November 2001
ISSUE #492
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CANADA $4.95

73® Amateur Radio Today

Special HAMSATS *Issue*

Alinco's New HTs
Fun, Fantastic and Affordable!

Check out the new DJ-596 dual bander or the DJ-196/496 monoband units. No matter which you choose, you'll get a transceiver that's rugged, easy to program and built for years of dependable operation. You expect more value from Alinco and we deliver!

DJ-596T VHF/UHF Dual-band HT NEW!

Loaded with features! ***The breakthrough design supports optional digital voice communications and you can easily switch the unit between analog and digital modes!***

- Full 4.5 watts output VHF/4w UHF
- Powerful NiMH battery
- 100 memories in any combination of VHF or UHF channels
- Direct frequency input from keypad
- Each memory capable of "odd split" operation.
- Alphanumeric channel labels
- CTCSS and DCS encode+decode plus tone bursts
- Full 2m and 440 band coverage
- Accepts 6 ~ 16 VDC direct input
- Three scan modes
- Illuminated keys and display
- Wide and narrow FM modes
- 10 autodial memories
- Theft alarm feature
- Optional EJ-40U Digital Voice Board!*

DJ-196T (2m) and DJ-496T (440 MHz)

These sturdy, full-featured monobanders are priced low and ready to go!

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- Long-lasting NiMH battery
- 40 memory channels
- Keypad frequency input
- CTCSS and DCS encode+decode
- Alphanumeric display
- 13.8 VDC direct input
- Wide and narrow FM modes
- Illuminated keys and display
- Autodial memories
- S-meter
- DJ-196 TX 144 ~ 148MHz; RX 135 ~ 174 MHz
- DJ-496 TX 430 ~ 450 MHz RX 430 ~ 450 MHz

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Great Accessories for Alinco and other radios!

Iron Horse antennas and accessories extend the use of your transceivers and scanners. BNC connections make it easy to take your HT mobile for BIG signals in and out!

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BNC connectors, window mount, sets up in just seconds!

IHMM270 Compact VHF/UHF Magnetic Mount Antenna

BNC connector, 9 feet of RG-174 cable and a powerful magnet. Less than 20 inches high, SWR less than 1.5:1 throughout either band. Max power: 50w/VHF; 25w UHF.

IHC 20 glass suction-cup mount

Extension BNC suction mount keeps your antenna inside but against the glass for a true "window on the world." For mobile or base use, includes 6 feet of RG-58U cable.

IHMM3 Magnetic Scanner Antenna

BNC connector, just 13.5 inches high. Powerful rare-earth magnet, 9 feet of RG-174 cable. Receives 100 ~ 1200 MHz, can transmit on 2m, 70cm and SMR frequencies.

www.ALINCO.com

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Specifications subject to change without notice or obligation.

***Digital communications require at least two similarly equipped transceivers.**

Digital mode is compatible with Alinco DR-135/235/435T mobile transceivers equipped with EJ-43U digital communications board.

Digital mode may not be legal in some countries. See FAQ on digital at www.alinco.com.

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NOVEMBER 2001
ISSUE #492

THE NEW!
73 Amateur Radio Today

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FEATURES

DEPARTMENTS

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COVER: The Space Shuttle *Atlantis* carried the first amateur radio equipment to the International Space Station during the STS-106 mission in September 2000. This was a major milestone for the ARISS (Amateur Radio in the Space Station) program. Photo courtesy of W5ACM.

QRX . . .

Terrorists Strike; Hams Ready

Amateur radio took to the airwaves to provide assistance in the wake of apparent terrorist attacks in New York City and Washington DC the morning of September 11th. More than 300 died in the four hijacked airliner crashes. The number of dead and injured on the ground is still being assessed. Amateur Radio *Newsline*'s Henry Feinberg K2SSQ, was near the scene and had this report:

Continued on page 6

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SS-10	7	10	1⅛ x 6 x 9	3.2
SS-12	10	12	1⅜ x 6 x 9	3.4
SS-18	15	18	1⅜ x 6 x 9	3.6
SS-25	20	25	2⅞ x 7 x 9⅜	4.2
SS-30	25	30	3¾ x 7 x 9⅝	5.0

MODEL SS-25M

DESKTOP SWITCHING POWER SUPPLIES WITH VOLT AND AMP METERS

MODEL	CONT. (Amps)	ICS	SIZE (inches)	Wt.(lbs.)
SS-25M*	20	25	2⅞ x 7 x 9⅜	4.2
SS-30M*	25	30	3¾ x 7 x 9⅝	5.0

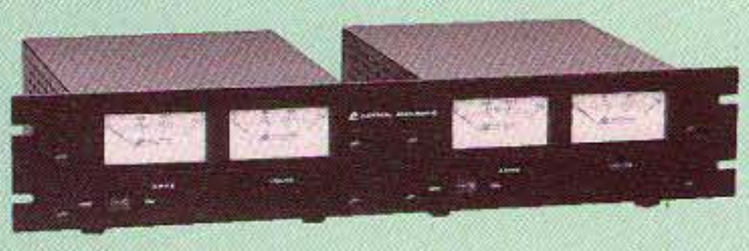
MODEL SRM-30

RACKMOUNT SWITCHING POWER SUPPLIES

MODEL	CONT. (Amps)	ICS	SIZE (inches)	Wt.(lbs.)
SRM-25	20	25	3½ x 19 x 9⅜	6.5
SRM-30	25	30	3½ x 19 x 9⅝	7.0

WITH SEPARATE VOLT & AMP METERS

MODEL	CONT. (Amps)	ICS	SIZE (inches)	Wt.(lbs.)
SRM-25M	20	25	3½ x 19 x 9⅜	6.5
SRM-30M	25	30	3½ x 19 x 9⅝	7.0



MODEL SRM-30M-2

2 ea SWITCHING POWER SUPPLIES ON ONE RACK PANEL

MODEL	CONT. (Amps)	ICS	SIZE (inches)	Wt.(lbs.)
SRM-25-2	20	25	3½ x 19 x 9⅜	10.5
SRM-30-2	25	30	3½ x 19 x 9⅝	11.0

WITH SEPARATE VOLT & AMP METERS

MODEL	CONT. (Amps)	ICS	SIZE (inches)	Wt.(lbs.)
SRM-25M-2	20	25	3½ x 19 x 9⅜	10.5
SRM-30M-2	25	30	3½ x 19 x 9⅝	11.0

MODEL SS-12SM/GTX

MODEL SS-10EFJ-98

CUSTOM POWER SUPPLIES FOR RADIOS BELOW

EF JOHNSON AVENGER GX-MC41
EF JOHNSON AVENGER GX-MC42
EF JOHNSON GT-ML81
EF JOHNSON GT-ML83
EF JOHNSON 9800 SERIES
GE MARC SERIES
GE MONOGRAM SERIES & MAXON SM-4000 SERIES
ICOM IC-F11020 & IC-F2020
KENWOOD TK760, 762, 840, 860, 940, 941
KENWOOD TK760H, 762H
MOTOROLA LOW POWER SM50, SM120, & GTX
MOTOROLA HIGH POWER SM50, SM120, & GTX
MOTOROLA RADIUS & GM 300
MOTOROLA RADIUS & GM 300
MOTOROLA RADIUS & GM 300
UNIDEN SMH1525, SMU4525
VERTEX — FTL-1011, FT-1011, FT-2011, FT-7011

NEW SWITCHING MODELS

SS-10GX, SS-12GX
SS-18GX
SS-12EFJ
SS-18EFJ
SS-10-EFJ-98, SS-12-EFJ-98, SS-18-EFJ-98
SS-12MC
SS-10MG, SS-12MG
SS-101F, SS-121F
SS-10TK
SS-12TK OR SS-18TK
SS-10SM/GTX
SS-10SM/GTX, SS-12SM/GTX, SS-18SM/GTX
SS-10RA
SS-12RA
SS-18RA
SS-10SMU, SS-12SMU, SS-18SMU
SS-10V, SS-12V, SS-18V

*ICS – Intermittent Communication Service

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SYNTHESIZED FM STEREO RADIO STATION

- Synthesized 88 to 108...no drift !
- Built in mixer – 2 line inputs and one microphone input!
- High power module available for export use
- Low pass filter for great audio

Our FM100 is used all over the world by serious hobbyists as well as churches, drive in theaters, and schools. The kit includes metal case, whip antenna and built-in 110 volt AC power supply.

FM100	**Super-Pro FM Stereo Radio Station Kit**	**$249.95**
FM100WT	**1 Watt, Wired Export Version**	**$399.95**

SYNTHESIZED FM STEREO TRANSMITTER

Professional quality rock stable synthesized transmitter. Dip switch settable for any frequency between 88-108 MHz. Strappable for high power output for export applications. Our most popular kit. Start your own radio station today with the FM25!

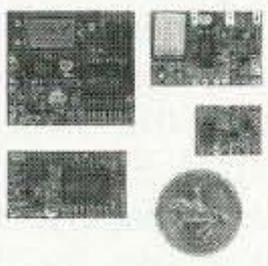
FM25	**Synthesized FM Stereo Transmitter Kit**	**$129.95**

FM STEREO TRANSMITTER

Great entry level FM broadcast kit. Thousands in use. Handy for sending music through house and yard, ideal for school projects too – you'll be amazed at the exceptional audio quality! Runs on 9V battery or 5 to 15 VDC. Add matching case and whip antenna set for great pro look.

FM10A	**Tunable FM Stereo Transmitter Kit**	**$34.95**
CFM	**Matching Case and Antenna Set**	**$14.95**
FMAC	**12V DC Wall Plug Adapter**	**$9.95**

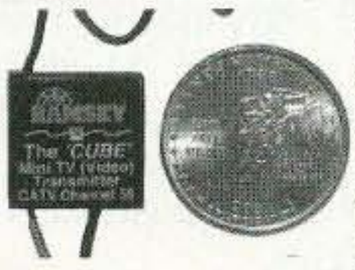
RF WIRELESS LINK MODULES



- SAW Resonators for high stabillty – NO Drift!
- Powerful +10 dbm output
- Range up to 600'
- 433 MHz license-free band
- Sensitive superhet receiver with RF LNA
- Stable over full 3–12 VDC range
- Optional on-board 12 bit encoder/decoder using Holtek HT12 series chips, Quarter not included!

RXD433	**433 MHz Receiver/Decoder Mod., Assembled**	**$26.95**
TXE433	**433 MHz Transmitter/Encoder Mod., Assembled**	**$24.95**
RX433	**433 MHz Data Receiver Mod., Assembled**	**$21.95**
TX433	**433 MHz Data Transmitter Mod., Assembled**	**$19.95**

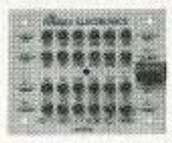
THE CUBES! MINIATURE VIDEO TRANSMITTERS



Wireless crystal clear reception, yet smaller than a quarter! Transmits color or B&W with fantastic quality almost like a hard wire connection to any TV or VCR tuned to cable channel 59. Crystal controlled for no frequency drift with performance that equals law enforcement models that cost hundreds more! Basic 20mW unit goes up to 300' while the high power version can virtually double that range! Fully assembled and tested, and ready to go. Powered by a standard 9V battery. Name that Quarter!

C2000	**Video Cube, Factory Assembled & Tested**	**$89.95**
C2001	**High Power Version, Assembled & Tested**	**$129.95**

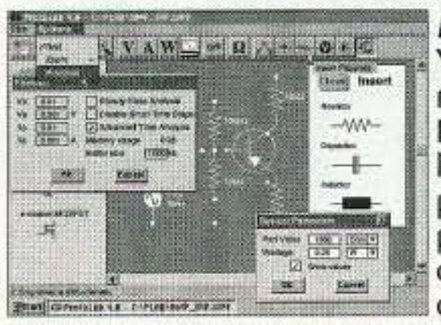
INFRA-RED VIDEO CAMERA ILLUMINATOR



Lets video cameras "see in the dark". Invisible light source to us, but lots of light to CCD B&W cameras! Illuminates the area just like light, yet cannot be seen. Draws 180mA at 12 VDC. 110VAC power adapter available.

IR1	**Infra-Red Camera Illuminator Kit**	**$24.95**
AC125	**12VDC Power Supply**	**$9.95**

ELECTRONIC PROTOTYPING SOFTWARE



Priced for the hobbyist!
You can create and test AC and DC circuits minutes after installing this package on your PC. Start from scratch, or from the included library of pre-designed circuits. Drag and drop placement from a complete list of active and passive components. Test using a complete list of virtual instruments, Oscilloscope, voltmeter, ohmmeter, ammeter, and watt meter.

PLAB4	**Electronic Prototype Software, Win95/98**	**$49.95**

ANALOG-DIGITAL PORTABLE LAB STATION

The COMPLETE analog-digital lab station in one. Includes function generator, clock output, power supplies, level switches, pulsers, pots, LEDs and a LARGE breadboarding area all in one! Includes a custom molded case as shown. Used through the world at universities, technical schools, and R&D labs. Available in "Learn as you Build" kit form or factory assembled and tested. A great buy either way!

ML200	**Lab Station, Kit**	**$155.95**
ML200WT	**Lab Station, Factory Assembled & Tested**	**$225.95**

CABLE WIZARD CABLE TRACER

Did you ever have to identify the "other end of that cable"? No more "ohming it out" with the Cable Wizard. Simply connect the wizard transmitter to one end of the cable and use the receiver to sniff out the other end. It's as simple as that! The transmitter sends a pulsating 2 KHz signal down the cable which is heard when the receiver is close to the cable. Works with any cable including coax, telephone pairs, ethernet and more. Equipped with an RJ45 for all telco connections and clip leads for single wire connections.

WCT20	**Wireless Cable Tracer Kit**	**$39.95**
CWCT	**Matching Case Set for Transmitter & Receiver**	**$29.95**
WCT20WT	**Factory Assembled & Tested WCT20**	**$99.95**

SPEEDY PERSONAL SPEED RADAR GUN

This low cost microwave radar uses the same principle found in police units costing thousands more. This has been the number one Science Fair project for years. Direct digital readout in miles/hour, kilometers/hour, or feet/second. An earphone jack allows you to actually hear the Doppler frequency shift of moving objects. Our detailed manual not only guides you through constuction, but covers the how's and why's of speed radar theory. Learn while you build. Uses two 13 oz coffee cans for the antenna (not included, so start drinking!) and runs on 12 VDC.

SG7	**Speedy Personal Speed Radar Kit**	**$99.95**
AC125	**12VDC Power Supply**	**$9.95**

AND...OUR FAMOUS *MINI-KITS*

These are easy to build kits that can be used either stand alone or as building blocks for more complex projects.

TS4	**Tickle-Stick Shocker**	**$9.95**
BN9	**Super Snoop Amplifier Kit**	**$8.95**
BL1	**LED Blinky Kit**	**$3.95**
TD1	**Tone Encoder/Decoder Kit**	**$6.95**
TT7	**Touch Tone Decoder Kit**	**$29.95**
CPO3	**Code Practice Oscillator Kit**	**$9.95**
UT5	**Universal Timer Kit**	**$8.95**

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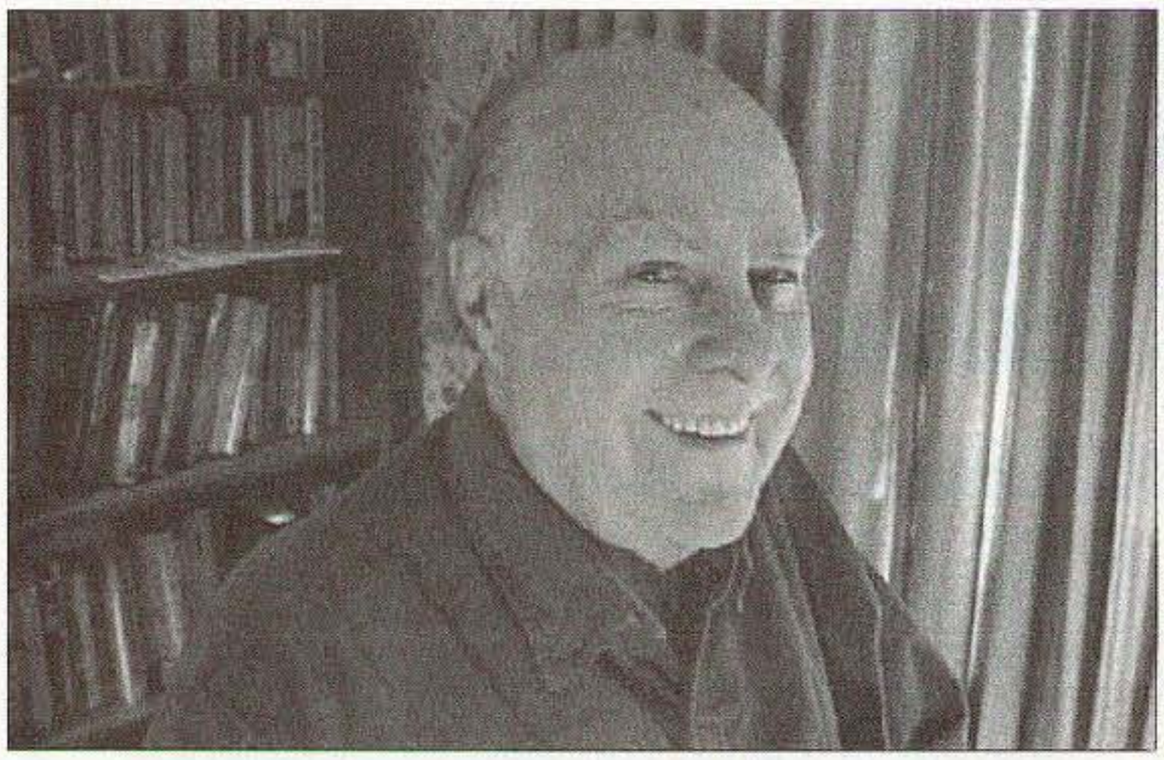

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A Call to Arms

Since it is unlikely that bin Laden had only one trick up his sleeve, I'm waiting to see what he has planned for us next. The hijacked kamikaze plane idea was right out of a Tom Clancy novel. It was a surefire attention-getter that required nothing more than a handful of his dedicated followers. No aircraft carriers, no missiles, not even a single gun.

Not that the expense of buying a few of those missing Russian suitcase-size nukes or the anthrax brewing and drying equipment would even make him blink. When the illegal drug industry is able to import hundreds of tons of their product every year, bringing in a few tons of high-tech explosives and some nukes is as easy as it was to hijack those planes. Add to that nasty mix a bunch of fiendish ways to wreck havoc on us that we haven't thought of yet.

We have three Arab groups that are upset with America — the Palestinians, the Iraqis, and the radical Moslems — and all with very good reason. All have billions of dollars available and millions of people to draw upon. So, have we seen the end of the "war"? Not bloody likely.

This war has the potential to strike America anywhere. By surprise at any time.

As we've seen in every serious emergency, one of the first parts of our infrastructure to fail is communications. Phones and cell phones go out. Police, fire, ambulance, and other emergency service repeaters go out, along with power.

The Challenge

We've been having a lot of fun with our repeaters and working DX, but we've let most of our old emergency systems fall apart. I challenge every ham club in America to not sit around and wait for another wake-up call, but to get busy right now in building a local emergency network. Make sure your repeater has emergency power. Have a spare portable repeater available. Heck, even back-to-back HTs can do the job.

I'd like to see every club outfit a van or small truck as an emergency communications headquarters — able to operate on any ham band, and interface with all of the other local mobile services. When there's a major emergency, it's often the hams who enable the fire, police, sheriff, ambulance, doctors, and other mobile services to keep in contact with each other.

Let's see that every ham has an HT handy 24/7. And has practice in using it with emergency drills.

Yes, of course I want to get reports on what your club has done and is doing to be ready for what well may come. Send me pictures of your mobile units.

This could be the first war where hams not only aren't thrown off the air, but will be needed as a basic communications resource. Heck, we're everywhere and we serve at our own expense and without pay.

We're going to need decals for our car windows and patches for our jackets to let the public know that we're providing a volunteer emergency communications service. Let's see what you can come up with for a design, and I'll make 'em available.

Toldja So

Okay, all you guys who have been snickering about gloom and doom Wayne for writing about the coming terrorist attacks on America. Are there really a hundred Iraqi eleven-person cells around the country making large batches of anthrax? The equipment needed is simple, relatively inexpensive, and easily purchased. Like those manure-made bombs. Duncan Long's 1998 Bioterrorism large-size inch-thick book is overpriced ($79), but it's packed with the grim details on germ warfare (anthrax, bubonic plague, smallpox, etc.) and sources of protective clothes and masks.

One of the FBI agents who managed to infiltrate one of the cells reported that their goal was to kill over 250 million Americans within a few days. The bad part is that their plan is doable.

Senators Hillary Clinton and Warren Rudman both brought up in TV interviews the potential for us to experience nuclear, chemical, and germ terrorism, so it isn't just old, crazy, conspiracy-theory, gloom and doom Wayne with this message.

For a fraction of the cost of one fighter jet, a terrorist attack could kill a couple hundred million Americans.

Cities

I've been recommending that people get the heck out of our major cities for years. Now a few million people are going to think more seriously about it. Cities are sitting ducks for nukes, bombs, and germ attacks. They're also a lot more stressful for daily life. I lived in New York City (well, the Borough of Brooklyn) for 30 years, off and on — mostly on. My folks moved there in 1933 when Tommy Luddington and Amelia Earhart sold Luddington Airlines to Eastern Air Transport. My dad had been the passenger and cargo manager of the airline and was suddenly out of work, right in the middle of the Depression.

So we moved in with my mother's folks in Brooklyn and dad got busy starting a new airline using flying boats between downtown Boston and downtown Manhattan. EAT and TWA invested in Marine Airlines as a way to bring Boston customers to their flights.

Then Pan American's Juan Trippe, worried over the starting of another flying boat airline, got his good buddy President Roosevelt to issue a Presidential Order saying that no airline could invest in another airline. Poof! There went Marine Airlines.

Dad then went to American Export Lines, America's largest steamship line, and convinced them that vacationers

Continued on page 7

Big Savings on Radio Scanners

Uniden® SCANNERS

NEW!

Bearcat® 780XLT Trunk Tracker III

Mfg. suggested list price $529.95

Less -$190 Instant Rebate / Special $339.95

500 Channels • 10 banks • CTCSS/DCS • S Meter

Size: 7^5/8" Wide x 6^15/16" Deep x 2^13/16" High

Frequency Coverage: 25.0000-512.0000 MHz., 806.000-823.9875MHz., 849.0125-868.9875 MHz., 894.0125-1300.000 MHz.

The Bearcat 780XLT has 500 channels and the widest frequency coverage of any Bearcat scanner ever. Packed with features such as Trunktracker III to cover EDACS, Motorola and EF Johnson systems, control channel only mode to allow you to automatically trunk certain systems by simply programming the control channel, S.A.M.E. weather alert, full-frequency display & backlit controls, built-in CTCSS/DCS to assign analog and digital subaudible tone codes to a specific frequency in memory, PC Control with RS232 port, Beep Alert, Record function, VFO control, menu-driven design, total channel control and much more. Our CEI package deal includes telescopic antenna, AC adapter, cigarette ligher cord, DC cord, mobile mounting bracket with screws, owner's manual, trunking frequency guide and one-year limited Uniden factory warranty. For maximum scanning enjoyment, order magnetic mount antenna part number ANTMMBNC for $29.95; The BC780XLT comes with AC adapter, telescopic antenna, owner's manual and one year limited Uniden warranty. Not compatible with AGEIS, ASTRO or ESAS systems. For fastest delivery, order on-line at www.usascan.com.

Bearcat® 895XLT Trunk Tracker

Mfg. suggested list price $499.95

Less -$320 Instant Rebate / Special $179.95

300 Channels • 10 banks • Built-in CTCSS • S Meter

Size: 10^1/2" Wide x 7^1/2" Deep x 3^3/8" High

Frequency Coverage: 29.000-54.000 MHz., 108.000-174 MHz., 216.000-512.000 MHz., 806.000-823.995 MHz., 849.0125-868.995 MHz., 894.0125-956.000 MHz.

The Bearcat 895XLT is superb for intercepting trunked communications transmissions with features like TurboScan™ to search VHF channels at 100 steps per second. This base and mobile scanner is also ideal for intelligence professionals because it has a Signal Strength Meter, RS232C Port to allow computer-control of your scanner via optional hardware and 30 trunking channel indicator annunciators to show you real-time trunking activity for an entire trunking system. Other features include Auto Store - Automatically stores all active frequencies within the specified bank(s). Auto Recording - Lets you record channel activity from the scanner onto a tape recorder. CTCSS Tone Board (Continuous Tone Control Squelch System) allows the squelch to be broken during scanning only when a correct CTCSS tone is received. For maximum scanning enjoyment, order the following optional accessories: PS001 Cigarette lighter power cord for temporary operation from your vehicle's cigarette lighter $14.95; PS002 DC power cord - enables permanent operation from your vehicle's fuse box $14.95; MB001 Mobile mounting bracket $14.95; EX711 External speaker with mounting bracket & 10 feet of cable with plug attached $19.95. The BC895XLT comes with AC adapter, telescopic antenna, owner's manual and one year limited Uniden warranty. Not compatible with AGEIS, ASTRO, EDACS, ESAS or LTR systems.

Bearcat® 245XLT Trunk Tracker II

Mfg. suggested list price $429.95/**CEI price $189.95**

300 Channels • 10 banks • Trunk Scan and Scan Lists
Trunk Lockout • Trunk Delay • Cloning Capability
10 Priority Channels • Programmed Service Search
Size: 2^1/2" Wide x 1^3/4" Deep x 6" High

Frequency Coverage:
29.000-54,000 MHz., 108-174 MHz., 406-512 MHz., 806-823.995 MHz., 849.0125-868.995 MHz., 894.0125-956.000 MHz.

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QRX . . .

continued from page 1

"The city remains completely shut down. No access to any bridges, tunnels or subways. F-16 aircraft are flying very noticeably in New York airspace — patrolling. We are literally under military and federal control and the governor has mobilized the National Guard."

