antennas, and encouragement. ■

nel sharing and message forwarding will be tested. The satellite subband on 2 meters is already getting crowded, and the six new OSCARS will add to this congestion.

Using the UoSAT-D PCE, we will try to find efficient ways to use a single 2 meter uplink channel, rather than using several uplinks like Fuji-OSCAR-12 and the Microsats. More information on the proposed experiments can be found in "The UoSAT-D Packet Communications Experiment," by J.W. Ward, in the *Proceedings of the ARRL 7th Amateur Radio Computer Networking Conference*, Oct. 1, 1988, Columbia, MD.

A satellite requiring a new modem and special protocol software might not sound like a good deal to the cost-conscious amateur, but UoSAT-D has its advantages in the RF area.

A multi-power transmitter will provide selectable downlinks of 1, 2, 5, and 10 Watts. The medium- and high-power downlinks will reach stations with simple, non-steered antennas: crossed dipoles or even vertical whips. The uplink requirements will also be simple: 10 or 20 Watts into an omnidirectional antenna will allow messages to be stored on UoSAT-D. Of course, stations tracking OSCAR antennas will have better links, but at 9600 bits/second, it takes less than a minute to transmit a message as long as this article! Amateur radio stations with simple RF systems and advanced packet radio equipment are becoming more common, and their operators will be attracted to the PCE.

Experiments on UoSAT-D and UoSAT-E

The PCE will interest packet radio enthusiasts, but what do we have in mind for the experimenters and educators who have grown to expect scientific and engineering data from UoSATs? UoSAT-D will be devoted primarily to the PCE, but it will also carry a Cosmic Particle and Total Dose Experiment (CP/TDE) designed to measure the effects of radiation on semiconductor devices.

The CP/TDE will, for the first time, provide us with calibrated measurements of the total radiation dose received by an OSCAR satellite in polar orbit. UoSAT-E will be dedicated to experiments. A parallel-processing array built from 3 transputer microcomputers will provide data compression and image enhancement for a newly-designed CCD camera. The on-board computer will monitor the efficiency of experimental solar cells made from several new materials, and protected by different cover glasses. Low-cost sun sensors and Earth-horizon sensors designed by researchers at the University of Surrey will be used in a simple, high-precision attitude control system. Of course, data from these experiments will be available on the UHF downlinks.

The launch of the Ariane 4 rocket carrying SPOT-2, UoSAT-D, UoSAT-E and Microsats-A through -D is scheduled for later this summer. For up-to-date news of developments at UoSAT (and throughout the AMSAT community), monitor the plain-text bulletins on UoSAT-2. If you aren't yet equipped to copy the satellite, AMSAT information nets, newsletters, and packet radio BBSs are all good sources of information.

I hope that this article has encouraged you to try your hand at satellite experimentation in the Amateur Satellite Service. If you want to see firsthand what is happening at UoSAT, and hear presentations from international AMSAT builders and operators, come to the 4th annual AMSAT-UK Satellite Colloquium, which will be held July 28–30th at the University of Surrey. If you're an adventurous engineering student, consider a course in Satellites and Telecommunications at UoS. The team building UoSAT-D and -E in England includes Zeno Wahl VE3LMX, Jeff Ward K8KA, and Michael Meerman PA3BHF, who were attracted to Surrey by the lure of building OSCARs while learning! 73

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factory claims that the unit will operate over a temperature range of −30 to +130 degrees F. Our temperature chamber test indicated operation to −45 degrees F, with an improved noise figure of 0.65 dB at this temperature!

Lastly, we did a two-tone, third order intercept point measurement test. This parameter shows the ability of a device to stay linear and not act as a mixer generating undesirable signals when two strong, in-band signals are applied simultaneously to its input. We plotted the intercept point at +26 dBm, with the tones spaced at 100 kHz. The −1 dB compression point occurred at +3 dBm.

Design and Execution

A quick analysis of the Ampire 146-OS showed a dual gate GaAsFET transistor amplifier, biased in Class A design for best noise figure and linearity performance. A high quality passive postselector filter is an integral part of the unit, and follows the GaAsFET amplifier. This arrangement maintains the best possible noise figure in the amplifier. (Note: A passive preselection filter's loss, placed in front of the amplifier, would add directly in dB to the receiver noise figure.) The idea is to have particularly good dynamic range, while maintaining the lowest noise figure, in order to handle undesirable signals before they can cause odd-order intermodulation products to fall within the receiver passband. The filter reduces the out-of-band undesirable signals, and the net effect is to improve the third-order intercept point of the following receiver stages. The gain of the amplifier improves on wanted, in-band signals which are further applied to the receiver.