Those were the words of one New York area ham familiar with emergency communications. He was describing by E-mail the situation late in the morning of Tuesday September 11th after what are believed to be terrorist-launched attacks against New York City and Washington DC.

Almost immediately after the apparently coordinated assaults, President George W. Bush announced that the US military was put on high alert here in the United States as well as abroad. At about the same time the Department of Transportation issued a nationwide notice closing off all domestic air traffic.

The FCC did not issue an emergency declaration or other special instructions to the amateur radio community, but the American Radio Relay League asked amateurs to stay alert to instructions from local authorities. And the ARRL said that hams WERE ready to assist in any way that they could.

In the Metro New York area, some ARES and RACES organizations opened emergency nets in response to the disaster. According to ARRL Section Emergency Coordinator Tom Carrubba KA2D, a net was set up on the WB2ZSE repeater with Guy Richman KC2AYG as its control station. The net handled emergency traffic and provided hams to shadow some New York City officials. Meantime, Kenneth Goetz N2SQW reported that New York State RACES nets were operational on 7.248 MHz and 3.993 MHz. Both nets handled emergency and government-related traffic.

In the Washington area, Maryland and DC Section Emergency Coordinator Mike Carr WA1QAA told the ARRL that RACES groups were activated in Montgomery County and put on standby in Howard County. Montgomery County Deputy Radio Officer John Creel WB3GXW reported that that county's RACES team was activated and under full tactical alert. Also, Virginia SEC Tom Gregory N4NW asked everyone to monitor the emergency frequencies and to keep a full tank of gas. The Old Dominion Emergency and Virginia Emergency nets were said to have been active.

At times like this, one group the nation always turns to is the Salvation Army. That organization reported that its Salvation Army Team Emergency Radio Network activated its high frequency net on 14.265 MHz. SATERN also handled health-and-welfare inquiries sent in via its Web site.

Meantime, the FCC's Riley Hollingsworth suggested that the amateur community remain calm but to be ready. He also recommended that amateurs monitoring any suspicious communications tape them and contact him. Hollingsworth says that he will relay relevant information to the FCC duty team.

One question on the minds of many hams is what will happen to the hobby if our government declares war in retaliation for this terrorist act. The American Radio Relay League advises that should a state of war be declared, amateur radio would not automatically be shut down. The League says that this requirement was eliminated prior to the Gulf War.

The September 11th attack also took most broadcast television off the air as well. Also destroyed were several radio station transmitters and a few amateur repeaters. And now its been learned that there was a human loss for ham radio as well.

The *ARRL Letter* reports that at least four Amateur Radio operators are among the many still missing in the aftermath of the attack. They include Steve Jacobson N2SJ, age 53, of New York City. Jacobson worked as a transmitter engineer for WPIX channel 11. Also, on transmitter duty at the time of the attack was Bill Steckman WA2ACW of West Hempstead out on Long Island. He is employed by WNBC channel 4 and is well known in the area for a number of repeaters he operated from the World Trade Center. Most notable among them a 434 MHz ATV system.

Another missing ham is Robert D. Cirri, Sr., KA2OTD, of Nutley, New Jersey. Cirri is a Port Authority police officer and the ARRL District Emergency Coordinator for Hudson County. He was last seen helping to evacuate workers from one of the buildings when it collapsed.

Also: Michael G. Jacobs AA1GO of Danbury, Connecticut, who works at Fiduciary Trust Company International, which had offices in the World Trade Center. He too has not been seen since the twin towers collapsed.

So sadly, we may learn of more.

As to over-the-air television in the New York City metro area, Bob Gonsett's *CGC Communicator* newsletter reported that only WCBS channel 2 was on with any really wide coverage signal. Unlike all other broadcasters that made the move to the World Trade tower back in the 1970s, WCBS decided to maintain its longtime transmitter site on the Empire State Building as an offsite back-up. When everyone was put off the air by the World Trade Center collapse, WCBS switched over to its Empire State Building site. It immediately became the lifeline of information to a city that needed to know what was happening.

Meanwhile, other broadcasters were scurrying to find and transport new or used transmitters to the Empire State Building where some still have their old antennas and feeder lines on the Empire Tower. WCBS offered assistance and space to help the stations get back on the air from the Empire State Building site. Both Canadian transmitter supplier Larcan and American manufacturer Gates had high-power VHF transmitters available and were reportedly shipping same.

Out west, because three of the four involved aircraft in this attack had Los Angeles as their destination, both the LAPD and the Los Angeles County Sheriff's Department went on tactical alert the morning of Tuesday the 11th. This activated the EOCs, the Emergency Operation Centers, and therefore the LA County version of RACES, the DCS or Disaster Communications Service, swung into action.

There's a multiband amateur radio station set up in or near the EOC in each of about 25 sheriff's stations around the LA area. There are also stations set up at major industrial facilities, such as NASA's Jet Propulsion Laboratory in Pasadena. These stations work with the EOCs in coordinating traffic with other county and city agencies, hospitals, and the Red Cross. All stations were up shortly, with almost 100 hams also checking in from field locations.

Back in Washington, the FCC headquarters at the Portals in southwest Washington was temporarily evacuated Monday morning, September 17th. This, after an unidentified package was discovered and checked out. According to the *CGC Communicator*, the incident occurred at about 10:15 a.m. eastern time. FCC spokesman David Fisk says that the employees were evacuated as a cautionary measure. About 10 minutes later an all-clear signal was given and employees were allowed back into the building.

Support for the people of the United States is coming from every corner of the world including the nations of the Middle East. And now one nation's society in that region has gone a step further.

Effective September 15th the Kuwait Amateur Radio Society, in conjunction with the Kuwait Ministry of Communications, authorized the use of the callsign 9K2USA. According to Bob Furzer K4CY, who is in Kuwait and licensed as 9K2ZZ, all ham operators in Kuwait would be using the 9K2USA call on all bands, on all modes simultaneously through the end of September. This, says Furzer, as a small token of the sympathy and support for the people of the United States from the people of Kuwait.

From Australia came more outreach, the words of Wireless Institute of Australia Federal President Earnest Hocking VK1LK, sent to all of us via ARRL President Jim Haynie W5JBP as Hocking expressed his feelings on the terrorist attack against our nation:

"It was with great sadness that I heard the news of the attack on New York, the Pentagon, and other U.S. sites. As many have already said words simply fail us at times such as this.

"As the representative of the amateur radio community in Australia, I believe that I speak for all radio amateurs when I extend my condolences and thoughts to all of the victims and their relatives of this attack. I have no doubt that many American amateurs and their families have been directly affected by this cowardly act of terrorism, and I would like to express my personnel feelings of sadness to these members of the amateur radio community.

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NEVER SAY DIE

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would eventually be flying to Europe and that they'd better get involved. Thus started American Export Airlines and its transatlantic service — which lasted through WWII, until Juan Trippe got Roosevelt to issue an Executive Order saying that no steamship line could own an airline. Pan American bought the airline for peanuts.

By the way, the comparisons of the World Trade Center attack to Pearl Harbor are baloney. As I wrote recently, Robert Stinnett published the documents in his *Day of Deceit* that nailed Roosevelt for having intentionally forced the Japanese into attacking us in order to get us into the European war. He knew exactly where the Japanese carrier fleet was, and their target. He replaced the smart general and admiral at Pearl with incompetents and then kept all information on what was going to happen from them. He also arranged for our carriers to be away, leaving some old and no longer needed battleships to be targeted. At the cost of only about 5,000 lives, Roosevelt got the American public to clamor to go to war.

Anyway, getting back to cities. Any place there are millions of people all in one small area makes a great enemy target. Two hijacked airliners were able to kill thousands of Americans. Imagine what spraying some anthrax from the Empire State Building and around the airports and subways could do!

And the first thing the authorities did was close all bridges and tunnels and shut down the subways, making it so that New Yorkers were completely trapped. That's okay for a day, but a city without power, water, and food would soon be a death trap for millions. No city has a highway system that would let more than a few thousand people escape, even if the authorities left them open, which is most unlikely. They would be commandeered for emergency traffic.

My advice? Do as I did and move to the sticks somewhere. Stay away from people concentrations like those towers. No one is going to bomb Peterborough, where the highest concentration of people is at Nonie's Diner.

Cities are becoming less and less safe places to live and work.

In the meanwhile, we've got to get as many of our 600,000 licensed hams into our emergency groups and trained. We need to interest a lot more people in our hobby/service. We want to be able to provide community and long-range communications no matter what emergency comes along, whether it be another enemy attack, that promised global super-storm, or a sudden pole shift.

This is our opportunity to justify the billions of dollars of radio frequencies we hold. Now, turn off the TV, get off that sofa, and get busy. And let me know how you're doing.

Schooling 2020

These are the pioneering days for distance teaching, whether it be via books, tapes, CDs, DVDs, seminars, the Web, or videotapes. I envision the DVD programs of 2020 using professional actors and writers, coupled with the magic of animation. How about a virtual electronics lab where circuits can be soldered together and tested?

Looking over the field, the outfit which could bring us the best in educational products right now is Apple Computer — by virtue of Steve Jobs' Pixar connection.

A few letters from me get shunted off to their legal department. They send me form letters saying that Apple is not interested in discussing new ideas. Maybe

Continued on page 64

LETTERS

From the Ham Shack

Hal Camlin W3QLP. Wayne, I am the guy who first told you about WinLink 2000. I am glad to see that Jack Heller wrote a great article in "The Digital Port" department of your September issue of *73*. It was the most informative "how-to" that I have seen on the subject.

In the QRX section of the same September *73*, there was a short article titled "The Greatest Generation." It was a well-written article about LST 325, but the writer failed to point out that the communications of KC6WYX, Jack Carter, LST 325 XO and retired USNR CDR and electrical engineer, included sending E-mail messages of the ship's log via WinLink 2000 (see September, 2001, *73*, "The Digital Port," "WinLink 2000 and the Airmail Package" by Jack Heller KB7NO) to nonhams to appear on the ship's Web site.

Also, the Web site was not 1st887/1st325, but lower case LST887/LST325. Thus: [www.palosverdes.com/lst887/lst325.html]. When LST 325 sailed across the Atlantic, unescorted with a crew of 29 whose average age was 73, and into Mobile AL, on January 10, 2001, they expected about 500 relatives and friends to meet them. However because of ham radio communications, WinLink 2000 communications and the news media, there were over 10,000 greeters.

It is sad that Jack Carter KC6WYX became a silent key on February 20, 2001, because of cancer, at the age of 71. He will be remembered by many as the ham operator that proved the versatility of WinLink 2000 as being the shot in the arm that amateur radio needs to compete and join in with computer/Internet communications. 73.

SK. William "Bill" Chapman W8TJQ was born on July 30, 1922, in Plainwell, Michigan. The son of Leland and Jeanetta (Webber) Chapman, he died Monday, August 6, 2001 at Ingham Medical Center. Bill was voted "most curious" by his high school classmates, and this trait was a defining feature of his life. He lived his life asking questions and learning new things, and encouraged his family to do the same. Bill served as a radio operator on merchant marine ships during World War II, making the dangerous Murmansk run several times. He graduated from Western Michigan University in 1949 and taught physics and math at Augusta High School where he also coached varsity basketball, taking his team to the 1950 state finals. Bill worked at Wedemeyer's Electronics in Lansing for 30 years. He was a devoted MSU sports fan, attending every home basketball game since 1951. Bill had many hobbies: He played trumpet and banjo in a college jazz band, was a member of S.P.E.B.S.Q.S.A., had his own plane and loved to fly, was an active participant in the Central Michigan Amateur Radio Club as W8TJQ with an Extra Class license, and engaged in tournament cribbage. He loved the friends who joined him in these activities. Bill was a worldwide traveler, but also enjoyed fishing at the cottage he built in northern Michigan. Bill married Mary Louise Stauffacher, who survives, on July 14, 1945. Together they raised seven daughters: Anne Martin (Ralph), Margaret Chapman (Bjorn Dag Gundersen), Mary Trese Cook (Mark), Elizabeth Murray (Mark), Bernadette Leone (Lucian), Jennifer Quinine (Patrick), and Jane Samaniego (Christobal). Bill cherished his 21 grandchildren and 3 great-grandchildren. Memorial contributions can be made to Mother Teresa House for the Care of the Terminally Ill, P.O. Box 13004, Lansing MI 48901, in memory of William W. Chapman.

Mike Miller WA8YKN. I'm sorry to report that my old ham radio and gunsmith mentor of many years, Tom Stence W8NQD/KN8B, has become a silent key.

Tom was born in 1910, and had enjoyed ham radio since its most exciting and magic early years. He taught me how to build my first regenerative detector, and helped me build my first CW transmitter. He administered my Novice and Technician exams back in 1967.

By watching Tom at work, I learned to operate the lathe, mill, and drill press, and many times saw him make a required tool on the spot to complete a difficult job. He always said, "A machinist can make tools, but tools can't make a machinist." He was a true artist in wood, brass, and steel back in those days, and made some of the most beautiful rifles I've ever seen.

Tom was also a writer, although his work seldom went any farther than his friends. I have a magazine from many years ago in which he sent a wonderfully funny letter to the editor, who presented it unabridged as an entire column. It's a classic. I see a bit of Tom's writing style in my own articles from time to time. When I complain that it's easier to find a clutch of auk eggs than a repair part for a modern ham rig, that's Tom peeking through.

Growing up around Tom's shop has had an effect on the way I look at problems and arrive at solutions. ... I wouldn't be a ham, an author, or an engineer today were it not for him.

Norm VK5GI. QRP is enjoying a renaissance — show the kids how to make receivers for almost no cost but a lotta fun, and us licensed hams how to make one-transistor transceivers and linear amps from one power transistor. I'd really, REALLY, like to know how to make a 10 gig transceiver from the motion detectors. (I have two — I only need someone to show me how!) If I had the money, I'd send a subscription to the mag to the science club at the local high school. Oh, Wayne — I could go on all night on getting folks off their butts and starting to live a healthy lifestyle. Here we are going to be shoveling it up-hill I fear. As for me, my wife and I did the drastic and at nearly 60 years young moved to an acre of paradise out in the donga where I can grow my own veggies and raise my chickens as well as run my desktop publishing business. I do work for the local area, which is rural, wine- and olive-growing. Truly, I have NEVER in my life felt better, and bear in mind that I was born in a bomb shelter during one of the frequent visits by the Luftwaffe over Liverpool! Your editorials, Wayne, are really inspirational and mean a lot to me. Keep on keeping on!! God bless!

Arnold Samuels, Ocean Shores WA. It is again my sad duty to advise you of the death of a good friend, Gary Paul Anderson N7JPG. Gary passed away April 27th, 2001, at the age of 60. He was born September 12th, 1940, in Spokane WA.

Gary loved the sea. He was in the U.S. Coast Guard and was a U.S. merchant marine seaman and officer from 1957 through 1971. He owned a charter boat called *Maverick* and was captain for the charter fishing vessel *Neddie Rose*. He was an outstanding mechanic and helped me several times, repairing my antenna tower and rotator. He belonged to the Grays Harbor Amateur Radio Club and the Masonic Lodge Franklin Lodge No. 5, Port Gamble WA. He lived in Westport WA until the time of his death at the VA hospital in Seattle. 73

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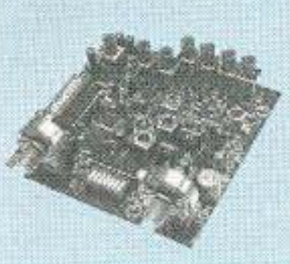

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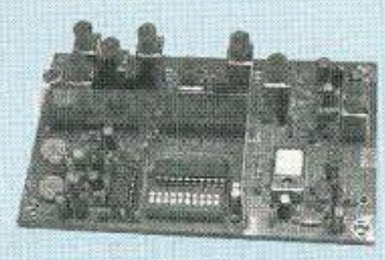

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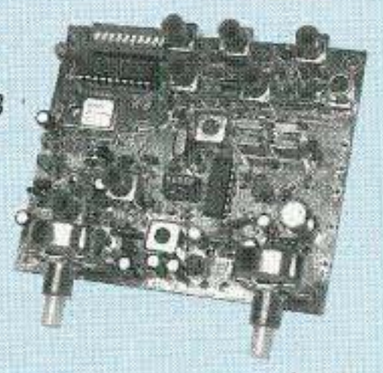

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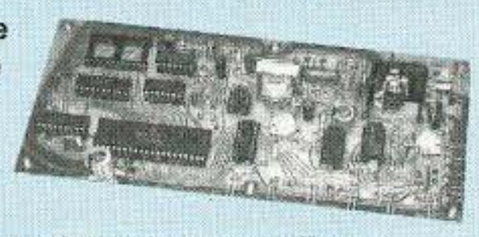

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Welcome, Newcomers!

You are about to embark on a journey into the fascinating high-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. Though international tensions rose, so did the excitement as scientists and engineers speculated on the potential of the 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. It's been 40 years.

Today, we have several hamsats. They have been built by amateur-radio enthusiasts all over the world. UoSATs from Great Britain. Fujis from Japan. RS units from Russia. 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.

All have telemetry output, and many have transponders for communications. Earth stations range from shortwave to UHF and microwave systems.

In this special satellite issue, you will find construction articles, satellite profiles, and informational topics on all facets of the amateur satellite program. Details of the program's history can be found on-line at [http://www.amsat.org], 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.

New satellites are being readied for launch from many sources. Packet radio from space, digitized TV pictures from low-earth orbit, voice synthesizers with two-meter FM downlink operation, and other modes will make 2002 a banner year for AMSAT and its international 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!

Glossary

AMSAT — The Radio Amateur Satellite Corporation, whose purposes include satellite construction and education as a nonprofit membership-funded entity. For details call (301) 589-6062, write to P.O. Box 27, Washington DC 20044, or check it out on the Web at [http://www.amsat.org].

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

AO-10 — AMSAT-OSCAR-10. The first amateur high-orbit communications satellite, launched in 1983. AO-10 is still on the air providing limited, but useful, linear transponder operation for voice and CW via Mode "B" — 70-cm up and two meters down.

AO-27 — AMRAD-OSCAR-27. A very popular low-orbit microsat with a two-meter to 70-cm FM crossband repeater system.

AO-40 — AMSAT-OSCAR-40. Our most recent amateur-radio high-orbit communications satellite. In spite of damage to some systems that occurred in December 2000, this hamsat has numerous experiments and systems that are fully functional.

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

ARISS — Amateur Radio on the International Space Station. The current gear is in use on two meters with packet and voice.

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

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

FO-29 — Fuji-OSCAR-29. An amateur-radio satellite built by hams in Japan and launched 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 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, while Mode "US" defines a transponder with a UHF uplink (70 cm) and an S-band downlink (13 cm).

OSCAR — Orbiting Satellite Carrying Amateur Radio.

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

RS-12/13 — The most popular Russian hamsat. These two devices are a part of the navigation satellite. They are a continuation of the Radio Sport 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.

UO-11 — UoSAT-OSCAR-11. The second University of Surrey hamsat was designed, built and launched in six months. Launched in 1984, this hamsat continues to transmit telemetry on 145.825 MHz FM at 1200 baud.

UO-14 — UoSAT-OSCAR-14. Built by hams at the University of Surrey in England, this low-orbit scientific/educational satellite is currently operational as a very popular crossband FM repeater with a two-meter uplink and 70-cm downlink.

Uplink — The earth-to-space signals sent to a satellite. 73

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United Kingdom

Practical RF Ground Stations for AMSAT AO-40

All you need to know.

AMSAT AO-40 is an exciting opportunity for the amateur satellite world. Its high elliptical orbit and consequent large visible footprint enables reliable intercontinental communications to be made using small, low-power, ground stations. AO-40 is of particular interest to a microwave amateur as it's the first amateur satellite to use microwave transponders for its primary communications platform.

In spring 2001, the first transponder tests were carried out; they were immediately successful with stations around the globe using AO-40's 70cm, 23cm uplinks and 13cm downlinks. These tests proved that AO-40 was going to be a huge success; this is particularly pleasing considering the uncertain start to life that the satellite had come through!

With the orbital maneuvers now complete and magnetorquing bringing the satellite back in a favorable orientation for transponder operations, it is fitting that *73 Magazine* has chosen this point in time to produce another "satellite special," and especially pleasing to be invited back to participate in this issue.

In the following piece, I will outline what equipment is required in the RF parts of an AO-40 ground station and where to obtain these items, plus give some hints and tips to help guide you to your first successful AO-40 contacts.

Currently, only the 70cm and 23cm uplinks are in operation; downlinking is via the 2.4 GHz band. Other transponders have been tested, but results have been inconclusive and further work is required to complete a detailed analysis of their status. So for the purpose of this article, I will be concentrating on what is actually available to operate on, i.e., 70cm and 23cm up and 2.4 GHz down.

Transponder configuration

Tables 1–3 show the transponders carried by AMSAT AO-40. These transponders are connected via a transponder IF matrix which allows any combination of uplink to be connected to any combination of downlink. Two separate combinations can be utilized, allowing two wholly separate configurations to be operated at the same time. Unfortunately, it is not yet known if the VHF/UHF transponders are still operational, so currently only the 70cm/23cm/2.4 GHz combination is being utilized, known as Mode UL/S.

The transponders are linear devices and thus allow the use of narrowband modes, i.e., SSB/CW or narrowband data (PSK31, etc.). In fact, the use of FM is frowned upon as it uses

Uplink	Digital (MHz)	Analog Passband (MHz)
15m	none	21.210–21.250
12m	none	24.920–24.960
2m	145.800–145.840	145.840–145.990
70cm	435.300–435.550	435.550–435.800
23cm(1)	1269.000–1269.250	1269.250–1269.500
23cm(2)	1268.075–1268.325	1268.325–1268.575
13cm(1)	2400.100–2400.350	2400.350–2400.600
13cm(2)	2446.200–2446.450	2446.450–2446.700
6cm	5668.300–5668.550	5668.550–5668.800

Table 1. *AO-40 transponder band plan. P3D uplink frequencies.*

Downlink	Digital (MHz)	Analog Passband (MHz)
2m	145.955–145.990	145.805–145.955
70cm	435.900–436.200	435.475–435.725
13cm(1)	2400.650–2400.950	2400.225–2400.475
13cm(2)	2401.650–2401.950	2401.225–2401.475
3cm	10451.450–10451.750	10451.025–10451–275
1.5cm	24048.450–24048.750	24048.025–24048.275

Table 2. *AO-40 transponder band plan. P3D downlink frequencies.*

Beacon	General Beacon (GB) (MHz)	Middle Beacon (MB) MHz)	Engineering Beacon (EB) (MHz)
2m	none	145.898	none
70cm	435.438	435.588	435.838
13cm(1)	2400.188	2400.338	2400.588
13cm(2)	2401.173	2401.323	2401.573
3cm	10450.975	10451.125	10451.375
1.5cm	24047.885	24048.035	24048.285

Table 3. *AO-40 transponder band plan. P3D telemetry beacons (IHU). Beacon frequencies have been measured before launch at Kourou and may change due to aging, vibrations, or temperature. 2m-MB and 13cm (2)-MB have already been measured in orbit. Remarks for tables: All receivers are inverting! Telemetry beacons are for command purposes and are modulated in 400 bit/s BPSK, AMSAT format. The MB can be switched between IHU-1 or IHU-2 telemetry.*

wideband widths and is a high-duty mode, which utilizes a lot of satellite power (so it is classed as unneighborly). So to operate on AO-40, some form of multimode SSB and/or CW uplink and downlink capability is required.

Station design

Putting together a station for AO-40 is not really "rocket science," excusing the pun! But its design really depends on whether you want to buy new, have existing equipment you can use, or wish to buy older equipment, perhaps purchased secondhand.

Buying new is an expensive way of getting onto AO-40. Simple as that! There are a number of modern dual-band VHF/UHF multimodes that would be suitable but are very expensive and would still need additional equipment added to become operational on AO-40. So far there is no commercial VHF/UHF transceiver with a 2.4 GHz receive capability built-in.

The second option is to consider using existing equipment in your station. You may already own a dual-band multimode or separate VHF-UHF multimodes. If you own this type of station, it could be quite simple to add a downconverter and some antennas and be up on the satellite quite quickly.

The best, and cheapest option, really, is to buy secondhand items and put together a station this way. It will perform just as well as new, but costs considerably less.

So let's look at what is required for a Mode UL/S AO-40 ground station.

Fig. 1 shows a UHF up/2.4 GHz down station and demonstrates the simplest station available for full AO-40 operation.