The tests described above indicate a relatively good trade-off between the noise figure and the intermodulation performance of the 146-OS product. On-board silicon diodes help to protect the preamplifier's input. (Another choice would have been to use an internally protected GaAsFET which would also use diodes.) During the tests we didn't note any evidence of intermodulation distortion caused by the diodes.

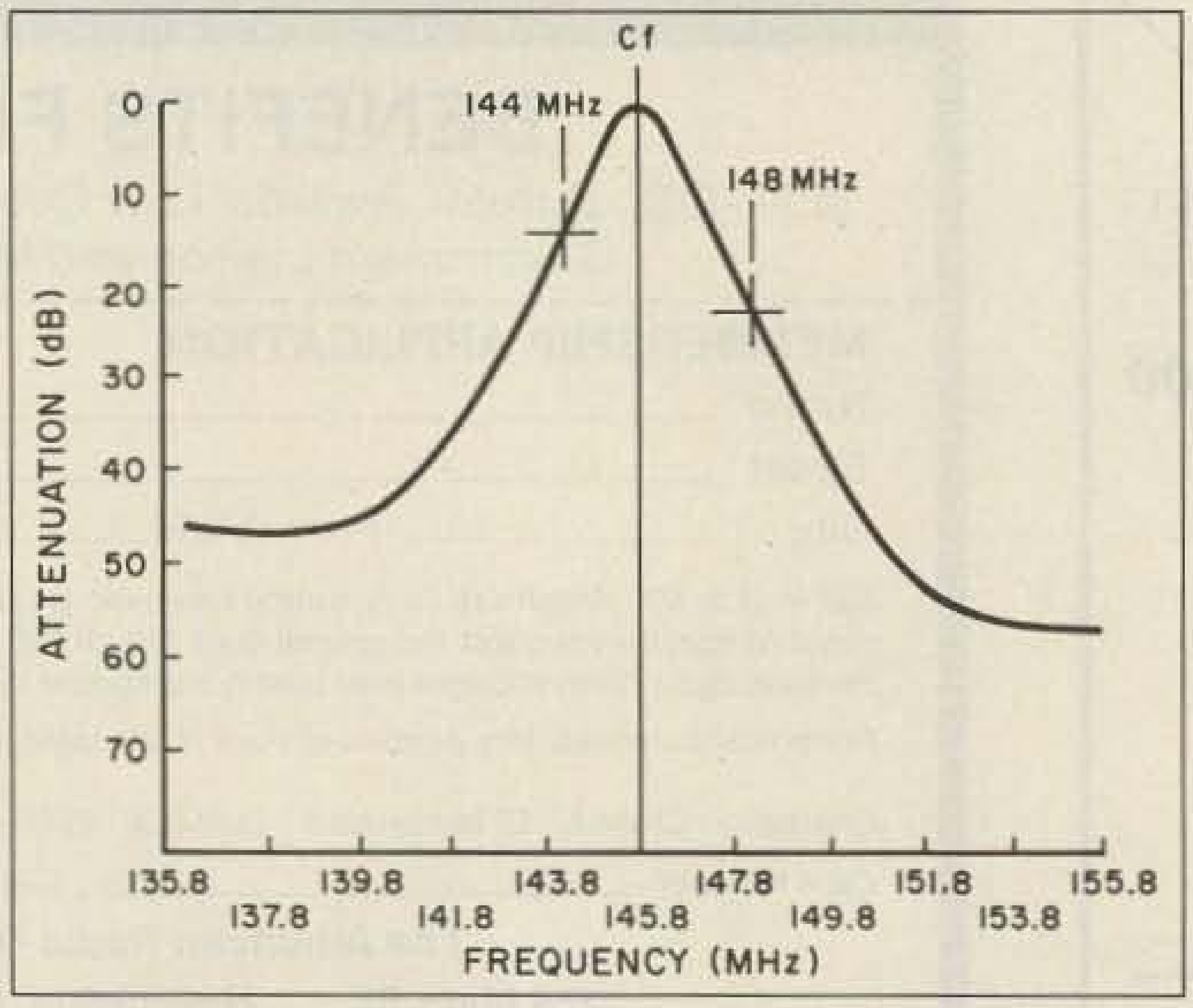

Figure 1: The Ampire 146-OS preamplifier shows good rejection of out-of-band signals.

Standard microstrip techniques on G-10 fiberglass material, using tuned quarter-wave miniature coaxial transmission lines, implement the entire circuit. This optimizes the noise figure, saves circuit board space, reduces electrical loss, and improves overall stability. Throughout the unit there are chip capacitors for decoupling.

The DC sensory circuitry is typical of this type of unit. The 146-OS is different because it uses commercial grade metal transistors instead of the more commonly found plastic equivalents. Unlike other units, the Ampire 146-OS features on-board DC regulation. Power requirements are 13 to 20 Volts at 105 milliamps. Mechanically, the unit shows a clean layout. The PC board is sprayed with a low dielectric clear compound which protects it against humidity. The unit is housed in a sealed iridited aluminum box ready for mast installation. In addition, the preamplifier comes equipped with good quality N-type connectors for reliability.

Conclusion

We tested and analyzed the Ampire 146-OS preamplifier against the manufacturer's specifications. It is our conclusion that it presents a good value for the money in applications where a quality product is required. 73

PROPAGATION

by Jim Gray W1XU

Jim Gray W1XU
PO Box 1079
Payson AZ 85541

An Overview of May

Generally, May will be a quiet month with very few really poor days for propagation on the HF bands. You can expect some good 2 and 6 meter openings this month as well.

May 12, 13, and 14 will be generally poor, as will the period between May 23 to May 27, and possibly until the 28th or 29th. The rest of the month will be Fair to Good, with propagation on the HF bands generally available on a worldwide basis from dawn until after dark, depending on the band you choose.

DX Opportunities

Ten and 15 meters will be jumping with DX opportunities, and 12 meters as well, although 12 has not been as highly populated as the other two. The new 17 meter band will be excellent from early morning until well after dark, with both transcontinental USA propagation and transoceanic propagation. Just pick your time and where you'd like to be heard.

As always, 20 meters will be the good old bread-and-butter band for DXers, with 17 meters becoming a close second, even though it has much less available bandwidth.

In case you don't know or can't remember, here are the WARC bands: 12 meters—24.890–24.930 MHz; CW—24.930–24.990 SSB; 17 meters—18.068–18.110 MHz; CW—18.110–18.168 MHz SSB; 30 meters—10.100–10.150 MHz CW (no SSB). I have not gone into other modes or power limitations here (and these vary from band to band). The WARC bands are getting a workout, and I think you'll find them all useful and fun. But don't neglect the old standbys!

Stay Informed

The WWV forecasts and current solar-terrestrial indices are, as always, available at 18 minutes past each hour on 10 MHz and 15 MHz and 5 MHz (AM). You will hear current solar flux values (the higher, the better); A index values (the lower, the better); and trends from the past 24 hours through the present, to the next 24 hours. Good hunting, and enjoy it while it's hot!

MAY

SUN	MON	TUE	WED	THU	FRI	SAT
	1 G	2 G	3 G	4 G–F	5 F	6 F
7 F–P	8 P–F	9 F–G	10 G–F	11 F–P	12 P	13 P
14 P–F	15 F–G	16 F–G	17 G	18 G	19 G	20 G
21 G–F	22 G–F	23 F–P	24 P	25 P–F	26 F	27 F–P
28 P	29 P–F	30 F	31 G			

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	15	20	–	–	–	–	–	20	–	–	–	–
ARGENTINA	15	20	20	20	40	–	–	–	15	10	10	10
AUSTRALIA	15	20	20	20	20	–	40	20	–	–	–	15
CANAL ZONE	20	20	20	20	40	–	–	15	15	10	10	10
ENGLAND	–	40	80	40	–	–	20	15	15	10	15	20
HAWAII	15	15	20	20	40	40	40	20	20	–	–	10
INDIA	–	–	–	–	–	–	–	–	–	–	–	–
JAPAN	15	20	–	–	–	–	–	20	–	–	–	–
MEXICO	20	20	20	20	40	–	–	15	15	10	10	10
PHILIPPINES	–	–	–	–	–	–	–	20	–	–	–	–
PUERTO RICO	20	20	20	20	40	–	–	15	15	10	10	10
SOUTH AFRICA	20	–	40	–	–	–	–	–	–	10	15	20
U.S.S.R.	–	40	–	–	–	–	–	20	15	20	–	–
WEST COAST	15	20	20	40/80	80	–	–	–	–	15	10	10