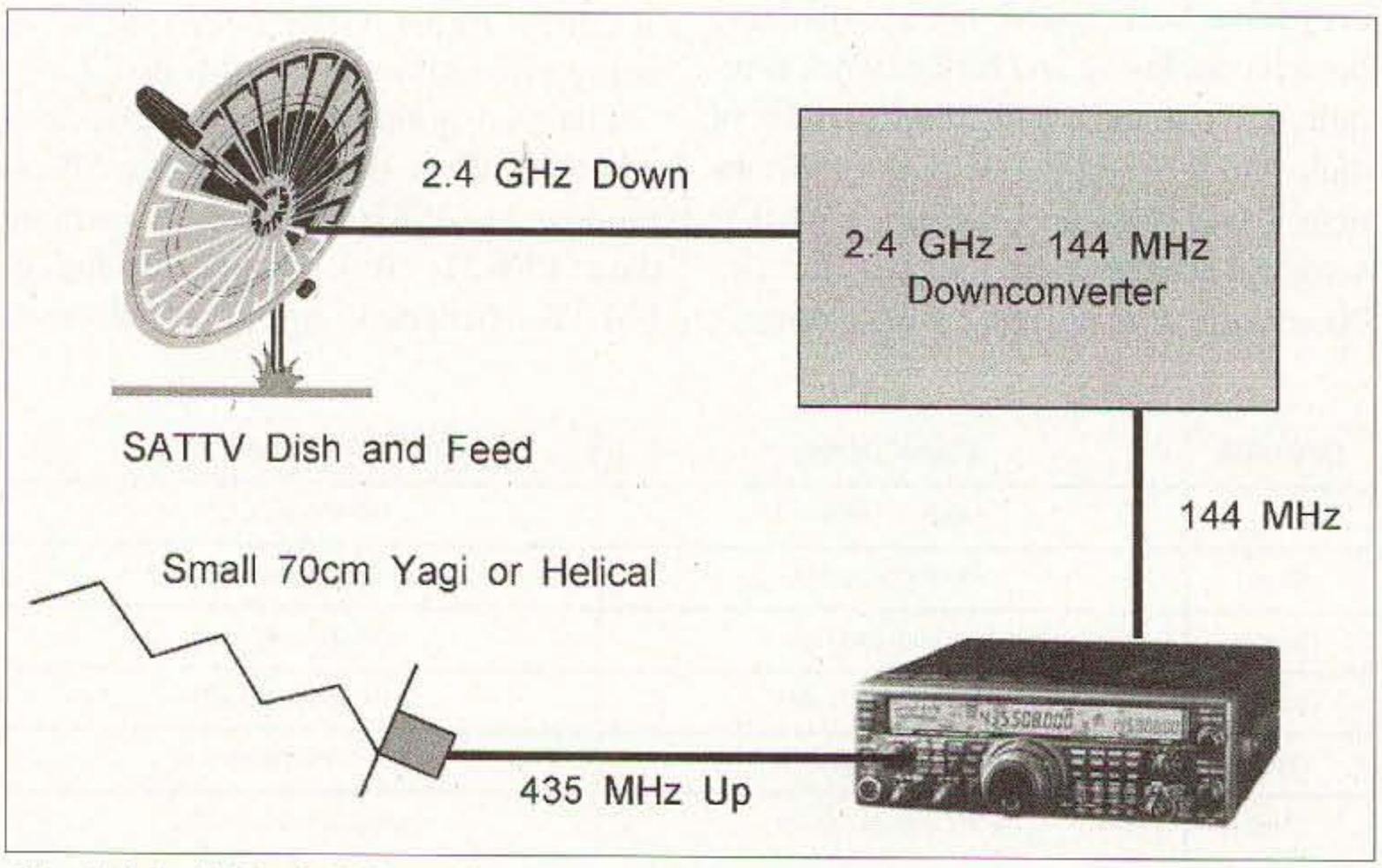

Fig. 1. *AO-40 Mode U/S satellite station.*

In this station, a 2.4 GHz downconverter is added and connected to either a 2m multimode or the 2m part of a multiband multimode. The 70cm antenna is connected to either a 70cm multimode or 70cm port of a multiband radio.

Ideas for antennas for both uplink and downlinks can be found elsewhere in this issue.

A more complicated station is shown in **Fig. 2**. This allows use of the L band uplink (1269 MHz). This is particularly useful if you own a 23cm radio or module for one of the multiband radios such as the Yaesu FT-736R or Kenwood TS-790.

Mode L — buy/build?

For most people, the purchase of a dual-band radio will not present any technical problems, but the 23cm uplink could be unknown territory for some. A word of advice here. There is nothing special about microwaves — it is simply a case of learning some new skills and techniques. Once you are over the hurdle of microphobia — the fear of anything small, such as microwaves! — you are high and dry!

So let's consider some options for 23cm.

If you own a multiband radio such as the FT-736, TS-790, or even the new IC-910, then adding a 23cm band module may be the easiest route, although it could never be classed as the cheapest. As an alternative, a single-band 23cm radio could be purchased, although these were never produced in massive amounts and can be hard to obtain.

Probably the easiest option is to buy or build a 23cm transverter. This will allow conversion in both transmit and receive to 1269 MHz from either a 28 MHz or 144 MHz transceiver. There are quite a few models available ready-built from sources such as Down East Microwave, DB6NT, and SSB Electronics. All are suitable for use on AO-40.

An alternative to a ready-built model is a kit. Building a 23cm transverter is not a major issue if you can handle a

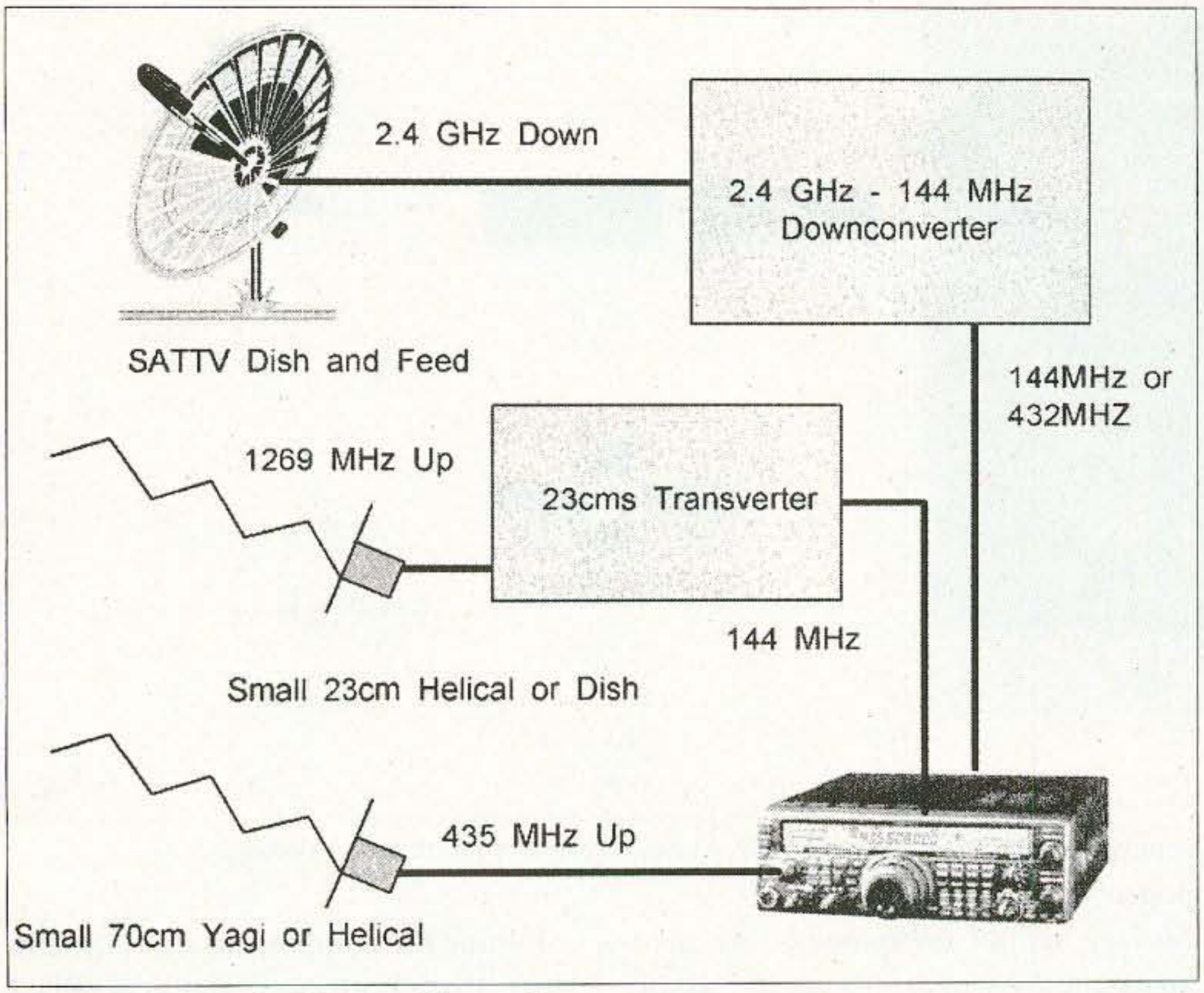

Fig. 2. AO-40 Mode UL/S satellite station.

soldering iron competently and follow a simple set of instructions to the letter. Most modern transverters are of single board design with either an onboard local oscillator or an external oscillator. Single board refers to the design concept that puts both transmit and receive stages on the same PCB. The transverter normally accepts low-power RF from a transverter and converts this signal to the 1296 MHz band. The receive function operates in a similar manner, converting received signals at 23cm to the 144 MHz band transceiver. The transverter normally contains DC voltage switching and the IF transceiver switching circuits.

There are a variety of kits available from a number of sources, many of which can be found on the Internet.

The G3WDG 23cm transverter (**Photo A**) is a typical example of a single board transverter design. The PCB carries the RF and DC switching. It uses an external local oscillator at 1152 MHz. In my station, this is provided by a G3WDG surface mount oscillator. Low-power RF from an FT-90 is fed into the transverter and mixed to 1269 MHz. This is filtered and amplified to produce RF at around 10 mW. In my station, the WDG transverter is

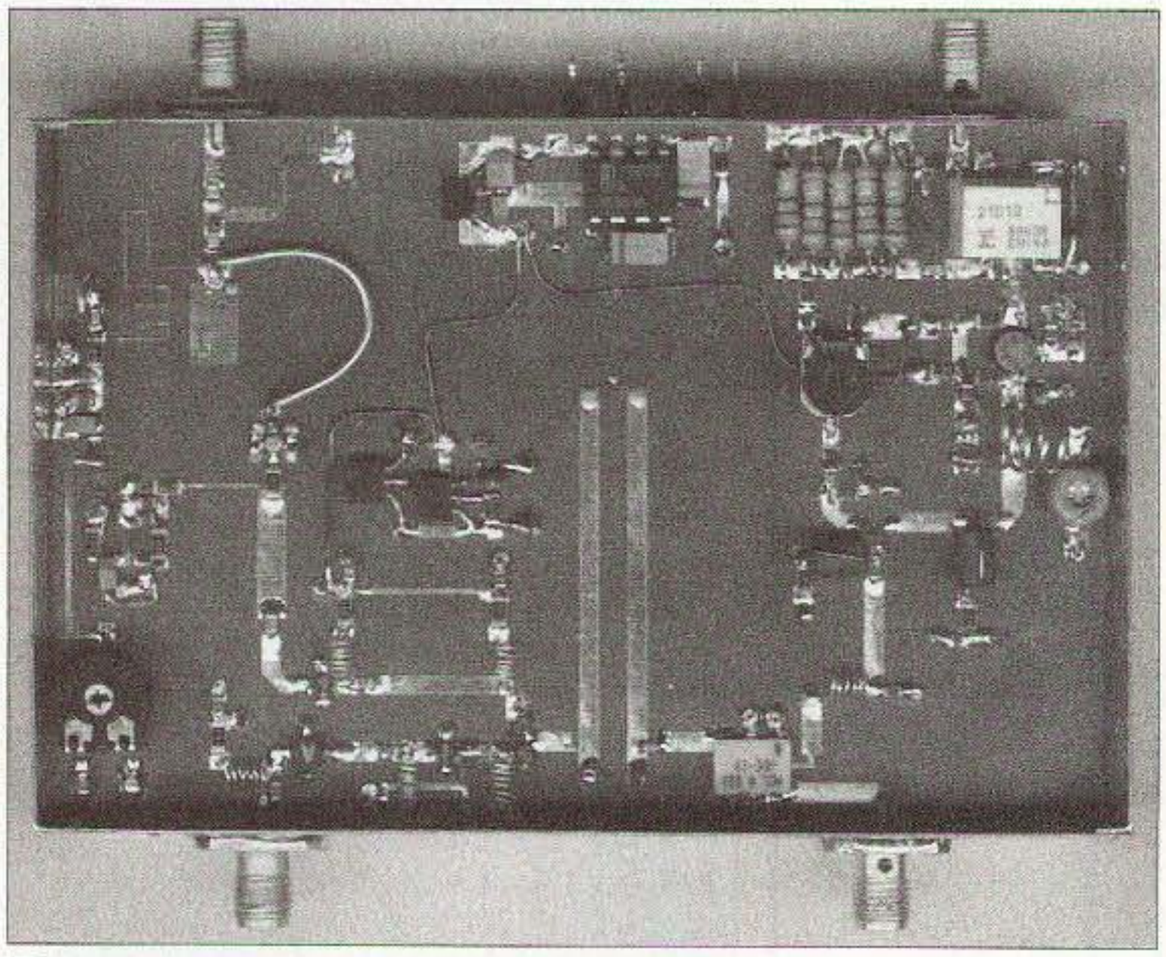

***Photo A.** G3WDG 23cm transverter.*

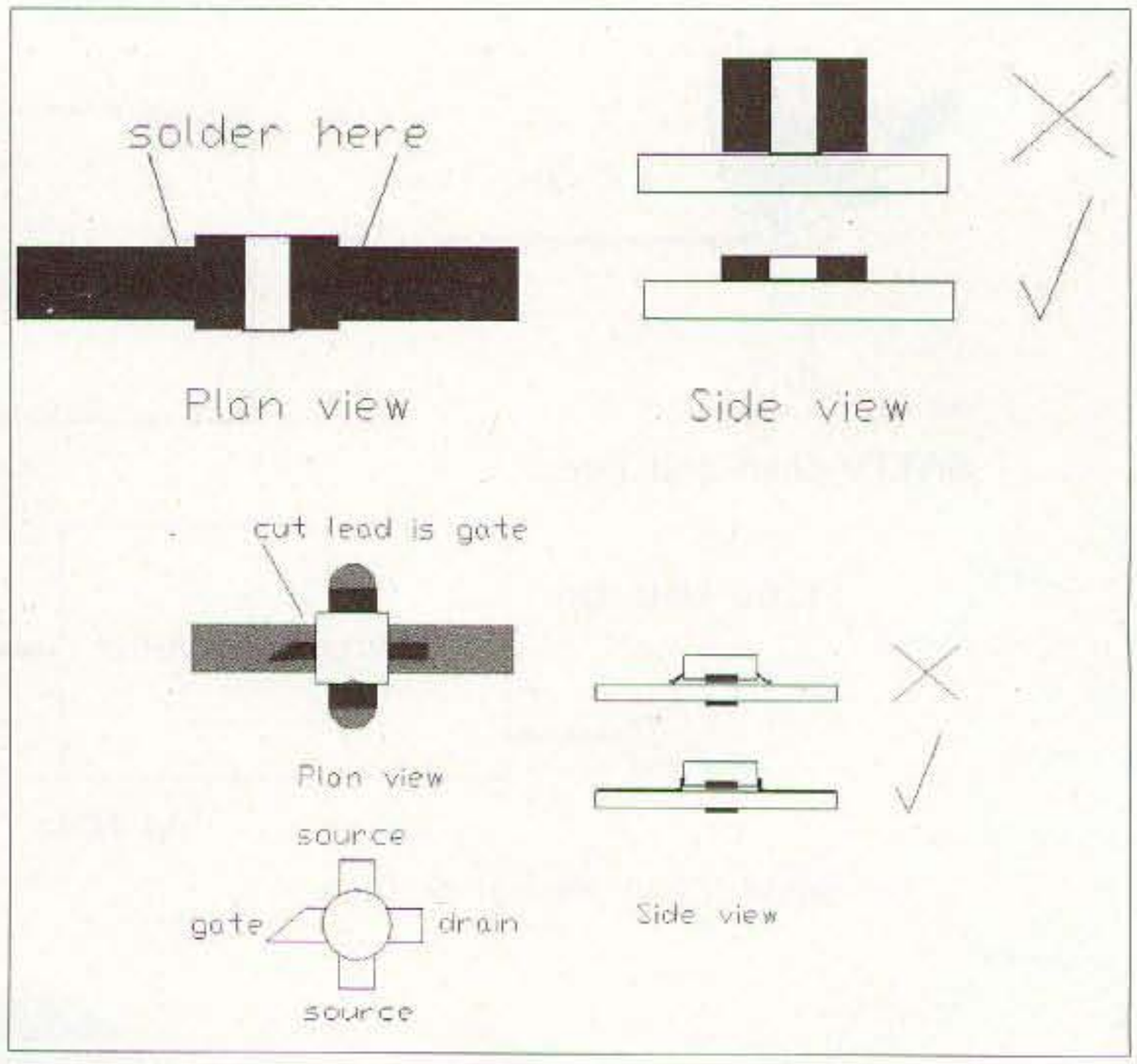

***Fig. 3(a/b).** Surface mount component placement.*

used solely in transmit for AO-40 purposes.

Building this kit is fairly simple. The kit is mounted in a small tinplate case that provides screening and a rigid mount for the PCB and connectors. The case is soldered together. Connectors are mounted directly on the PCB tracks by soldering them to the sides of the tin plate case. In my station, a mixture of microwave SMA- and SMC-type connectors is used. Do not use BNC types at 23cm or above — you will be wasting your hard-earned cash in connectors that are useless at these frequencies. N-types are acceptable and will work up to 10 GHz. Once the case and connectors are made up, the PCB can be tacked into place and then, once checked correct, seam-soldered along the PCB edges. This provides an excellent RF-tight enclosure and a rigid mount for the PCB. Now the mounting of components can begin.

Surface mount components are actually quite easy to use; again it's simply a matter of technique. They can be handled easily by using a fine-tipped soldering iron and fine-gauge solder. SM components lay flat against the board and not on a vertical edge [see **Fig. 3(a/b)**]. To solder them, arrange the position of the component and then hold in place with a fine-tipped tool. The iron is then tinned and brought onto one end of the component and the PCB. This should then hold the component in place. The iron and solder are then used to solder the opposite end of the component. Finally the first joint is remade using the iron and a little solder. This all sounds complicated, but it takes longer to describe than to actually "do"!

Putting the components on is usually quite a quick process, and generally I find it much easier than using components with long leads.

Most microwave kits need only basic alignment. This is because all the hand work, such as filtering and matching, has been done at the PCB level. This makes building a modern microwave transverter easier than ever.

Uplink amplifiers for Mode L

Although our basic transverter is now producing power, some amplification is still needed to get the transmit power up to a decent level. For most applications, 15-20 watts are sufficient especially when coupled to a reasonable gain 23cm antenna such as a helical or small dish. (See elsewhere in this satellite special edition.)

Producing power on 23cm is as easy as 2m but not as cheap! Fortunately for us, Mitsubishi manufactures a range of amplifier "black bricks" for 23cm. To get 20 watts on 23cm requires two bricks: one to take our 10 mW to 1 watt and then a second brick to take the power to 20 watts. These blocks are quite easy to use, and the only downside is their price!

Kits for 23cm amplifiers (1 watt and 20 watts) are readily available from a number of kit manufacturers, both in ready-made or kit form. This enables

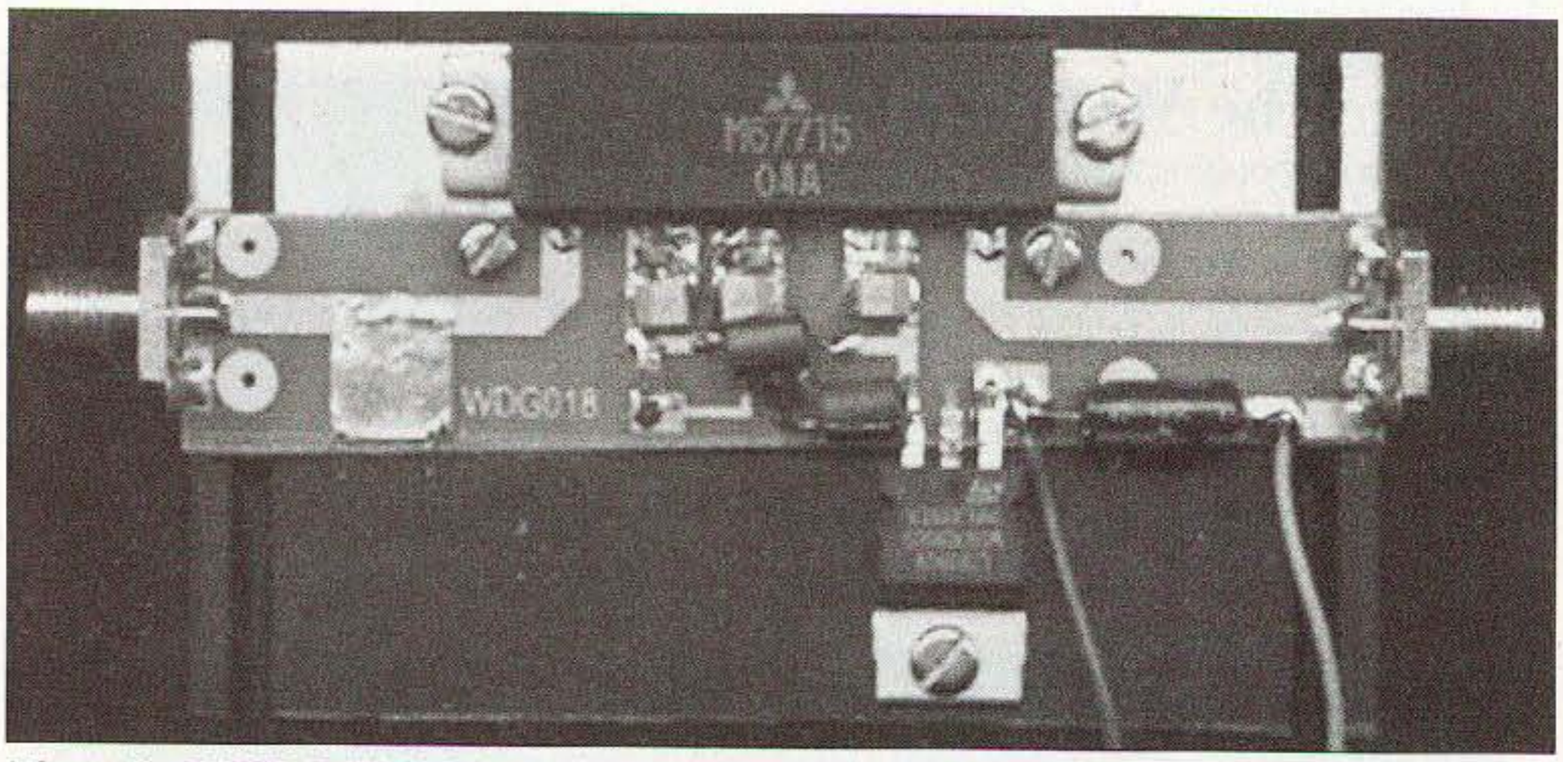

***Photo B.** G3WDG 1W 23cm PA.*

them to be easily integrated into an existing station.

If you decide on these bricks amplifiers you need to make sure you stick to a few ground rules! They need to handled carefully! Make sure you do not exceed the maximum rated voltage, keep them well cooled using a suitable sized heatsink, and use a fan if necessary: A 20 watt module may dissipate as much as 60 watts in heat! And don't overdrive them. If you keep to the rules, then they will perform well and have a long life. Two modules are shown as examples of this type of technology. Again, these are by Charlie G3WDG. I make no apologies for being biased towards his kits. They are well documented and he makes little secret of his kits, which makes them easy for showing how the technology is used. The first module is the G3WDG018 (**Photo B**) 1 watt PA. This is mounted on a small fiberglass PCB. The component count is very small and easy to construct. It will take the 10 mW from the transverter up to 1 watt. The design has an onboard bias supply and a DC switch to disable it during receive periods.

The second amp is the G3WDG017 (**Photo C**), which takes the 1 watt to about 20 watts. The technology is the same as the 1 watt amp, but it will need a substantially larger heatsink.

Connectors and cable

If producing power at 23cm is easy, then losing it in poorly chosen connectors and cable is easier still! Why, after paying plenty of bucks for a PA, do people then choose to lose it all by selecting incorrectly rated connectors to save a few dollars?!

At these frequencies, choosing the right connectors and cable is an important part of your station design. Choose them with the same care as you would any other part of your station.

All antennas, if they are of quality build, will use N-type connectors. Never use BNCs or PL-type plugs and sockets at 23cm. N-types are also good for frequencies up to 10 GHz and so should be your primary choice between antenna and the shack.

Interconnections between the shack should be made using N-types as well, but keep the number of connections to a minimum. Every connector you use eats up a little more power you so preciously generated.

Within equipment the best choice of connectors is the SMx range. These are a range of miniature microwave connectors designed for both miniature flexible cables and the hardline microwave cables.

Whilst on the subject of cables, the interconnection between shack and antenna is vitally important on your L-band uplink. Choose the wrong cable and your precious power will simply heat the cable. Choose a length of Belden hardline or Andrews Heliax and this will ensure that the most power reaches the antenna.

Downconverters for 2.4 GHz

So far we have discussed only how our uplink is designed. To receive the satellite, you will also need a 2.4 GHz receive capability. The very best way to achieve this is to downconvert to either 70cm or 2m.

As with the other items mentioned in this article, there are a variety of converters available on the current market.

Commercially-built converters are available from Down East Microwave, DB6NT, and SSB Electronics, to name a few.

There is also a good range of kits available, and as with the 23cm transverters, these are easily built as long as you can solder proficiently and follow some simple instructions. Charlie G3WDG has just released a new kit for a high-performance but easily built 2.4 GHz downconverter. **Photo D** shows a picture of the completed unit. Similar designs are also available from a number of microwave kit manufacturers.

An alternative option to a kit or commercial unit is to modify an existing commercial unit. Amateurs are always quick to find sources of equipment that can be pressed into service on the amateur bands. A number of commercial SATTV downconverters have been identified as suitable for use on AO-40, and there is plenty of information on

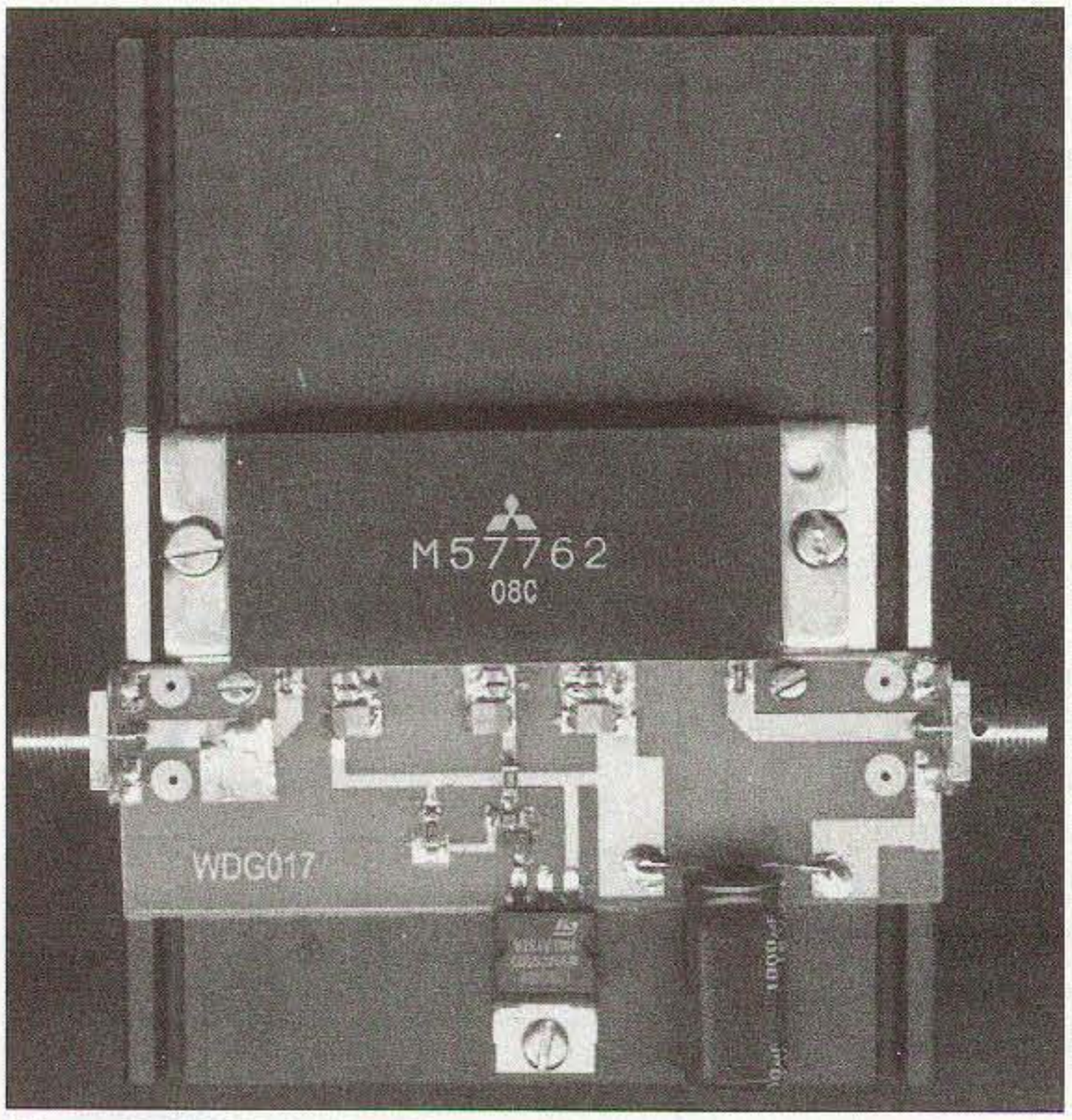

Photo C. G3WDG 18W 23cm PA.

identifying, converting, and tuning them on the Internet.

Above and beyond

AO-40 carries transponders for other microwave bands as well. So far, tests for these units have not been completed, or have given inconsistent results. With the orbital changes to AO-40 now completed, these transponder tests will no doubt continue.

Suffice to say that the techniques for L/S band will give you a great start for the higher bands. Kits for 5.7 and 10 GHz are available, and with some practice at 1.2 and 2.4 GHz, it is possible to construct equipment for the higher bands as well. Modern components are helping in this development, allowing easily built, high-performance kits for the amateur market.

Finale

AO-40 offers amateurs an exciting opportunity. With its large visible footprint and long orbit, the satellite will not need to be chased across the sky. This leads to leisurely and enjoyable QSOs. The use of L and S band means that some will need to learn new skills, but evidence from the AMSAT bulletin board has shown that even people who have never used microwaves before can successfully learn these new skills and adapt easily to this new technology. It's never too late to learn new tricks! It simply takes a little willpower and dedication.

There are now more kits, modules, and commercial equipment available than ever before. There really is no excuse! A station for AO-40 is fairly easy to construct, and hopefully this article has given some insight into what is required and how it connects together.

AO-40 is an exciting satellite that will revolutionize the amateur satellite world. The future is here and now — I hope you come and enjoy it!

Resources

AMSAT Home pages — [http://www.amsat.org]

DB6NT Kits — [http://www.db6nt.com]

Down East Microwave Kits — [http://www.downeastmicrowave.com]

Drake 2880 SATTV Mods — [http://www.g0mrf.freeserve.co.uk]

G3WDG Microwave Kits — [http://www.g3wdg.free-online.co.uk] 73

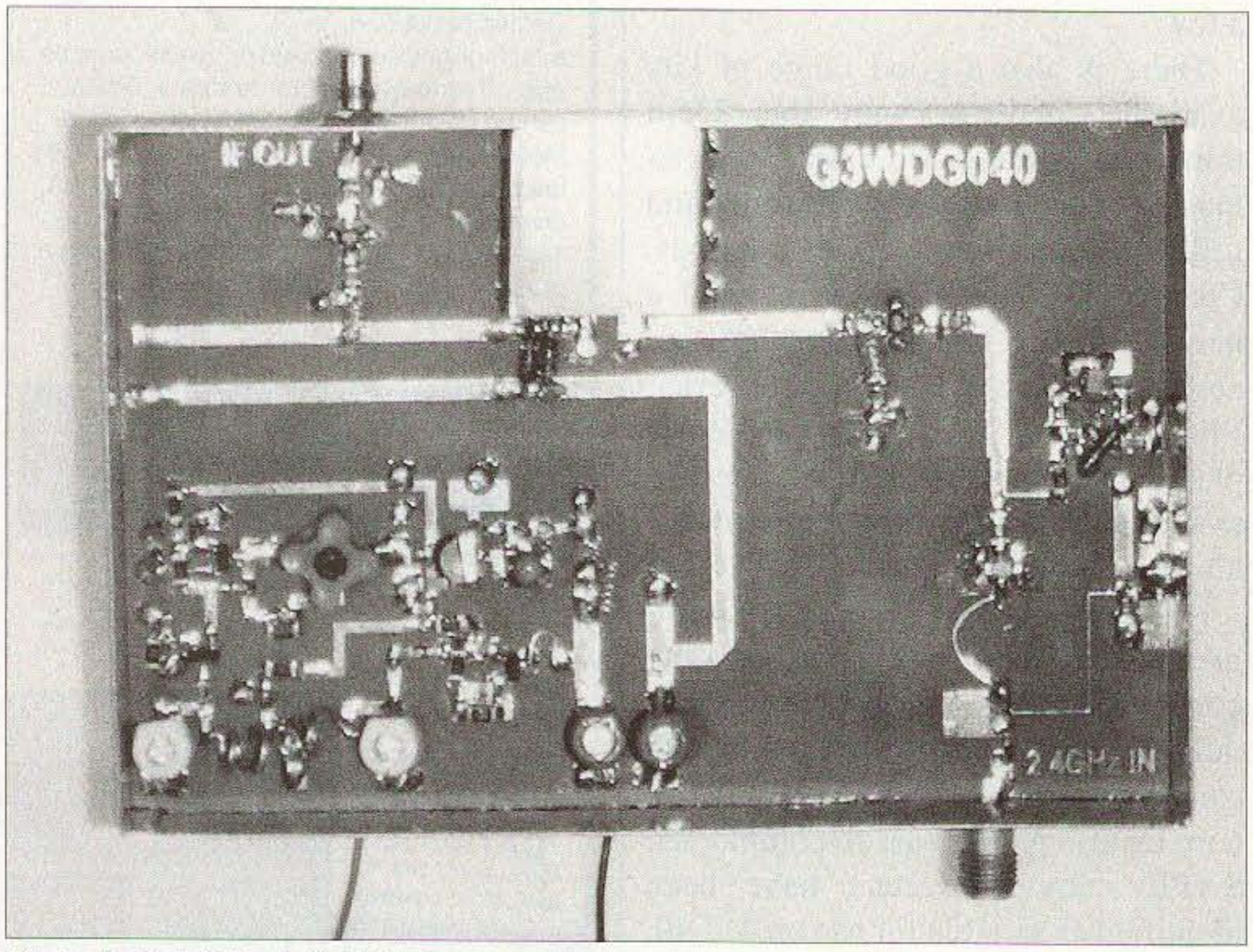

Photo D. 2.4 GHz–144 MHz downconverter.

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United Kingdom

Microwave Antennas for AO-40

The expert speaks.

Over the past few months, AO-40 has really made its mark in the amateur satellite–microwave world. The small period of transponder operation allowed many amateurs to test and tune their equipment and prove their station concepts were correct. This period has also allowed for a period of experimentation and has shown that there are a number of small compact antennas that will work perfectly well via AO-40. This article outlines some of the antennas that have been proven to work via this new satellite and includes some easy-build designs, which can be reproduced at home using simple hand tools and materials easily at hand.

Microwave antennas offer major advantages over their lower-frequency counterparts. Generally they are compact and offer high gain in relation to their size. Most microwave antennas are actually quite simple affairs and do not require major amounts of engineering to be successful. In typical amateur fashion, we have been quick to utilize the ever-growing supply of microwave parts from the telecoms, data, and television industries and put these to use in our microwave stations on the amateur bands. Many of these parts are suitable for use, and I will be showing how to construct very effective microwave antennas from parts easily available at junk sales, swapmeets, and trunk sales. The ground rule for this is to keep your eyes open — it's quite amazing, the bargains you can pick up!

Most microwave antennas come in three main flavors: Slotted or cylinder antennas used for omnidirectional work, yagi antennas, and dish antennas of various types. Some combine to form dishes and feeds, such as the G6LVB SATTV dish and feed I will be describing later. So be prepared for a little variety in life!

Omnidirectional antennas are of little use for serious satellite work, so I will concentrate on yagis and dishes for the purpose of this article.

Yagis and helicals

Yagi antennas for microwave work are generally available up to 2.4 GHz. At these frequencies, yagis offer high gain with compact boom lengths. The trade off is that building antennas at these frequencies requires accuracy, as even small errors in construction can significantly alter the

Photo A. *Paul G6UAJ's 144 MHz yagi and 10 GHz 1.2m Landrover dish array.*

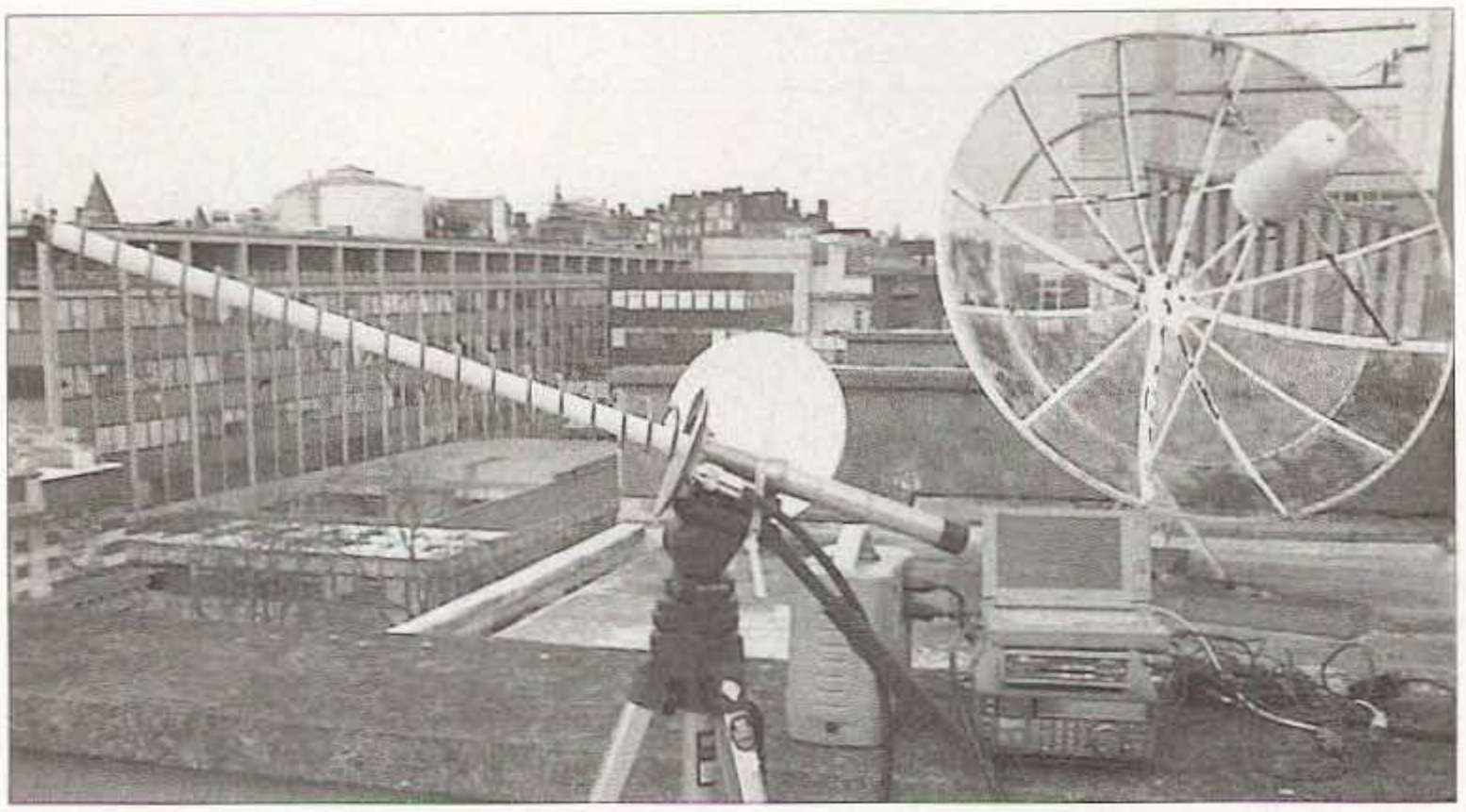

Photo B. *The helical antenna has only one active element which is wound in a spiral fashion. A small reflector is mounted at the rear of the antenna to radiate the RF wave forward and in a circular motion around the shape of the helical.*

performance of a design. Designs for antennas at 1.2 and 2.4 GHz are freely available and with a little skill and patience it is possible to construct a good microwave yagi using simple tools and a little patience. A typical yagi array is shown in **Photo A**. This is Paul G6UAJ's 144 MHz yagi and 10 GHz 1.2 M dish array on his Landrover used for rover operating. Yagis can be scaled from HF all the way through to the GHz region if designed with care, and are very versatile.

A downside to the yagi is that it is linearly polarized — that is, it is either horizontal or vertically polarized, dependent on the physical orientation of the antenna's elements. For amateur satellite working, circular polarization is the accepted norm; the linearly polarized yagi will work, but not as effectively as circularly polarized antennas. Luckily for us, the helical antenna fills this design requirement nicely and is easy to build.

The helical antenna (**Photo B**) is very different from its yagi counterparts. It only has one active element, and this is wound in a spiral fashion — hence the term "helical." A small reflector is mounted at the rear of the antenna, and this radiates the RF wave forward and in a circular motion around the shape of the helical. The helix can be wound in either right-hand or left-hand motion, and this gives rise to the same polarization. Building a helical is very easy, and many people already active on AO-40 are using home-made helicals. I will show you how to construct simple helicals later on. The picture shown here is of G6LVB's portable Mode S station using a Sandpiper Communications 23cm helical on the roof of his London flat. His neighbors' 8-foot TVRO dish is also visible.

Dishes

Probably the most popular antenna in the microwave world is the parabolic dish antenna (**Photo C** is HB9DRD adjusting his feedhorn on his small dish). They are very popular, as they offer very high gains in a very small space. For example, a 2-foot. dish at 2.4 GHz can offer as much as 24 dB gain. Gain is only limited by diameter and the mechanical difficulties of handling numerous square feet of dish surface accurately — especially in times of poor weather! The mechanics of the dish are very simple. A concave surface of either metal or composite material covered with a reflecting surface is used to "focus" the incoming parallel RF waves to a point. At the focus of the dish some form of feed is mounted to transfer the received signal to waveguide or coax to be fed to the RF

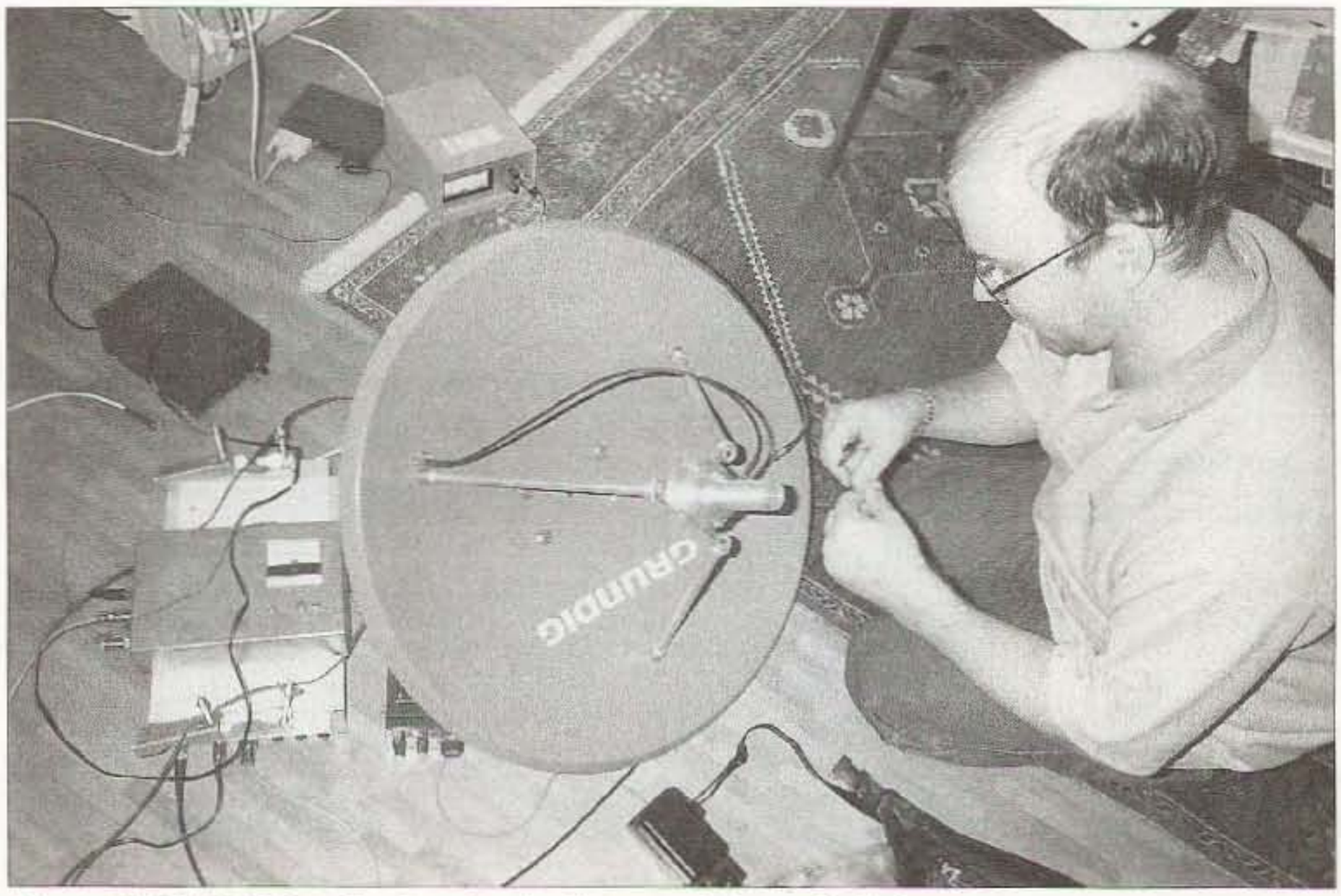

Photo C. *HB9DRD adjusting the feedhorn on his small dish.*

Photo D. *This dish antenna is a section of a full parabola but does not include the center of the dish.*

equipment. The mechanics of small dishes are very simple, and fortunately for us they come in many flavors and types. Prime focus dishes are the typical microwave antenna we see for satellite systems consisting of the full circular dish antenna and a feed at the focal point. Another type that has appeared recently, particularly with the flood of satellite TV, is the offset dish (**Photo D**). This dish antenna is a section of a full parabola but does not include the center of the dish. The feed is mounted on a small arm from the back of the dish, holding it in place at the focal point. There are a number of advantages of this in that the feed does not block the dish, giving better performance, and also does not pick up noise from behind the dish like a full parabolic, leading to a lower noise temperature — this is highly important with today's sensitive microwave equipment.

Feeds

Dish feeds for microwave satellite work can vary in size and shape! Small feeds based on helicals are easy to build and will perform well on both prime focus and offset dishes and are especially popular on the lower microwave bands, I will show you an easily built design that will transform a surplus SATTV dish into a very effective AO-40 antenna. The offset dish can use a similar feed for the lower bands, but feeds can also be built for the higher bands using copper water pipe parts. As we progress, I will show how some of these feeds are designed, and show how easy they are to make using parts easily found at your local hardware store. A quick visit to your local hardware store is like visiting an antenna parts store — all you need to know is what to look for!

Easy-build designs

Building microwave antennas for AO-40 does not require a degree in engineering or science. Designs for the antennas are already available and ready to build. They have been tried and tested and can be reproduced using a few simple hand tools at home. Most of the parts can be obtained from local hardware stores or DIY shops. Armed with a list of material requirements and a tape measure, you will find all you need on a Saturday morning tour of the local DIY establishments. Be warned, however! You will get some strange looks if you tell the shop assistant what you really need that copper pipe for! So just humor them! It's safer that way!

The following designs and projects are not an exhaustive list, nor is it an attempt to be such. I do not claim any of the designs as my own. I have simply

Fig. 1. AMSAT-OSCAR-40 logo.

brought them together to show what kind of designs and technology are in use on AO-40 today. Using simple tools, all should be easy to replicate and work well. The advantage is that they also can be built for a few dollars and save a small fortune over their commercial versions. You will also get some pride out of working AO-40 on an antenna you built yourself. Now there is a talking point on-air or at the local club.

Antennas for 1.2 GHz: a 23cm helical

An easy-to-build 23cm helical is offered using the dimensions in **Fig. 2**. The helical is easy to construct and tune and will give good performance on the Mode L/S uplink at 1269 MHz. The dimensions were calculated using the excellent JAVA applet at [http://vhf.worldsbest.com.au/Helix.htm]. It is a simple matter to manipulate the design to suit the size and gain required and then use these as a basis for a design that you know will work. The 23cm design shown here is a 16 dB gain 16-turn design measuring approximately 3 feet in length. Of course, if you are more ambitious you can build a larger helical, but watch for narrowing beamwidths! The main element can be made from small-bore copper piping or the center of large-diameter coax. It's really a case of what you have easy at hand! The main element can be mounted onto a PVC drainpipe tube or by using small insulated standoff pillars. A boom from a 10mm aluminum square tube can be found in local DIY stores — this makes an excellent boom that will not sag even as a single part. The reflector should be approximately 6 inches square and from either PCB material or aluminum. Again, it's really a case of using what you have on hand! The connector should be an N-type. For more construction information, you should read a description of the antenna constructed by James Miller G3RUH; a copy is available at his Web site [www.jrmiller.demon.co.uk]. The ARRL manual also contains an excellent description of building helicals and should be read in conjunction with the information presented here.

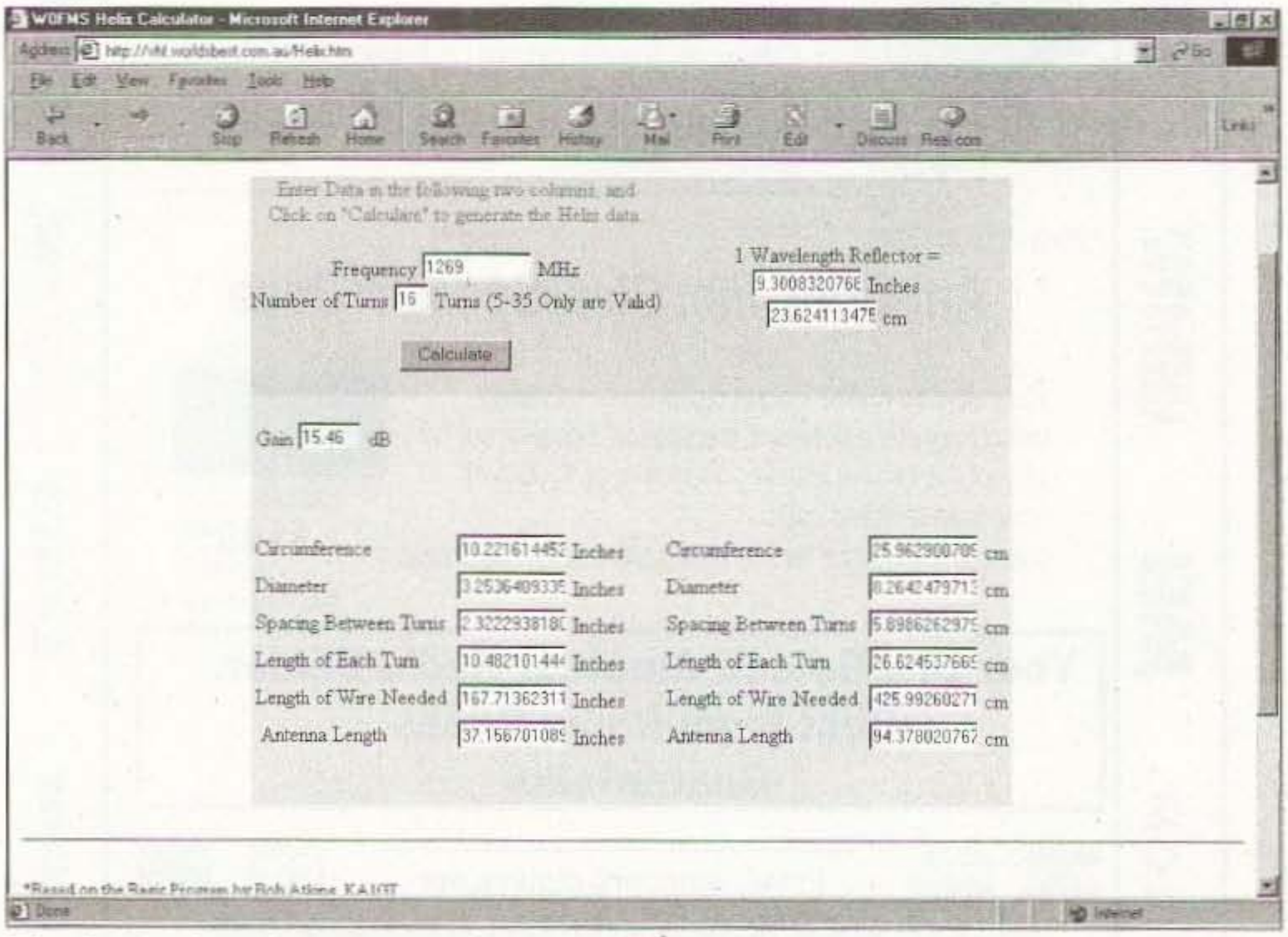

Fig. 2. Use these dimensions to build the 23cm helical.