CENTRAL UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	15	20	20	20	–	–	40	20/40	20	–	–	–
ARGENTINA	15	15	20	20	40	40	–	–	–	–	10	10
AUSTRALIA	15	15	20	20	20	–	40/80	40/80	–	–	15	15
CANAL ZONE	10	10	20	40	40	40	–	15	15	10	10	10
ENGLAND	40	40	–	–	–	–	–	20	15	15	15	20
HAWAII	10	15	20	20	40	40	–	20	20	15/20	15	10
INDIA	–	–	–	–	–	–	20	20	–	–	–	–
JAPAN	15	20	20	20	–	–	40	20/40	20	–	–	–
MEXICO	10	10	20	40	40	40	–	15	15	10	10	10
PHILIPPINES	15	15/20	–	–	–	–	–	20	20	–	–	–
PUERTO RICO	10	10	20	40	40	40	–	15	15	10	10	10
SOUTH AFRICA	20	20	–	–	–	–	–	–	15	15	15	15
U.S.S.R.	–	–	–	–	–	–	–	20	15	15	20	–

WESTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	10	15	20	20	20	20	40	40	–	–	–	15
ARGENTINA	15	20	20	40	–	–	–	–	–	–	10	10
AUSTRALIA	10	15	20	20	20	–	40	–	20	20	–	15
CANAL ZONE	20	20	20	40	40	–	–	–	15/20	15	10	10
ENGLAND	–	–	–	–	–	–	–	–	20	20*	20*	20
HAWAII	10	15	15	40	40	40	40	40	–	20	20	20
INDIA	–	15	15/20	–	–	–	–	–	20	–	–	–
JAPAN	10	15	15	20	20	20	40	40	–	–	15	15
MEXICO	20	20	20	40	40	–	–	–	15/20	15	10	10
PHILIPPINES	15	15	20	20	20	–	–	–	20	15/20	15/20	15
PUERTO RICO	20	20	20	40	40	–	–	–	15/20	15	10	10
SOUTH AFRICA	20	20	–	–	–	–	–	–	–	–	15	20
U.S.S.R.	–	–	–	–	–	–	–	–	20	–	–	–
EAST COAST	15	20	20	40/80	80	–	–	–	–	15	10	10