Antennas for 2.4 GHz — a 13cm helical

A design for a similar helical for 2400 MHz is shown in the dimensions in **Fig. 3**. Again it's a simple matter to construct using the same techniques and materials as above. Reflector size is approximately 120 mm square.

Dish feeds

2.4 GHz helical feed — G6LVB helical feed

One of the cheapest ways to become operational on the 2.4 GHz downlink is to use a surplus SATTV dish. In April 1983 during tests of the AO-13 2.4 GHz downlink, James Miller G3RUH constructed a small multiturn helical feed for a prime focus reflector constructed from a lampshade. The original article is still available on G3RUH's Web page and formed the basis of a complementary dish feed that was constructed by Howard Long G6LVB. Howard uses a 60cm offset SATTV dish now widely available in the UK, and a similar design is almost

certainly available in any of the countries where DBS broadcasting has penetrated the domestic market! There are probably hundreds of these antennas just waiting to be liberated from the sides of buildings, yard sales, trunk sales, and hamfests. I acquired three for less than $5 at a trunk sale in one morning alone!

Howard has modified the design slightly by using the original LNB mounting bracket to keep the feed at the right angle to the dish, which is key to best performance. The bracket is modified (with a saw) to make room for the feed reflector. **Photo E** and **Photo F** are pictures of the completed feed. Incidentally, Howard was extremely pleased about how well the dish and feed perform, and if you visit his Web site, take a listen to the audio files of his local beacon. He compares the dish against a 30-turn helical and the dish performs very well. Even after being dropped over the edge of a balcony onto the floor 7 feet below! The dish looks a bit bent but still outperforms the helical by a large margin! Howard claims that it took about 2 hours to build the feed and mount it to the dish! The feed is also very simple to construct and uses 2-1/4 turns of wire or thin tubing wrapped around a 40mm former (socket set bit used in the original!) and a turn pitch of 28mm. This is matched, in Howard's case, by some copper PCB material. The reflector measures approximately 125mm x 125mm and again is made from PCB material. Of course, you can use aluminum and copper shim if you have them on hand. The N-type is mounted using an aluminum spacer to bring the tip of the center level with the reflector. The pictures explain this a little better. Some enterprising person on the AMSAT -BB reflector suggested hacking an SO-239 socket to bits by cutting off the threaded part and removing the inner insulator, as they make nice blanks for this precise job! Never thought I would see an SO-239 being used at 13cm!

This probably represents the cheapest 13cm downlink antenna I can think of, and it is so easy to make that it is no wonder it has become a very popular

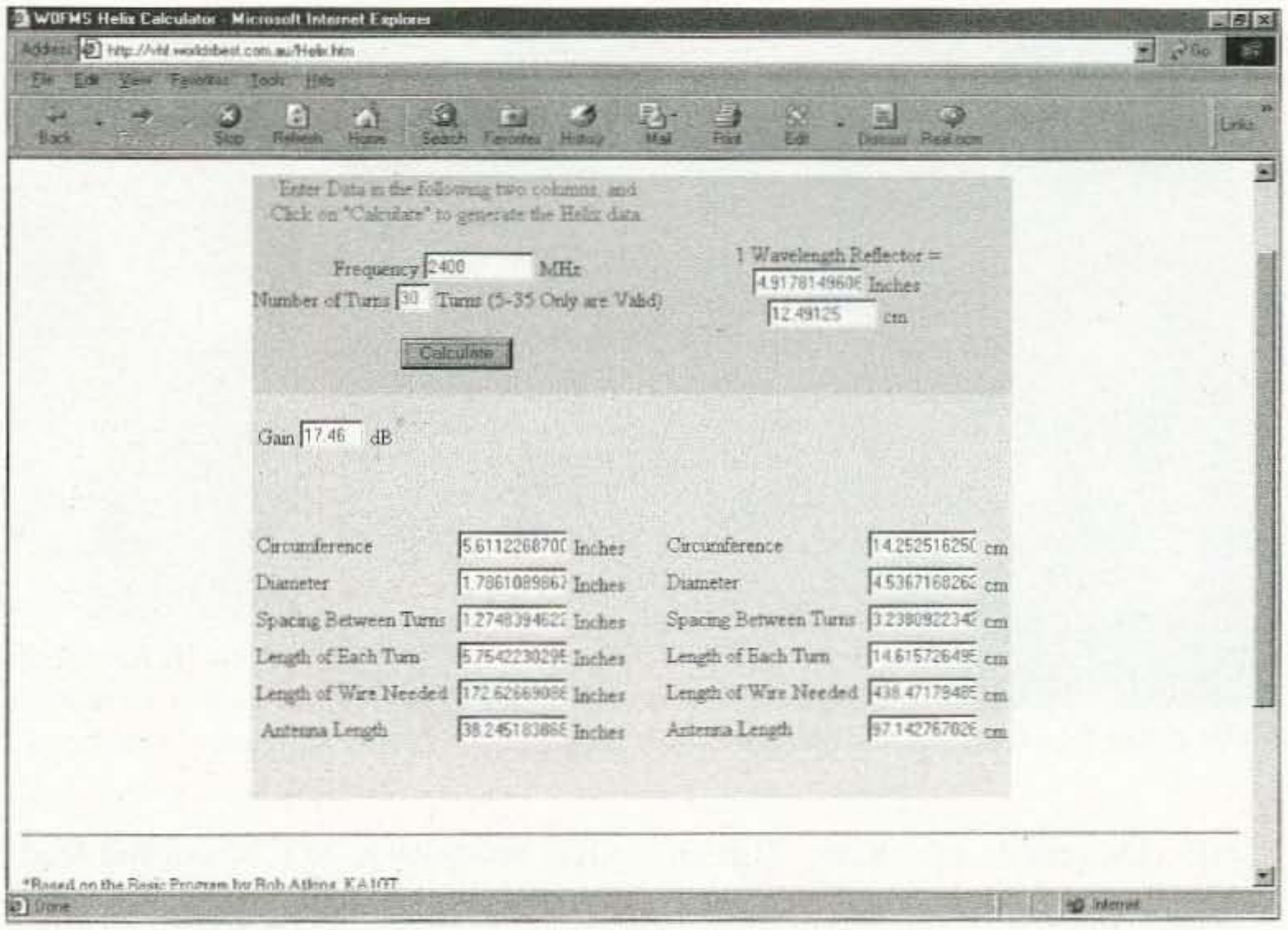

Fig. 3. *Dimensions for a 2400 MHz helical.*

design, especially as it performs so well and costs so little. Thanks for the time taken to publish the design, Howard!

Further details of the design and testing, and a link to James Miller's original article, can be found on G6LVB's Web site at [http://www.g6lvb.com].

5.7 GHz helical feed — GØMRF helical feed

Dave Bowman GØMRF produced a similar design for the 5.7 GHz band. Although the true status of the C-band system is not yet fully determined, I thought that I would make this satellite special complete by offering some useful designs so that you can at least see that designs for the higher bands are just as easy to complete.

The dish feed consists of a small 4-turn helical wound using 1.6mm-diameter enameled copper wire, with a diameter of 17mm and a turn pitch of 12mm. The helical is mounted to a diecast box of 50 x 50mm that acts as the reflector. At these frequencies you can use an N-type, but for size's sake David used an SMA connector. Again, pictures speak a thousand words, so **Photo G** shows the completed feed. The feed is fairly simple to construct and works well as long as constructed exactly as shown.

For outdoor purposes, a small "radome" or suitable enclosure will need to be completed. This will prevent corrosion between the matching section and the diecast box, and the detuning of your hard work by bugs, water, and other undesirables!

Broadband satellite feed

An alternative to feed a dish is a linear feed. This is not a major disadvantage, as the angle between the antenna on the satellite and an earthbound antenna will change. Subsequently, the potential 3 dB loss in polarization difference could be considerably lower.

The feed shown here is simplicity

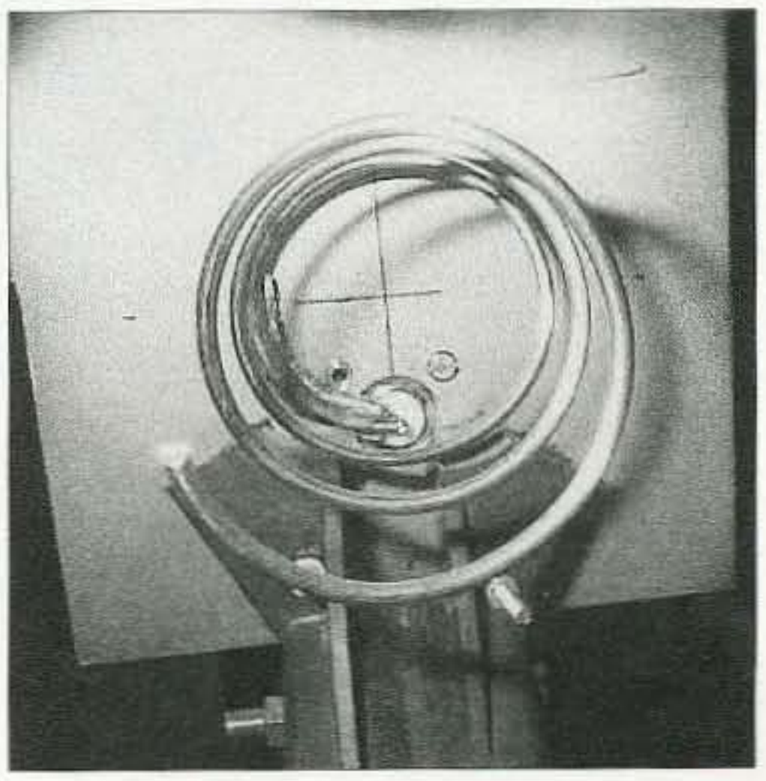

Photo E. *Howard used the original LNB mounting bracket to keep the feed at the right angle to the dish.*

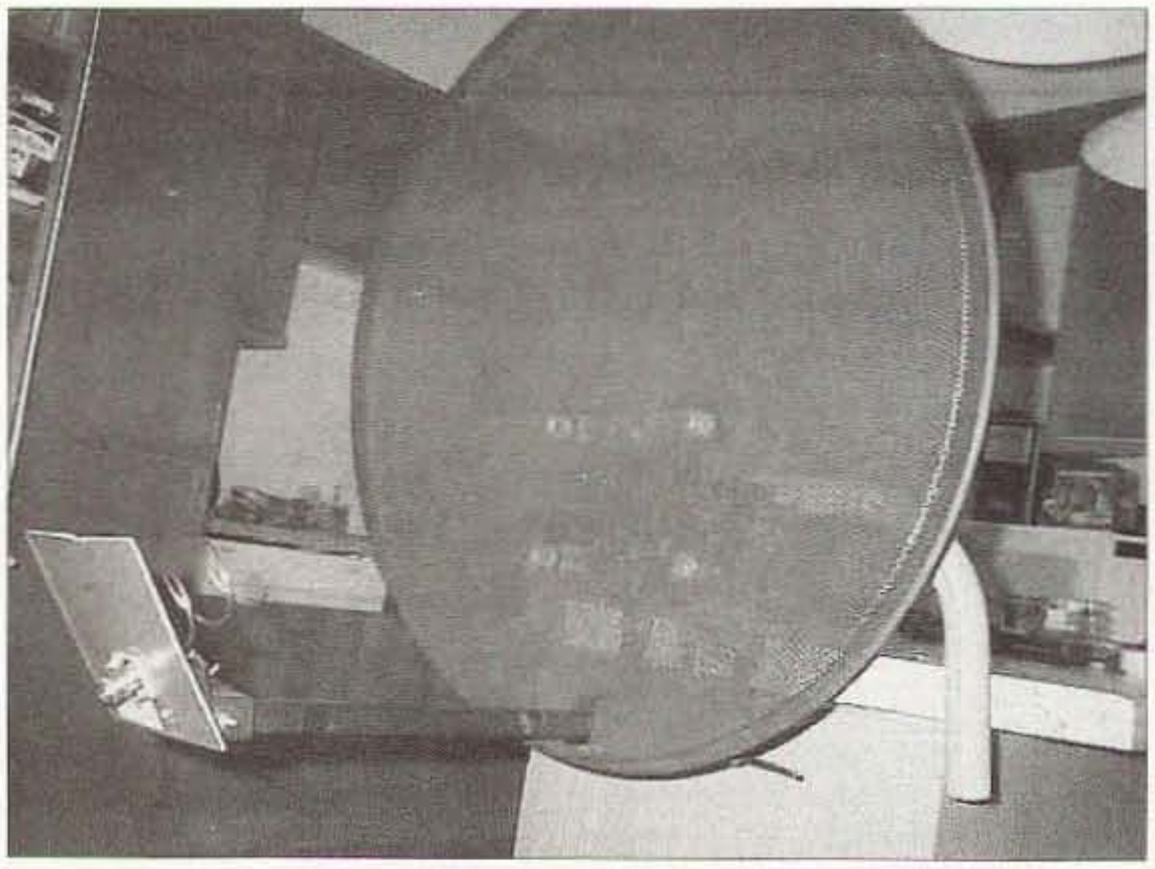

Photo F. *The bracket is modified to make room for the feed reflector.*

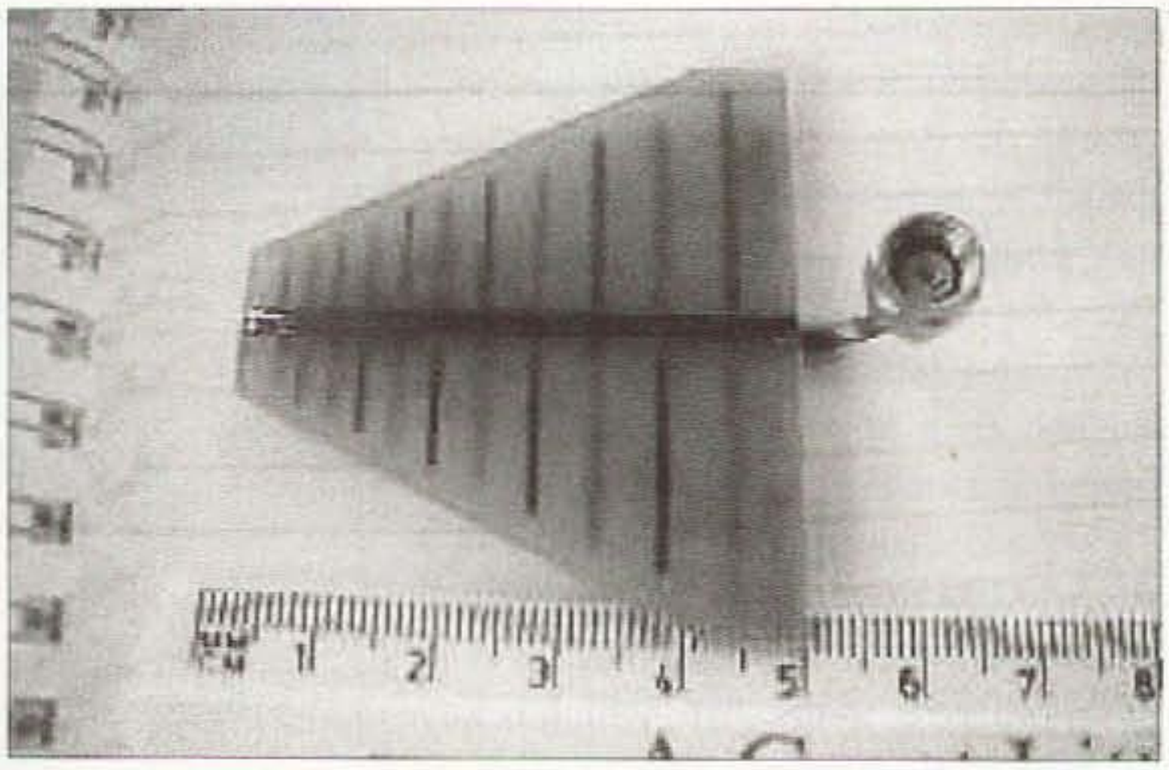

Photo H. *Kent Britain WA5VJB designed this very simple feed. It is etched on a piece of double-sided PCB material and covers a frequency range of 2.1–6 GHz.*

itself! Designed by Kent Britain WA5VJB, the feed is etched on a piece of double-sided PCB material and covers a frequency range of 2.1–6 GHz (**Photo H**). This means it could be quite easily used on the S-band downlink or C-band uplink. A ready-made PCB is available in the U.S. and U.K. for the feed. It simply needs a small length of semirigid cable and an SMA plug soldered to the feed. There is one slight disadvantage in a broadband feed, in that there is a slight loss in efficiency due to the feed characteristics not being constant across the design range. However, in terms of simplicity, this far outweighs any minor change in design characteristics. You will probably not even notice at the strength you will receive AO-40!

10 GHz offset dish feed — G3PHO dual-mode feedhorn

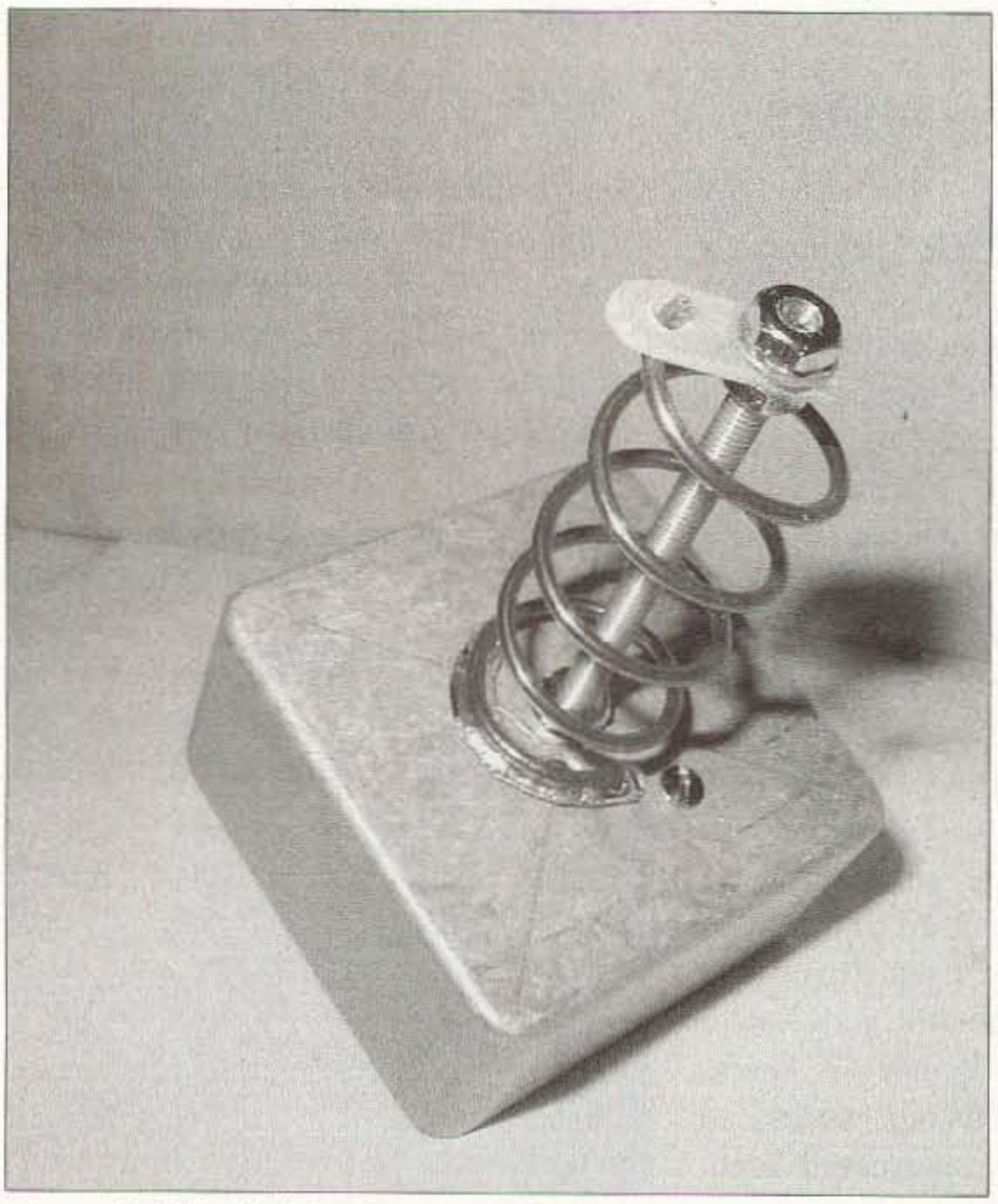

Photo G. *This dish feed consists of a small 4-turn helical wound using 1.6mm diameter enameled copper wire, with a diameter of 17mm and a turn pitch of 12mm.*

For feeding a 60 or 80cm offset dish at 10 GHz, you could do a lot worse than construct an offset dual-mode feed as shown in this example by Peter Day G3PHO. Peter has shown that an excellent feed can be constructed using copper water pipe fittings available from your local hardware or DIY store. The design was originally shown by W2IMU in two articles in the *Microwave Update* 1991 edition. The design is suitable for offset dishes of 0.5–0.6 FD size and produces an excellent symmetrical radiation pattern in both E and H planes. This design is especially suited to offset dishes, illuminates the dish correctly, and does not pick up noise from behind the dish.

The design is made from a 22mm to 42mm coupler and a straight 42mm coupler which is cut down in length to 47mm. The end of the 22mm–42mm coupler is mounted to 22mm copper water pipe and can then be mounted to a round to square waveguide coupler and WG16 waveguide flange. Or, as an alternative, a 22mm round waveguide-to-SMA adapter can be utilized.

As with the other designs, here are some photos to describe the feed visually (**Figs. 4** and **5**).

The feed is mounted using the existing dish mount bracket.

Designing antennas and feeds

There is a variety of design and build information available in printed and electronic form. Most of these will assist you in designing and building antennas and feeds for almost any amateur microwave location. But with so much of the groundwork and testing done in the designs presented here, there is little point in a newcomer, struggling through the complicated design issues, trying to get a working station together for AO-40.

In printed form, the ARRL and RSGB publish a number of microwave manuals that are extremely useful. They contain tried and tested designs from a number of authors over the

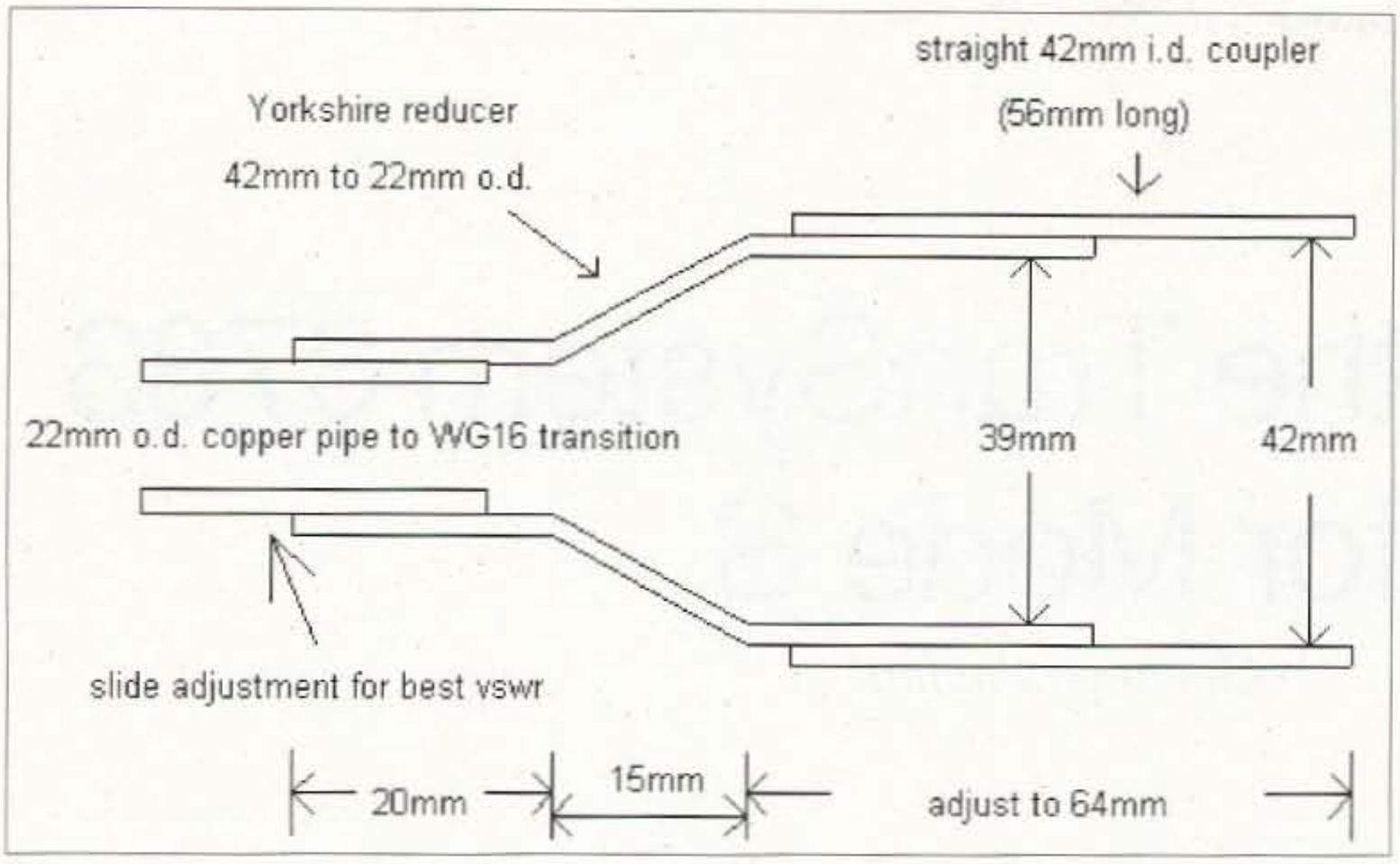

Fig. 4. Actual dual-mode horn assembly dimensions using a 60cm Amstrad offset-fed satellite dish.

years. The *ARRL Handbook* is another excellent resource, and this has also contained some very useful designs over the past few years. The current edition contains some nice designs for both 70cm and 23cm uplink bands.

The best source of antenna design information has to come from the Internet, and I make no apologies for repeatedly referring to it. The net has a great deal of live and up-to-date information available, and many sources of information on antennas and feeds that simply never makes it to print. Many amateurs publish small items on their Web site, such as G6LVB's dish and feed design here, that are of great interest but would never make it to print in a full-blown article in a magazine. There is also some highly useful information on W1GHZ's Web site: [http://www.w1ghz.cx]. This includes a very useful on-line antenna handbook for microwave antenna construction. This shows a number of useful designs and background design information, as well as antenna polar patterns and information on commercial feeds available. This resource is an invaluable site and veritable treasure trove from the experimenter. The site is also rich in other sources of design and component information for antennas, and is a must-see.

Software

Of course, apart from written and printed information, these sites also contain a variety of software packages.

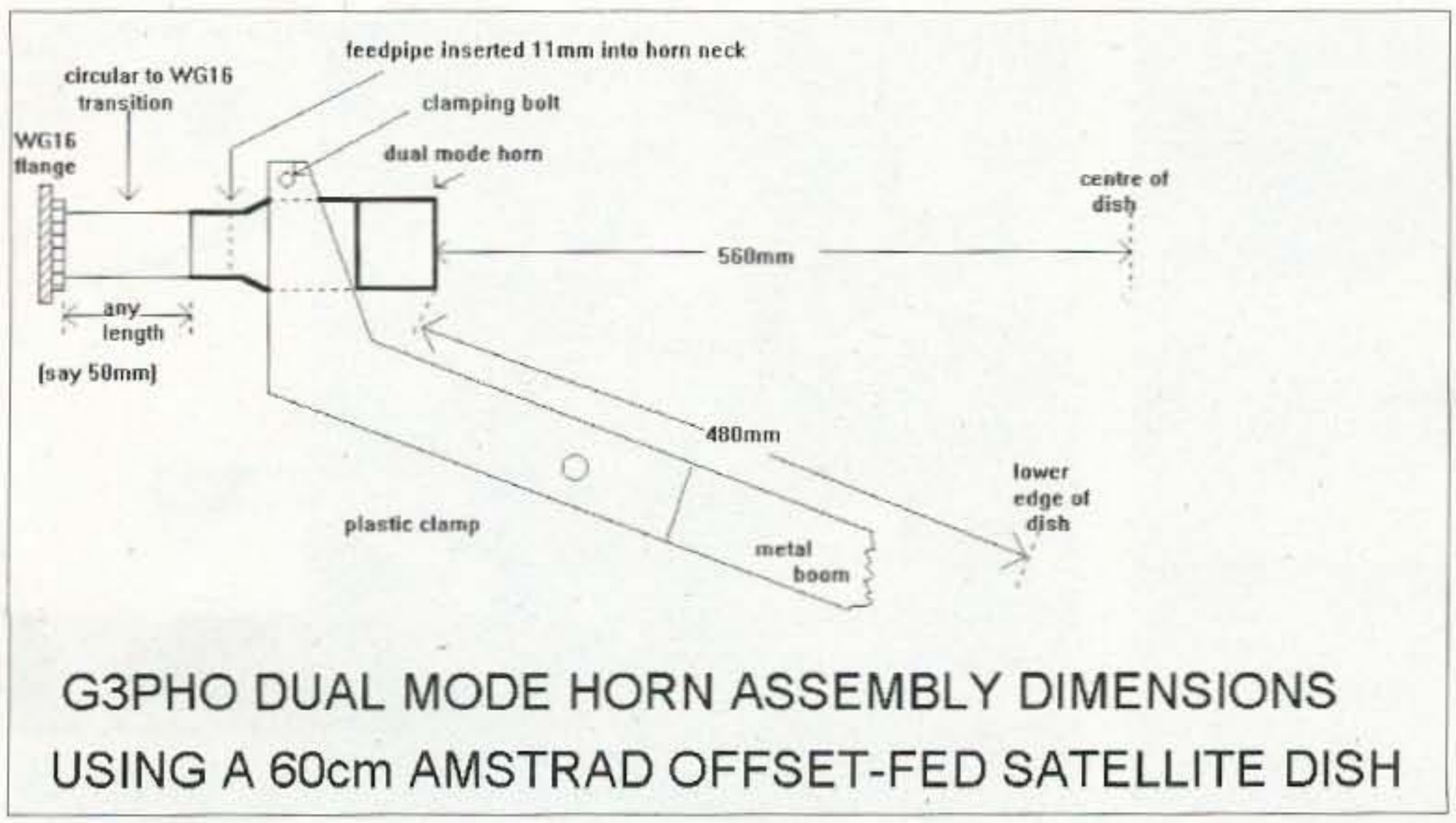

Fig. 5. Dual-mode horn mounting configuration.

W1GHZ's site contains a number of software packages specifically aimed at the microwave antenna experimenter. HDL_ANT is a particularly useful package for antenna calculations, and will calculate offset and prime focus dish feed and gain calculations. FEEDPATT is a similar package that is specifically designed to calculate design parameters for microwave feeds. Again, another very useful package!

There are plenty of other resources on the net, and all are well worth looking for. An evening spent browsing will reveal a range of packages and information resources to help you along.

Conclusion

Amateur microwave antennas and feeds are not difficult to construct and are easily built using small hand tools and readily available parts obtainable from your local DIY or hardware store. The designs shown in this article are tried and tested and will perform as intended as long as you build them in the way the designer intended, using the same size and types of materials shown. Just remember that at these frequencies small errors in measurements equal a large change in design due to the small wavelengths involved. Build the design as intended and using the measurements shown, and you will be successful every time. However, you don't need to become too exact and measure to fractions of a millimeter. You *can* get *too* accurate! Use a little common sense. Generally measurements to the nearest millimeter are quite sufficient.

Many of these designs will also be found replicated in the commercial world. Feeds for the higher bands are especially easy to find and should not be written off. The greatest fun at microwave is trying something new, and with AO-40 you have a flying signal generator to test your antennas on.

Have fun building your designs. It will almost certainly become the talking point of your contacts and give great pleasure to know that you have saved yourself hundreds of dollars and

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Modifying the TranSystem 3733 for Mode S

Get in on the fun!

To paraphrase Mark Twain, the demise of AO-40 has been greatly exaggerated! Many of us are having a ball on mode S with low-cost downconverters. Here is how you can get in on the fun using the TranSystem 3733 downconverter.

The TranSystem 3733 shown in **Photo A** is a modern marvel of electronics. It was designed for use in "wireless cable TV" systems. It takes the signal we want from 2400 MHz and converts it to VHF where we can use it. With very little modification it can be turned into a high-performance amateur downconverter. It comes in a weatherproof enclosure and features an integrated antenna, eliminating feedline losses and allowing the use of low cost cable such as RG-6.

The first thing you need to do is acquire a downconverter and power supply. A little snooping on the Internet should do the trick. They are relatively common items on places like eBay. Bob Seydler K5GNA [k5gna@aol.com] is selling the units as well as many other parts and accessories that can be used for modification. You are not going to need any exotic test equipment or strange tools to get on the air with this unit.

A special note on the power supply: The downconverter was designed to be powered by a DC voltage placed on the coax feeding it. This prevents the need for running additional wires for power. Typically, a "power inserter" is placed between the radio and the downconverter. This inserter will send power to the downconverter and block the DC from getting to the radio. A "wall wart" usually powers the inserter. The downconverter needs at least 15 volts DC to operate; this is due to the 12 volt regulator inside the unit. The need for this high of a voltage will probably prevent you from powering the downconverter with your radio's preamp power supply.

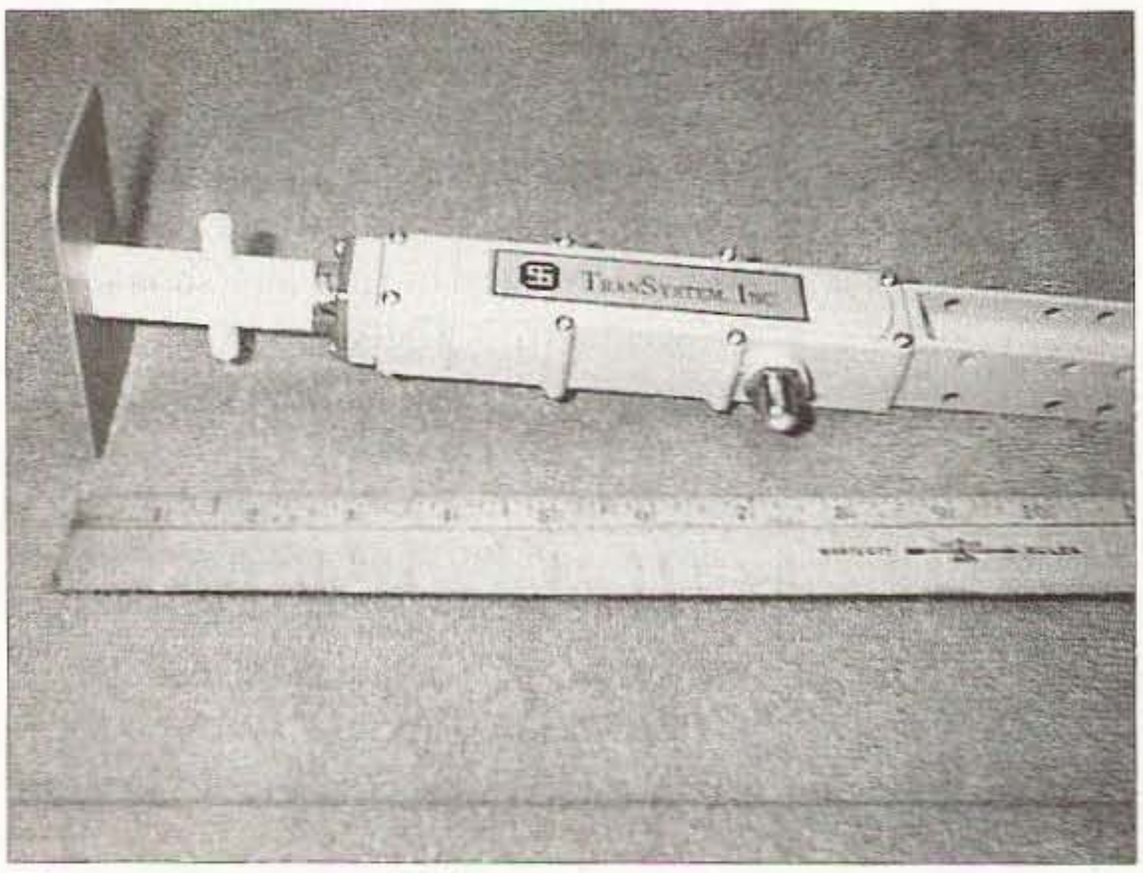

Photo A. *TranSystem 3733 downconverter.*

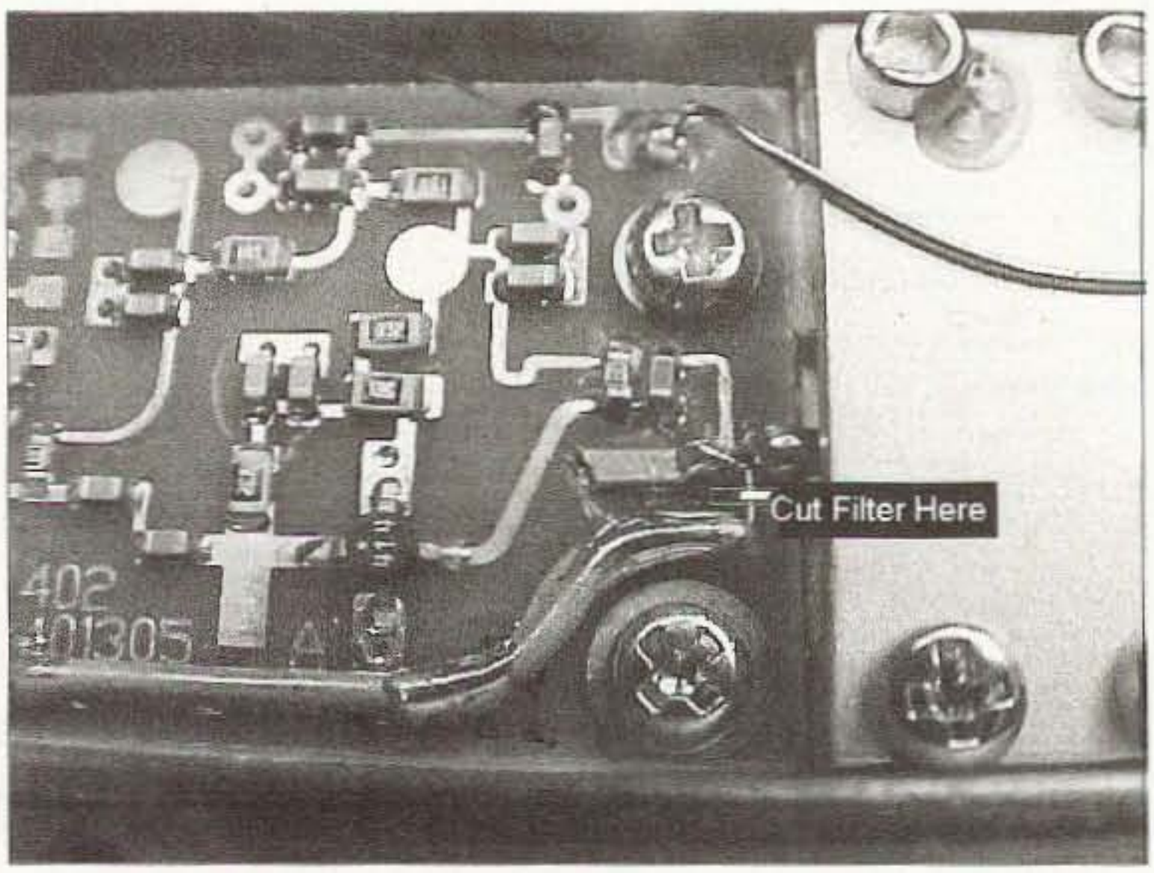

Photo B. *Stub cut location. [Photo by Mark Hammond N8MH]*

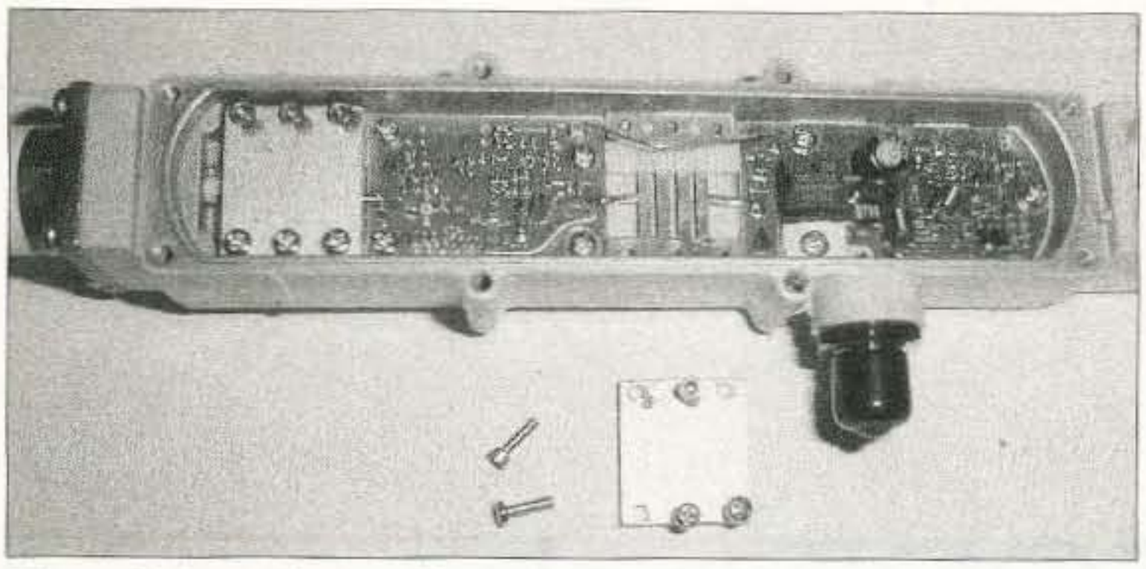

***Photo C.** Second stage filter (cover removed). [Photo K5GNA]*

Now here is the one modification required to get on the air. The unit was designed to work both above and below the 2400 MHz amateur band. In fact, it has a notch filter on the amateur frequencies. We need to disable this notch filter. Fortunately, this is rather easy to do! The notch filter is a piece of small-diameter coax. Remove the cover on the side that says "TranSystem" in large print. With the integrated dipole to the left, between the two square aluminum plates (we'll talk about them later) is the small piece of coax. Snip the coax right where the center conductor ties into the circuit as shown in **Photo B.**

If your radio will tune SSB at 122 MHz, this is all you need to do to get on the air! I worked quite a few stations on AO-40 using my 3373 having only this mod. The guys with the fancy test gear say this yields a noise figure of less than 4 dB.

If you want better performance (and who doesn't?), there is another mod that is fairly easy to do and yields a noise figure of about 1.4 dB. In this mod, we will replace the second stage filter with a bandpass filter. The original design was for use above and below the ham band. The notch (that we just removed) provided image rejection in the original design. We could add another notch filter tuned for below 2400 MHz, but it is easier to add a bandpass filter replacing the second stage filter. The filter of choice is the Murata DFC22R44P084BHD — its passband is from 2400 to 2480 MHz. I purchased the filter and PC Board from K5GNA.

Start by removing the second-stage filter. It is located under the metal plate near the middle of the unit. It is shown without the cover in **Photo C**. Be sure to save the pieces, because we are going to need them. Install the Murata filter on the circuit board (skip this step if yours was already mounted). I set it on a piece of cardboard and held it in place with a couple of straight pins as shown in **Photo D**.

Next, cut the "fingers" off the old filter, and use the strip with the holes in it as a washer on the top of the filter (where the cap head screws go). The new filter is shown installed in **Photo E**. Take a couple of small pieces of #20–#22 wire and connect the new filter in the circuit. This is also visible in **Photo E**.

At this point, you have a high performance downconverter that takes a 2400 MHz signal and outputs it at 122 MHz. This is the configuration I use my downconverter in. I like using it at 122 MHz because if I accidentally key my radio

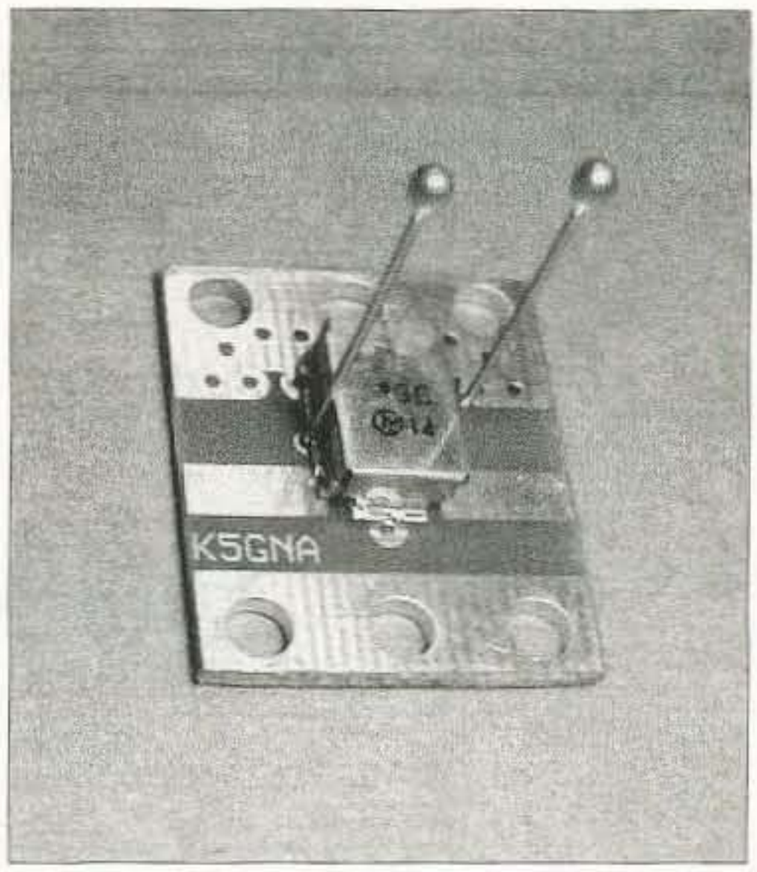

***Photo D.** Bandpass Filter ready to be soldered. [Photo K5GNA]*

instead of sending RF into the converter my rig just says error. If your radio doesn't work at 122 MHz, you will want to replace the crystal. The crystal is on the other side of the unit and it is socketed. It is a rather simple thing to replace. And the crystal is available from Jan, ICM, K5GNA, and just about any other crystal supplier. Very close to the crystal is a small variable capacitor that can be used to fine-tune the oscillator frequency. I have never worried that much about fine-tuning the frequency. If I can tune in the beacon and other stations to make QSOs,

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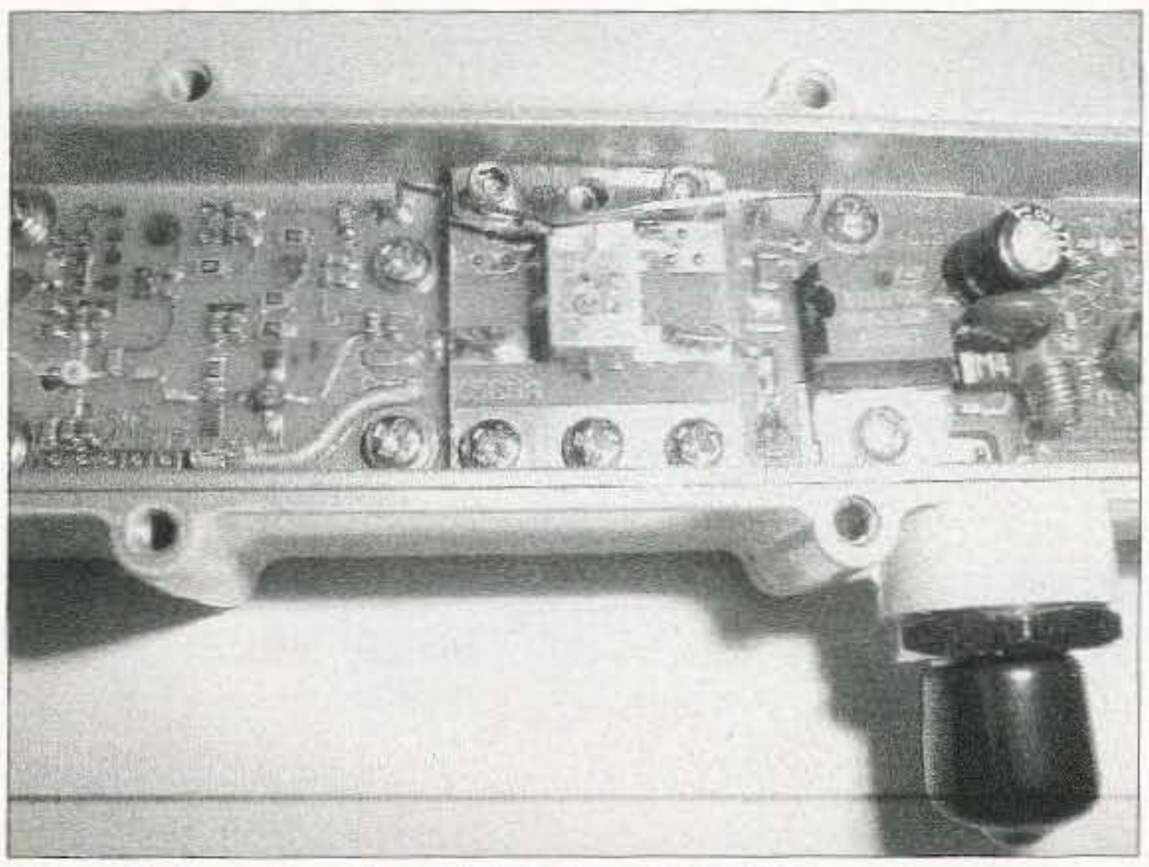

***Photo E.** New filter installed. [Photo K5GNA]*

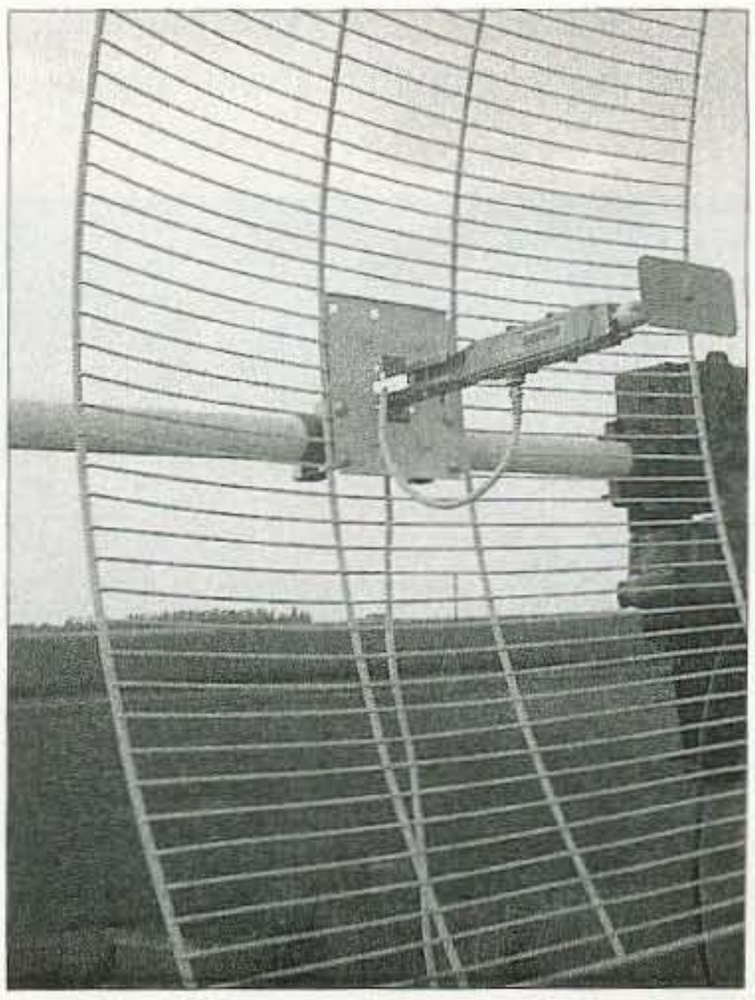

***Photo F.** Downconverter and integrated antenna installed. [Photo KAØYOS]*

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Build the FODTrack

How about a low-cost tracking interface?