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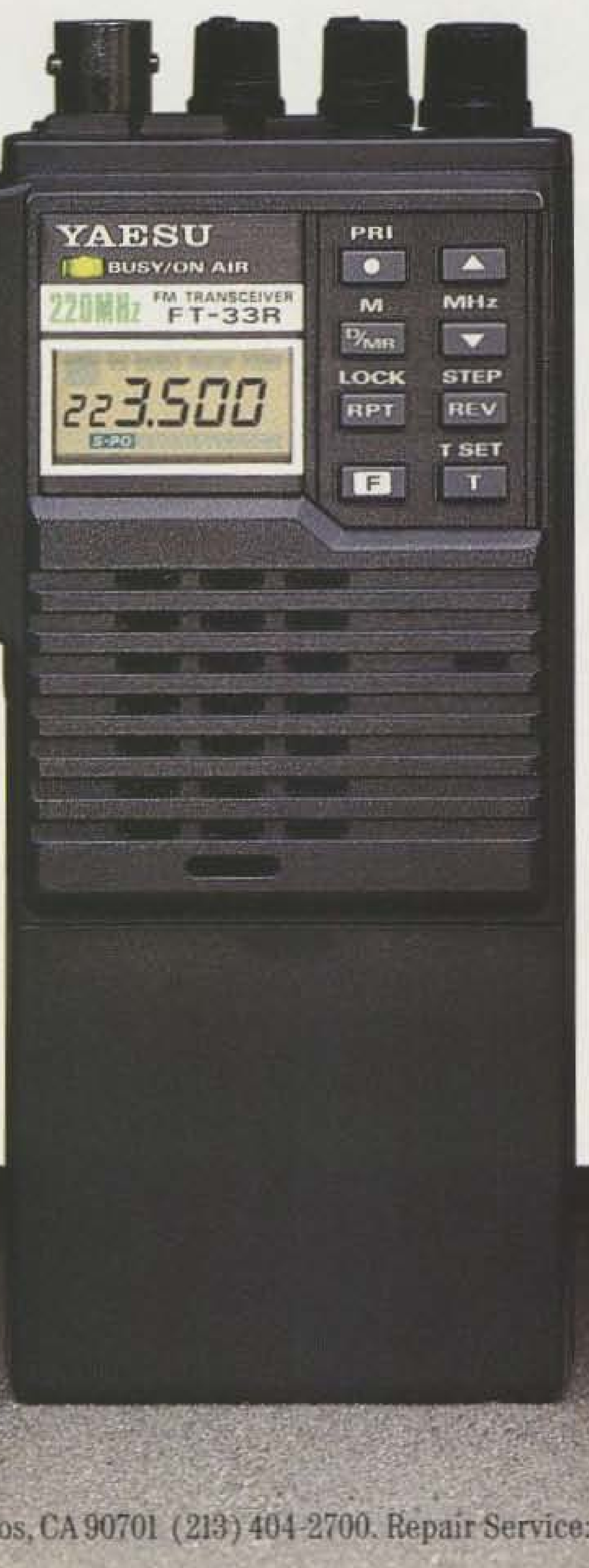

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TS-790A
Satellite Transceiver

The new Kenwood TS-790A VHF/UHF all-mode tri-band transceiver is designed for the VHF/UHF and satellite "power user." The new TS-790A is an all-mode 144/450/1200 MHz transceiver with many special enhancements such as Doppler shift compensation. Other features include dual receive, automatic mode selection, automatic repeater offset selection for FM repeater use, VFO or quick step channel tuning, direct keyboard frequency entry, 59 memory channels (10 channels for separate receive and transmit frequency storage), multiple scanning and multiple scan stop modes. The Automatic Lock Tuning (ALT) on 1200 MHz eliminates frequency drift. Power output is 45 watts on 144 MHz, 40 watts on 450 MHz, and 10 watts on 1200 MHz. (The 1200 MHz section is an optional module.)

- **High stability VFO.** The dual digital VFOs feature rock-stable TCXO (temperature compensated crystal oscillator) circuitry, with frequency stability of ±3 ppm.
- **Operates on 13.8 VDC.** Perfect for mountain-top DXpeditions!
- **The mode switches confirm USB, LSB, CW, or FM selection with Morse Code.**
- **Dual Watch allows reception of two bands at the same time.**
- **Automatic mode and automatic repeater offset selection.**
- **Direct keyboard frequency entry.**
- **59 multi-function memory channels.** Store frequency, mode, tone information, offset, and quick step function. Ten memory channels for "odd split."
- **CTCSS encoder built-in.** Optional TSU-5 enables sub-tone decode.
- **Memory scroll function.** This feature allows you to check memory contents without changing the VFO frequency.
- **Multiple scanning functions.** Memory channel lock-out is also provided.
- **ALT—Automatic Lock Tuning—on 1200 MHz eliminates drift!**
- **500 Hz CW filter built-in.**
- **Packet radio terminal.**
- **Interference reduction controls:** 10 dB RF attenuator on 2m, noise blanker, IF shift, selectable AGC, all mode squelch.
- **Other useful controls:** RF power output control, speech processor, dual muting, frequency lock switch, RIT.
- **Voice synthesizer option.**
- **Computer control option.**

Optional Accessories:

• **PS-31** Power supply • **SP-31** External speaker • **UT-10** 1200 MHz module • **VS-2** Voice synthesizer unit • **TSU-5** Programmable CTCSS decoder • **IF-232C** Computer interface • **MC-60A/MC-80/MC-85** Desk mics • **HS-5/HS-6** Headphones • **MC-43S** Hand mic • **PG-2S** Extra DC cable

Complete service manuals are available for all Kenwood transceivers and most accessories.
Specifications, features, and prices are subject to change without notice or obligation.

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