Here is a low-cost solution to fulfill your automated satellite tracking needs. Manfred Mornhinweg XQ2FOD has made this free for noncommercial use. He says, "If you want to reward me somehow, write a piece of useful software and put it in the public domain!" I have built several of the FODTrack interfaces for less than $35 each using all new parts. Here is what I have found.

The FODTrack controller connects to the parallel port (the printer port) on your computer, and plugs directly into the back of the controller for the Yaesu G-5400/5500/5600 rotators. If you are using another rotator or combination of rotators you will need to do some modifications. All of my testing has been done with a Yaesu G-5400B rotator package.

I started by downloading the entire FODTrack package from the PC Software section of the AMSAT Web site. As of this writing the current version is 2.6. The package contains some pretty good documentation as well as the schematic and art work for the circuit board. FODTrack is much more than just a tracking interface, but I am limiting my discussion to that portion.

Let's move to the computer end. The parallel port — your new computer may not have one! If it doesn't, you can buy PCI or ISA cards that will add parallel port(s) to your system. You may want to consider pulling that old 486 out of the closet and using it exclusively for tracking. If you only have one parallel port, maybe it is time to buy a new USB printer and free the parallel port up for the FODTrack. Maybe you just need a parallel port switch and can select between the FODTrack and the printer. Anyway, you need a parallel port to make this work! Personal experience recommends that you do not switch from printer to FODTrack or FODTrack to printer with the computer on. Let's just say this is why I know the PCI parallel port cards work!

Fig. 1 is the schematic. It is not that

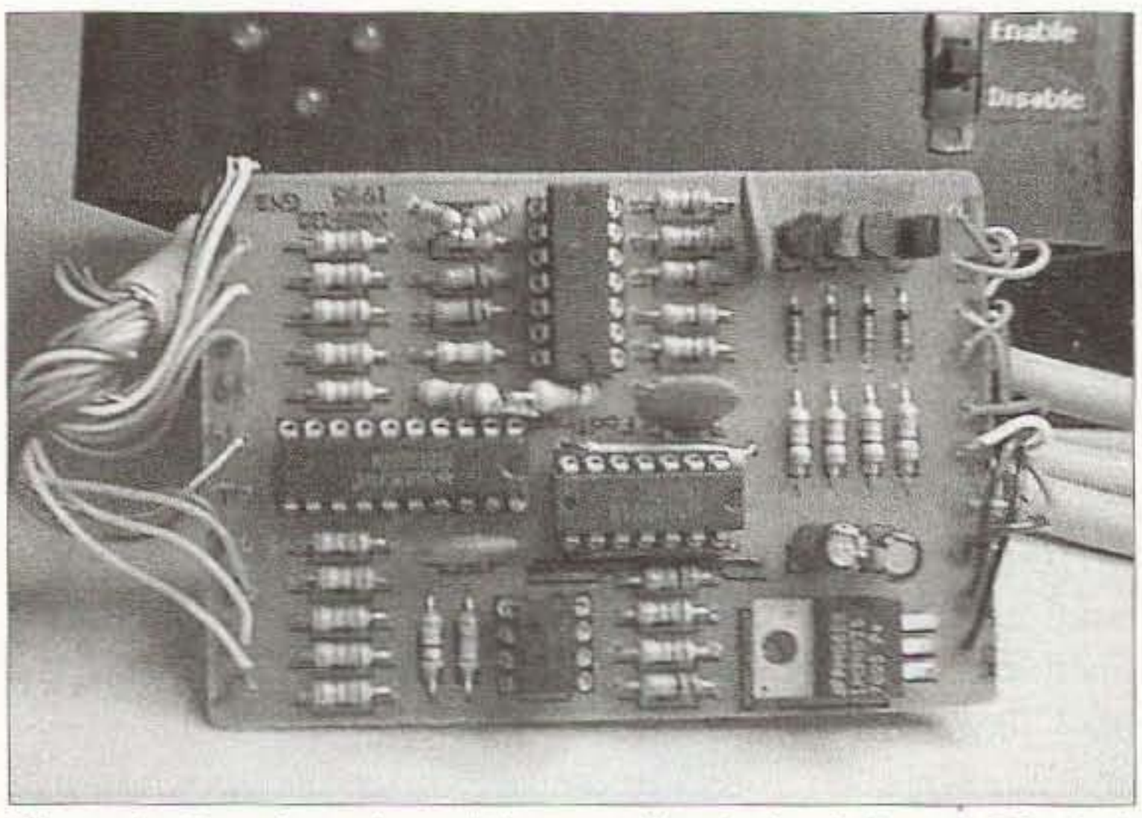

Photo A. *Here is a view of the completed circuit board. My junk box came in handy for this.*

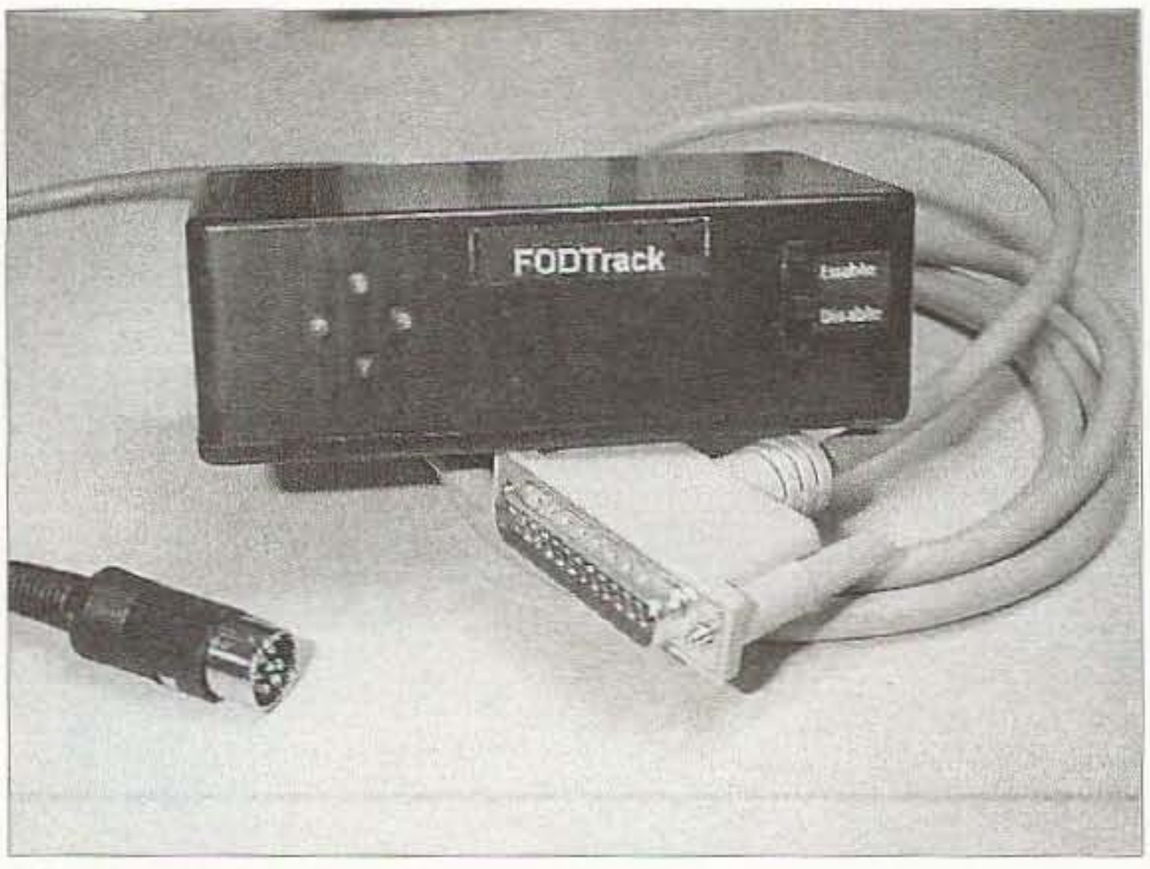

Photo B. *Front view of the completed controller.*

complex of a circuit, and should not be too difficult to wire point-to-point. I chose to etch my own board from the included artwork file. I just printed it out on a laser printer (actually printed it twice on the same sheet of paper for a double coating of toner), and ironed it onto some circuit board material. If you do this, be sure to touch up any light or missing spots with a permanent marker. I did the same thing for the parts overlay and ironed it on after I etched the board. Radio Shack's circuit board experimenter's kit has enough materials to do three of these boards. I have since learned that the boards are available from FAR Circuits [http://www.cl.ais.net/farcir/].

Unlike many projects, this one does not require any unobtainium. All of the parts except the circuit board are available from Digi-Key at [http://www.digikey. com/]. See **Table 1**.

Photo A shows my completed circuit board. Use standard building techniques. Solder in the sockets, but don't put the chips in the sockets until you are ready to go. I have a couple of construction notes to share. I must confess I raided my junk box for a couple of the parts shown in the picture. If you use the parts list above you won't have any resistors wired in series for equivalent values. I could not find the BC546 transistors shown in the schematic. It doesn't do anything other than switch so I substituted a good old 2N3904; just about any NPN transistor would do. The 2N3904 has worked well. The legs on the 2N3904 are in a different order than the BC546. They wind up going in backwards from what the parts overlay shows. Just make sure your base, collector, and emitter connections are the same as in the schematic and you will be fine. It is cheaper and easier to buy a manufactured parallel cable (make sure it is long enough) and cut it and connect it to the circuit board. Building a cable from the ground up is more heartache than it is worth. Just use your ohmmeter to determine which wire connects to which pin. For added show, I placed an LED in series with the output (collector) of the up, down, left, and right transistors. This way, I get an indication when the controller is moving the antennas.

Photo B shows my completed controller. My up, down, left, and right LEDs are on the left-hand side. You may have to do a tiny bit of filing or trimming on the circuit board to have it fit in the enclosure I have chosen. Be sure not to damage the circuit board traces if you do this. Since the enclosure is black, I printed white text on a black background from the Paint program onto the labels. I think it looks nice!

Follow the included instructions for calibration and setup and you should be set! There is a driver available to use the FODTrack interface with WISP. There may be other drivers as well. I use the FODTrack program that comes with the package. It is easy to

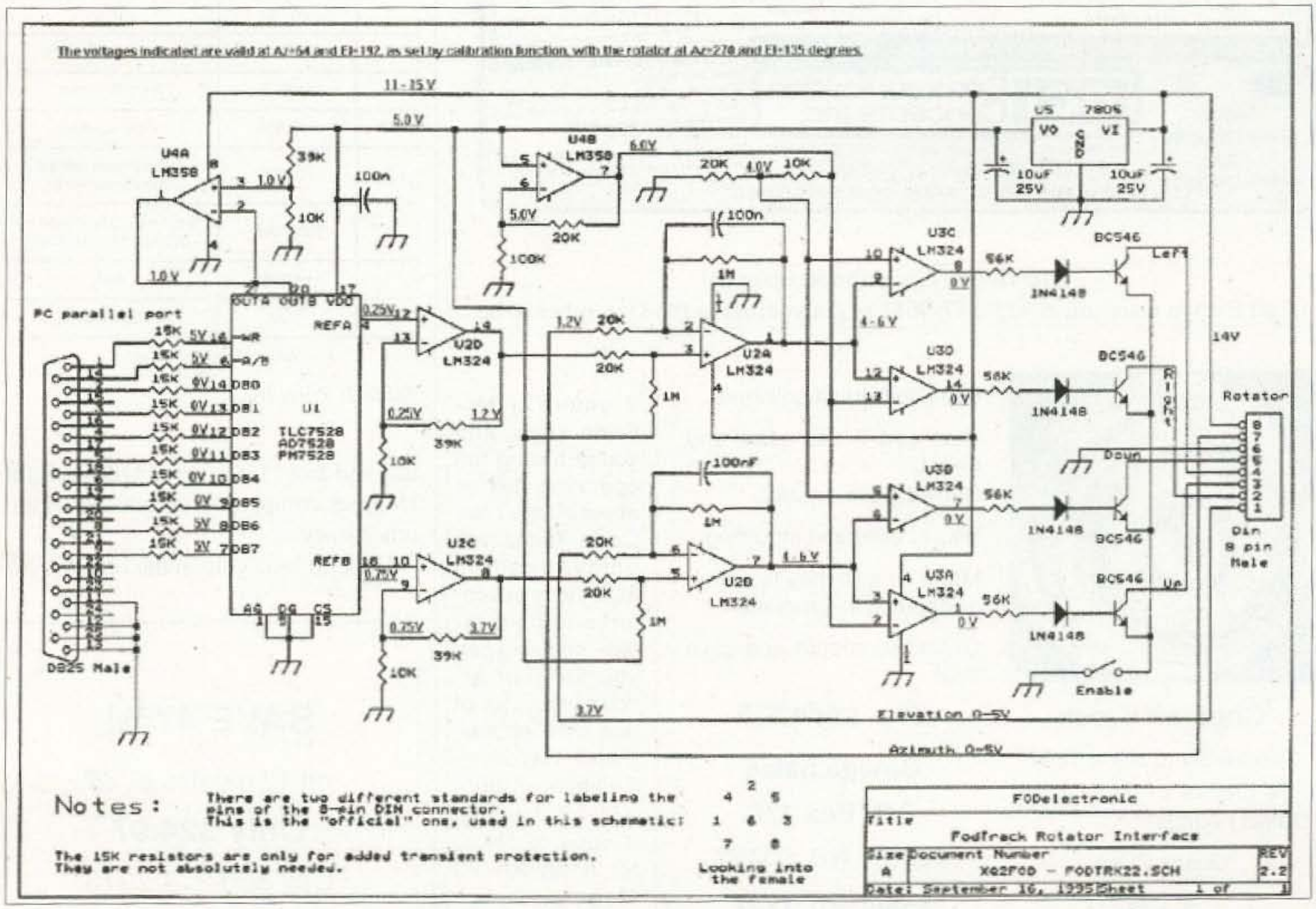

Fig. 1. This circuit is not too difficult to wire point-to-point.

If you're a No-Code Tech, and you're having fun operating, tell us about it! Other No-Code Techs will enjoy reading about your adventures in ham radio—and we'll pay you for your articles. Yes, lots of nice clear photos, please. Call Joyce Sawtelle at 800-274-7373 to get a copy of "How to Write for *73* Magazine."

Qty.	Digi-Key P/N (add -ND)	Description
Resistors (Qty. in 5-packs)		
1	10KQBK	10k
2	15KQBK	15k
2	20KQBK	20k
1	39KQBK	39k
1	56KQBK	56k
1	100KQBK	100k
1	1.0MQBK	1 meg
Capacitors		
3	P4201	0.1 µF ceramic (100 nF)
2	P5148	10 µF electrolytic
ICs		
1	LM340T-5.0	LM7805 Voltage regulator
2	296-1392-5	LM324 Op Amp
1	296-1395-5	LM358 Op Amp
1	296-1871-5	7528 Analog-to-Digital converter
Semiconductors		
4	1N4148MSCT	1N4148 diodes
4	2N3904	2N3904 transistors
Miscellaneous		
1	SW102	Switch
1	AE7220	20-pin IC socket
1	AE7208	8-pin IC socket
2	AE7214	14-pin IC socket
1	AE1112	Parallel cable (get the length you need)
1	275-1005	8-pin male DIN connector (plug in to rotor box)
1	HM104	Box
1	PCB	Not from Digi-Key
Additional wire, tools, etc.		

Table 1. *Parts list.*

use and free! I also use FODTrack for Doppler compensation, but that is another story.

Hope to hear you on the birds! 73

Gerald R. Brown K5OE
Houston TX

What IS an EasySat, Anyway?

Now you know.

With all the press about the latest and greatest satellite, AO-40, many people forget that we have a fleet of lesser, yet perfectly workable and fun, Low Earth Orbit (LEO) "EasySats."

There have been numerous articles — for decades — extolling the ease of getting on the "EasySats." Why then don't more amateurs try them? They truly can be "easy," when you know four critical things: (1) what frequencies and modes to use; (2) how to make a QSO; (3) when they are overhead; and (4) where they are. Now that seems simple enough, but it takes a little work and it takes a little practice — but not too much. This article supplies you with some of the basics, and the Sources at the end provides some excellent references, both in print and via the Internet, for finding operating frequencies and practical tips for successful operation.

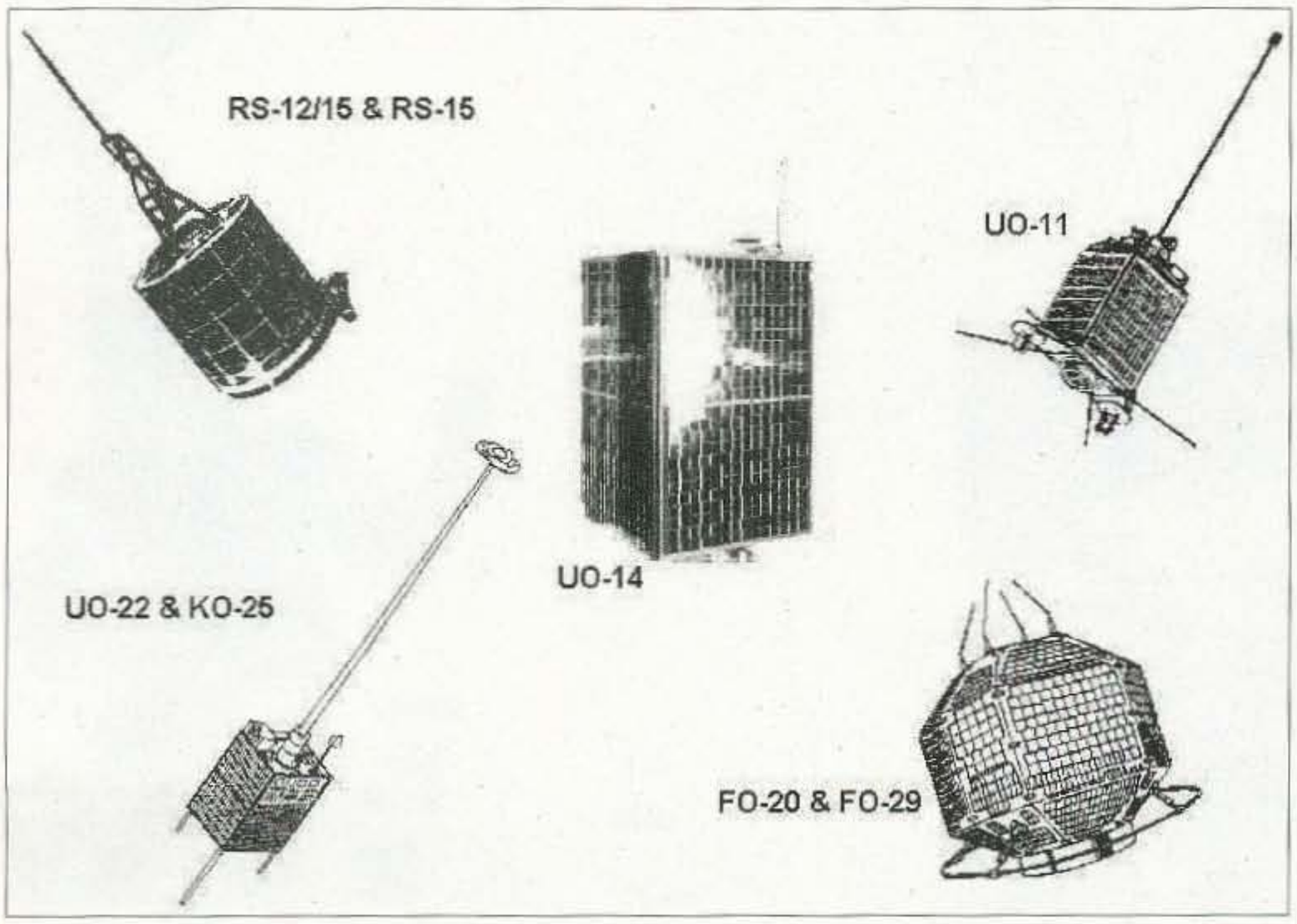

Fig. 1. *Some of the current "fleet" of amateur satellites you can work with simple equipment and antennas (not to scale).*

What and how

First, let's agree on what an "EasySat" is and how to work one. Generally, an "EasySat" is defined as one an amateur radio operator can work with equipment already owned. After all, what could be easier than just learning a new mode with the equipment you are already familiar with and have in front of you? For example, my first satellite QSO was made using my HF radio in "split" mode — just like working DX on 40 meters. It was on RS-12, using 15 meters for the uplink and 10 meters for the downlink. Unfortunately, the days of HF satellites are quickly drawing to an end, as most of the satellite activity is now on VHF — and above — frequencies. Even if all you have is a 2-meter FM radio, you still have the ability to work an EasySat: the International Space Station (ISS). The ISS has both packet and voice capabilities on 2 meters. Oh, and APRS, too!

The next class of satellites easily workable with typical shack hardware are LEOs operating with 2-meter uplinks and 70cm downlinks, both FM. Currently the "fleet" consists of two "birds": AO-27 and UO-14. Many

Fig. 2. The author's QSL card from a 2-meter QSO with Susan Helms (NA1SS) aboard the International Space Station earlier this year.

people work these satellites with HT's and mobile FM radios — even while driving. These are without a doubt the most easily accessible and popular satellites today. Many operators take an HT with them when they go fishing or camping, even boating or on a cruise, and give other operators the chance to work rare grid squares. VUCC is alive and well on the satellites. One important point: UO-14 is much easier to hear than AO-27, and thus can be extremely crowded (competitive!) at times, so weekday morning passes are highly recommended for beginners. Listening first for a few passes is also recommended to get the feel for the action — it can be fast and furious. Make your calls by "tail-ending" another QSO, and make it fast.

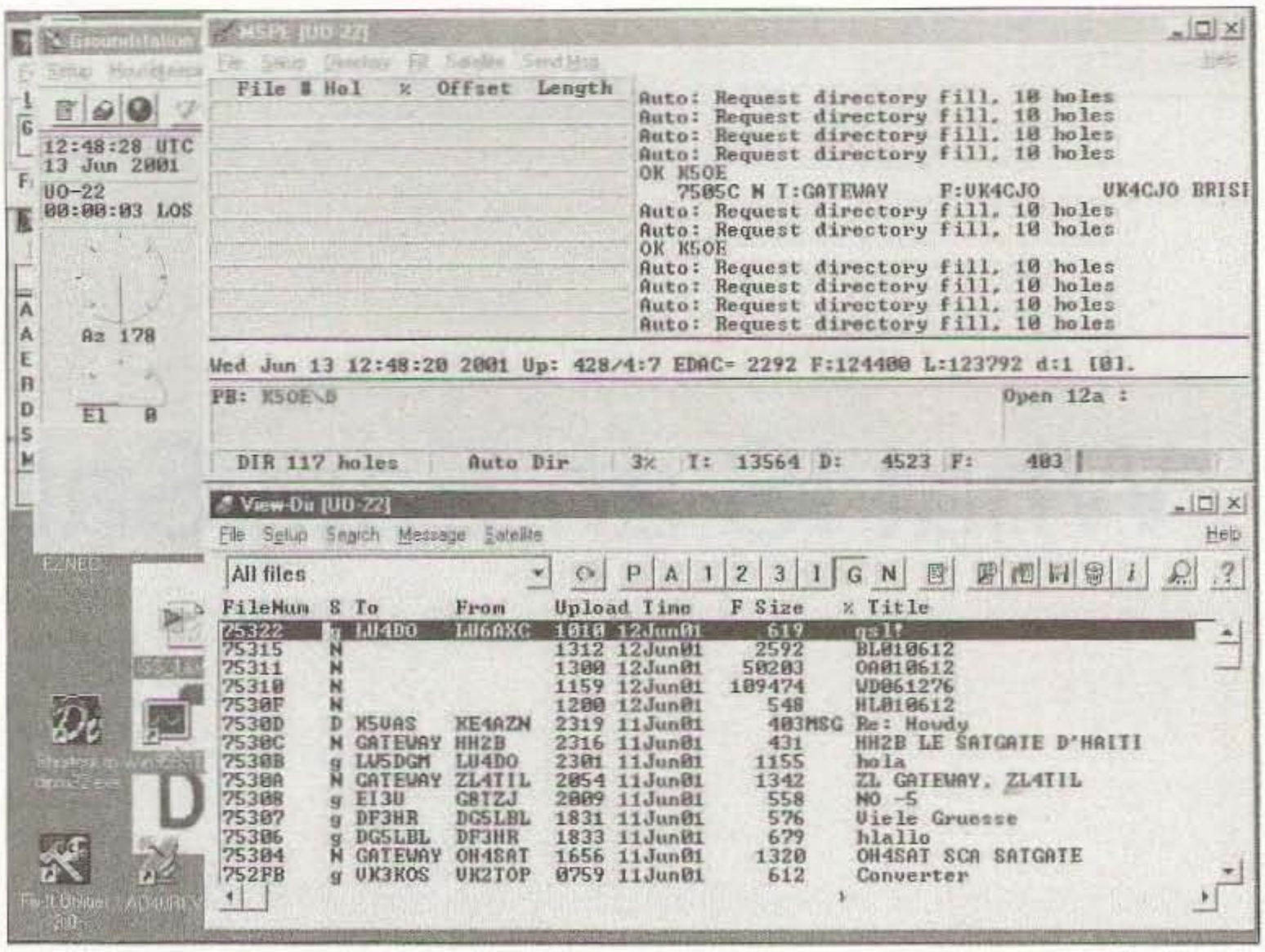

Fig. 3. UO-22 operation using WISP PacSat software.

If you have V/UHF FM capability and have a digital bent, then maybe packet satellites will interest you. There are currently two packet satellites (pacsats) operating at 9600 baud that are relatively easy to work: UO-22 and KO-25. The only difference from terrestrial packet, other than being at 9600 baud and not 1200 baud, is the special pacsat software required. Of course, a 9600 baud TNC (or PC soundcard TNC program) is required. The PB (DOS) or WISP (Windows PC) software available from AMSAT handles all the software routines automatically, from tracking the satellites to downloading messages, and connecting to the satellite for upload of any messages, pictures, whatever. Full, unattended station operation is possible, and you can try the software out for free. Most modern dual-band

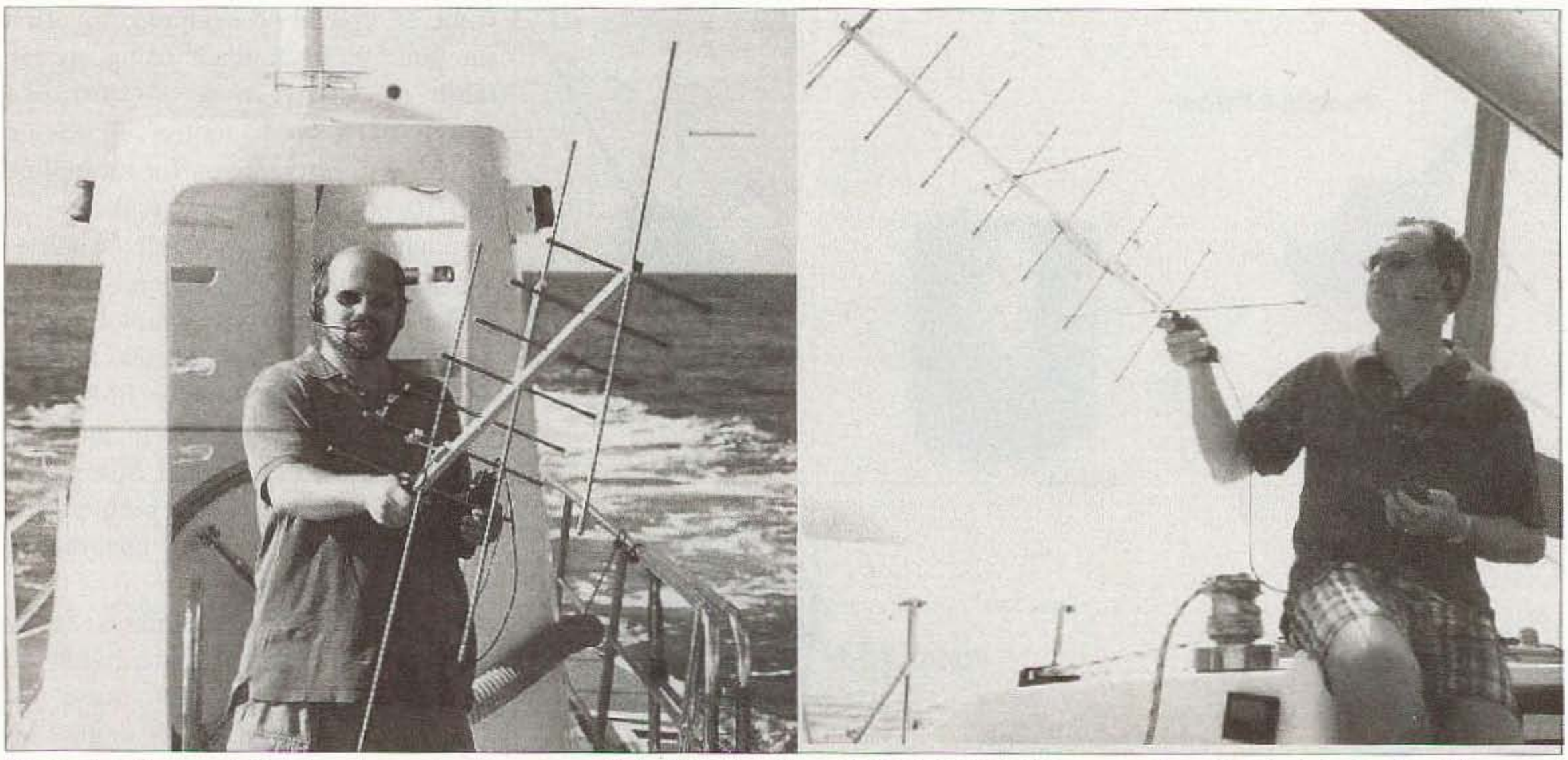

***Photo A.** Using an HT and an Arrow Antenna to work the FM EasySats, ZF1DH (VA3DH) is on a submarine deck in the Caribbean and G3VZV is on a sailboat in the Mediterranean. I told you it was fun!*

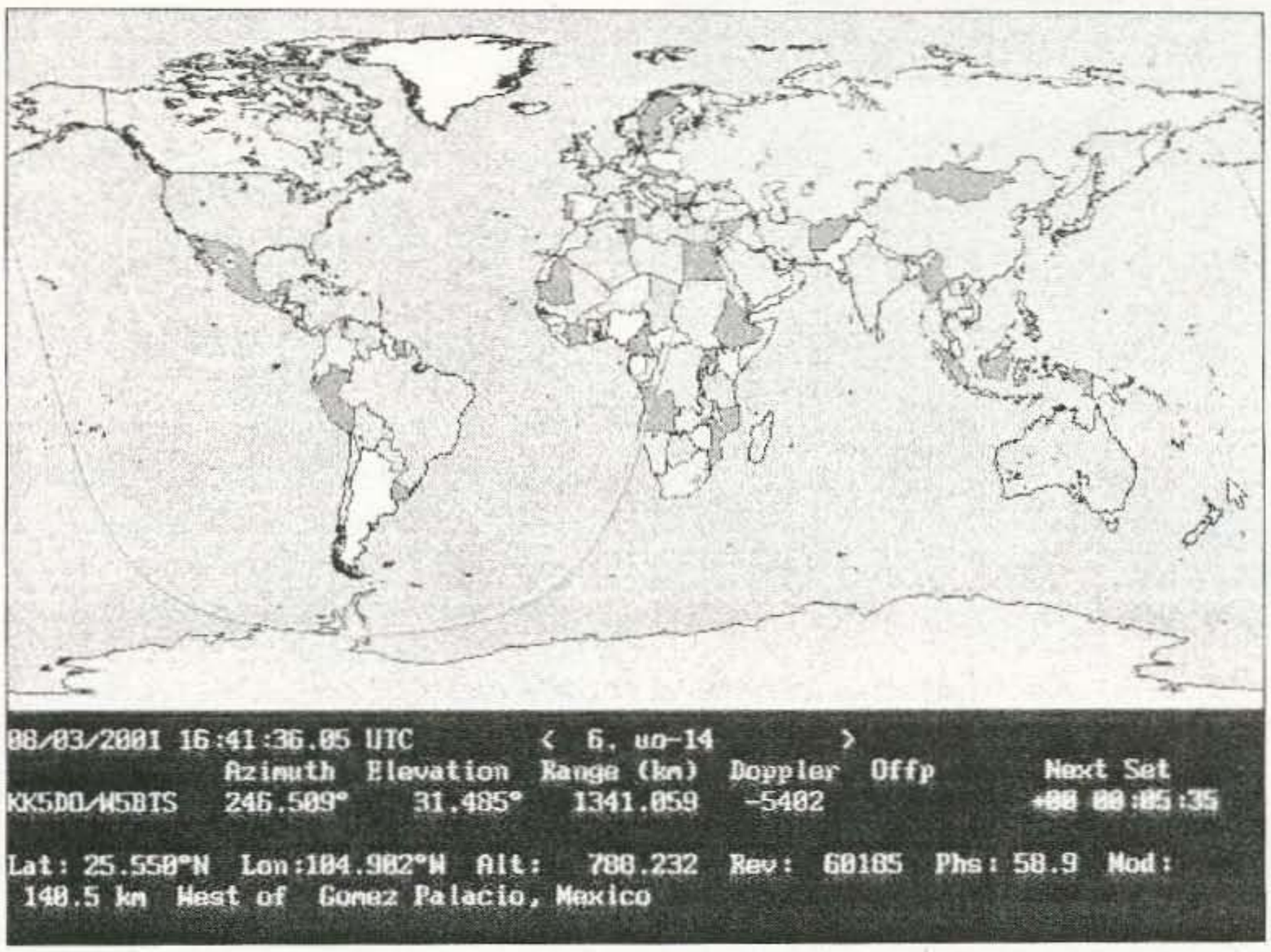

Fig. 4. Tracking satellite passes using AMSAT's InstantTrack.

mobile radios have full 9600 baud capability built-in. Also see the Sources for references to information about some of the older 1200 baud digital satellites such as UO-11 and the ASTARS program.

The next-easiest satellite class are those that have 2-meter SSB/CW uplink and 10-meter downlink: RS-12/13 and RS-15. If you have a radio with 2-meter SSB/CW capability, this mode is still easily workable in "split" fashion as I noted above. It helps to be able to hear your downlink, but it is not critical at these frequencies. RS-12 is quite easy to hear and work. Typical stations use a dipole on 10 meters to receive the signals and a 2-meter ground plane or J-pole antenna with 10–50 W uplink power. Late-model mobile radios like the FT-100, FT-817, and IC-706 are often heard on this satellite. RS-12 can

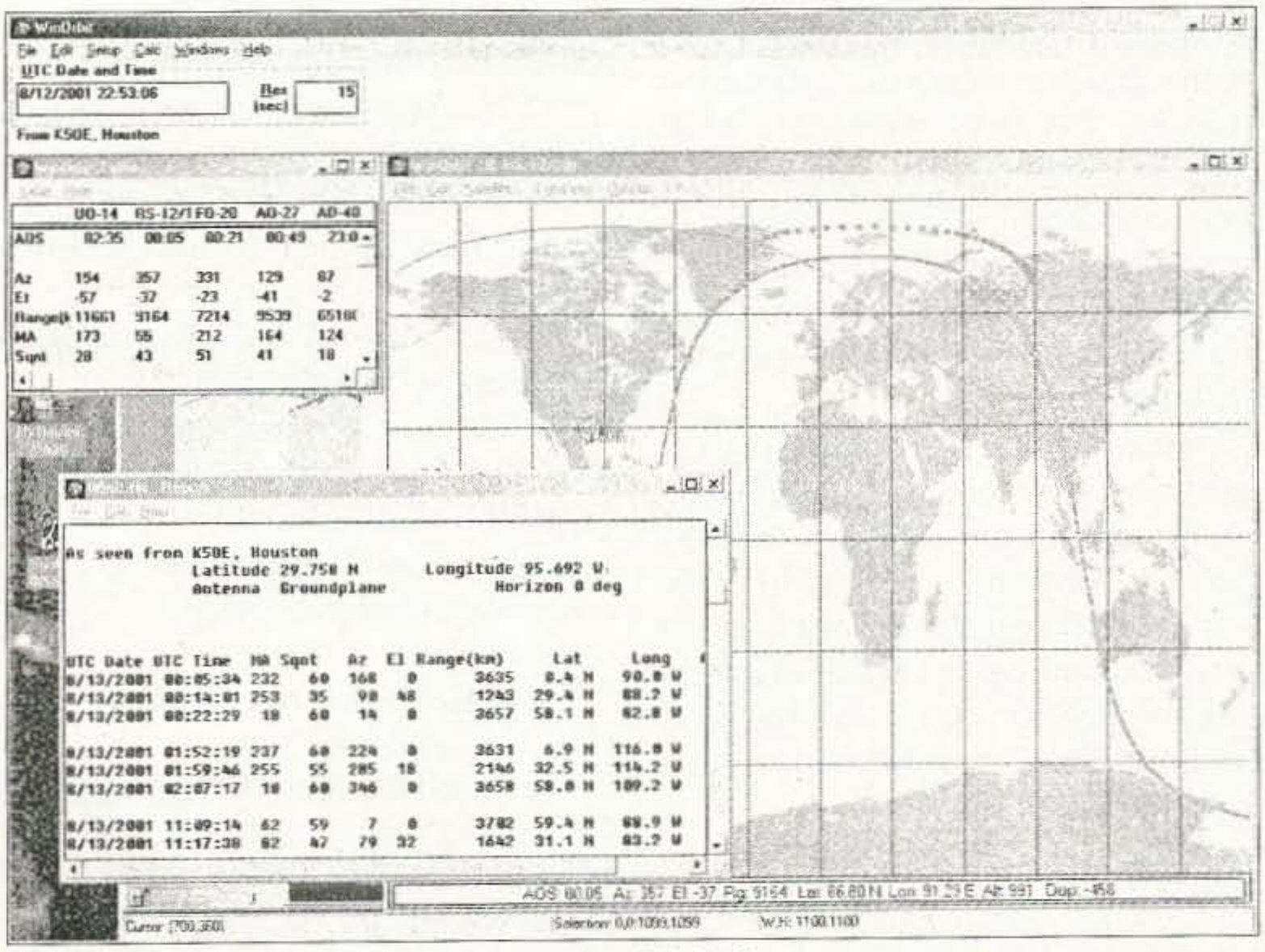

Fig. 5. Plotting future satellite passes using WinOrbit.

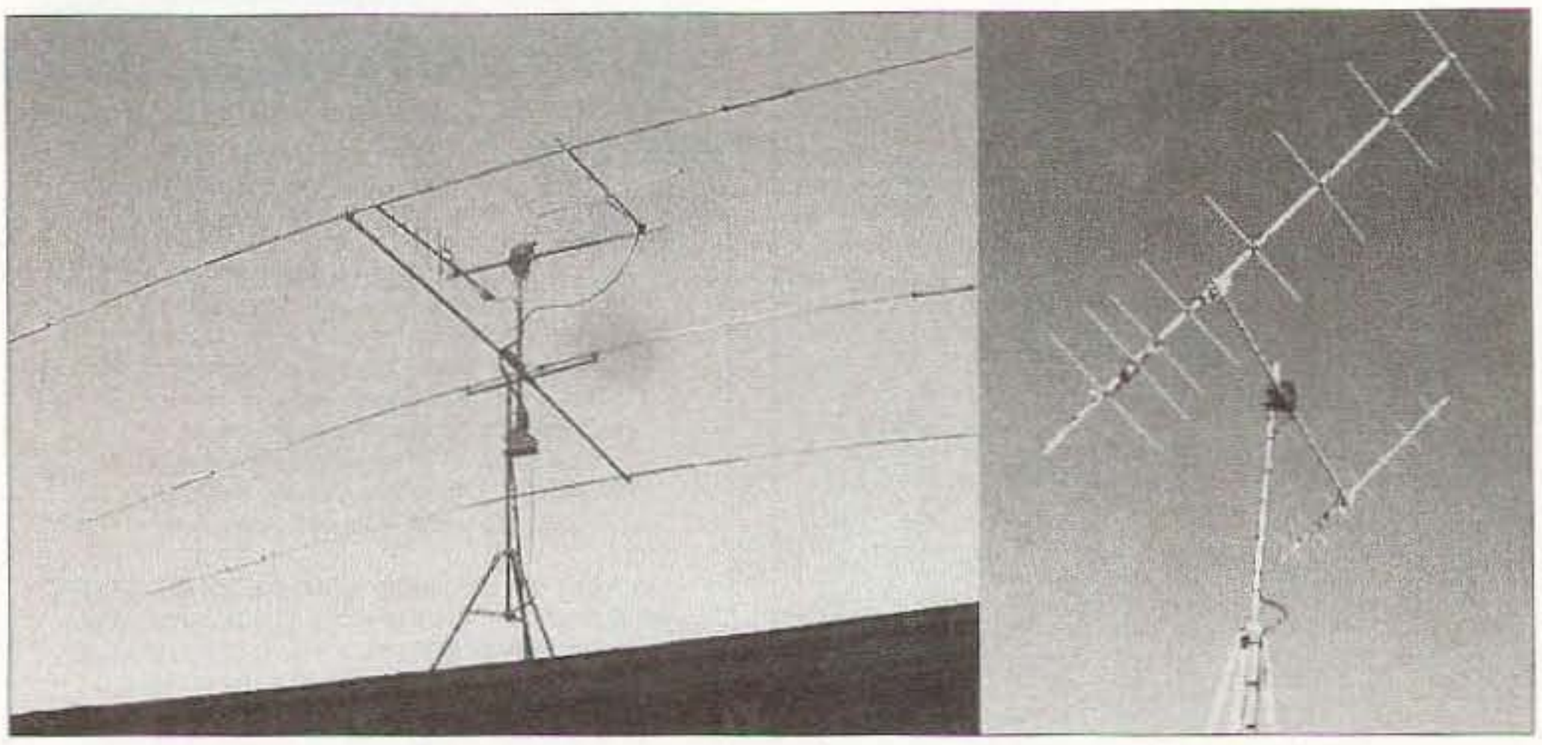

***Photo B.** V/UHF satellite antennas on the rooftops at KO4MA and KD9KC.*

operate with other uplink/downlink combinations, including multiple uplinks or multiple downlinks at times. When this solar cycle wanes, perhaps the controllers will return it to simultaneous 2-meter and 15-meter uplinks. In that mode, CW was very popular. RS-15 is a difficult satellite to work, requiring significant uplink power and a very good receive system — thus is lightly used.

Finally, the last class of EasySat LEO, the SSB/CW birds FO-20 and FO-29. These really are the ultimate LEOs, but are really more like "IntermediateSats" than EasySats. Both of these satellites also use 2 meters for the uplink and 70cm for the downlink, but full-duplex operation is generally required due to the high Doppler shift of the signals. These satellites have excellent audio characteristics and have 100-kHz-wide passbands — allowing many simultaneous conversations for 10 to 15 minutes at a time. Roundtable discussions with 3, 4, or 5 operators are not uncommon. Radios such as the FT-726/736/847, TS-790/2000, IC-820H/821H/910H, and older pairs such as the IC-271/471 are typically used along with beam antennas controllable in both azimuth and elevation. Antennas for these satellites range from simple omnidirectional antennas like eggbeaters to the big "OSCAR-class" setups.

When and where

Now that you have an understanding (and lots of references for further information) of what satellites might be easy to work and how to work them, let's move on to the other two critical items: when and where to find them. Fortunately, both of these questions can be answered with the convenient computer-based tracking tools available today. Modern personal computers handle with ease the calculations necessary to predict and plot the orbits of the amateur satellites. Software is available for DOS, Windows, Mac, CE, Linux, etc. I often use a Palm PDA (personal digital assistant) when mobile/portable to track the satellites. Real-time tracking tools are even available as Web-enabled screens over the Internet.

Maybe "easy" has always been a stretch, as it is a lot of new information to the uninitiated. But, it can be handled a little at a time and soon becomes second nature. I encourage you to read further, ask questions at a local club meeting, or see if you can find a satellite "Elmer" to help you learn and to join in on the fun.

Sources

In Print:

The ARRL Handbook For Radio Amateurs, The American Radio Relay League

The Radio Amateur's Satellite Handbook, M. Davidoff K2UBC (available from both AMSAT & ARRL)

On the Web:

The first place to stop, AMSAT-NA: [http://www.amsat.org/]

FAQ and introductory articles (be sure to read *Working The Easy Sats* by WA4YMZ): [http://www.amsat.org/amsat/intro/faqs.html]

Software: [http://www.amsat.org/amsat/ftpsoft.html]

Elmers: [http://www.amsat.org/amsat/fieldops/AAC.html]

Nets: [http://www.amsat.org/amsat/activity.html]

The ISS APRS map of stations (cool!): [http://www.ariss.net/]

Home-brew handheld antenna: [http://xe1mex.gq.nu/]

Home-brew antennas: [http://members.aol.com/k5oe]

Mobile operation: [http://members.aol.com/dquagliana/beginner.html]

Portable operation: [http://www.qsl.net/wb8erj/]

APRS Satellite Tracking and Reporting System: [http://web.usna.navy.mil/~bruninga/astars.html]

Amateur radio on the ISS: [http://www.rac.ca/ariss.htm]

RS-12/13 FAQ: [http://www.qsl.net/ac5dk/rs1213/rs1213.html]

AO-27: [http://www.amsat.org/amsat/sats/n7hpr/ao27.html]

UO-14: [http://www.ee.surrey.ac.uk/CSER/UOSAT/missions/uosat3.html]

UO-11 News from G3CWV: [http://www.users.zetnet.co.uk/clivew/index.htm]

UO-22: [http://www.amsat.org/amsat/sats/n7hpr/uo22_kd2.html]

On-line satellite tracking: [http://liftoff.msfc.nasa.gov/RealTime/JTrack/]

On-line satellite tracking: [http://www.heavens-above.com/]

On the Air:

The AMSAT HF Net: Sunday 1900 UTC, 14.282 MHz.

The Houston AMSAT Net: Tuesday 2000 local time (0200 UTC Wed.), 145.190 MHz (PL 123.0); also broadcast live via the Internet at [www.amsatnet.com]. 73

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The PCSat APRS Satellite

More fun on the horizon ...

If all went well, in September 2001, the amateur satellite community gained another amateur satellite. Named by the students as PCSat, for Prototype Communications Satellite, this satellite should offer handheld communications capability to amateur radio travelers anywhere worldwide.

The downlink from PCSat will be fed into the Internet for live worldwide distribution of data. A unique feature of PCSat is that it contains no computer. The entire telemetry and command/control system was built from an off-the-shelf Kantronics PK-9612Plus TNC.

Just like its smaller cousin, the KPC-3plus, the 9612+ TNC gives Telemetry, Beacon, GPS, and communications capability including a digipeater and 4-channel command/control channel as well. We modified our TNC to gain a total of 16 telemetry channels and 10 command I/O bits. The 9612+ TNC adds a second comm port to the TNC, offering one port at 1200 and the other at 9600 baud. We modified it for a total of 8 configurable command or I/O bits, four ON/OFF command bits, and one input bit. Because of the added 9600 baud comm port, the KPC-9612+ TNC was designed into the final PCSat design. PCSat is just one of a possible constellation of student-built satellites supporting the ASTARS Mission all based on using AX.25 TNCs in orbit.

The ASTARS Mission

The ASTARS Mission is a generic mission (supported by any TNC in orbit) to provide real-time message, position, and status relay via satellite to a worldwide Internet-linked amateur radio tracking system. Any amateur or university payload can support this mission by simply enabling the DIGIPEAT-ON function in any AX.25-compatible transponder (TNC). The users of such a relay system can be boats at sea, remote environmental sensors, cross-country

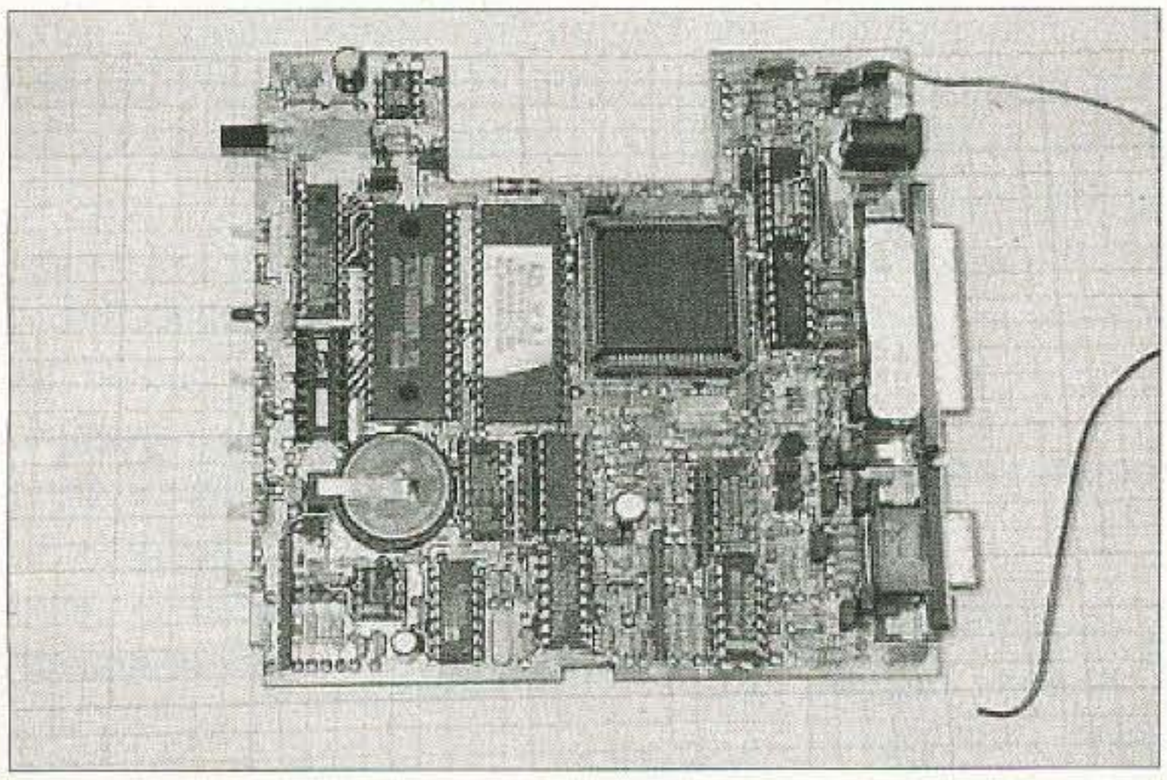

Photo A. *The KPC-3+ TNC that can serve as the basis for a satellite design. For PCSat we used the dual port KPC-9612+ to gain an additional receive channel.*

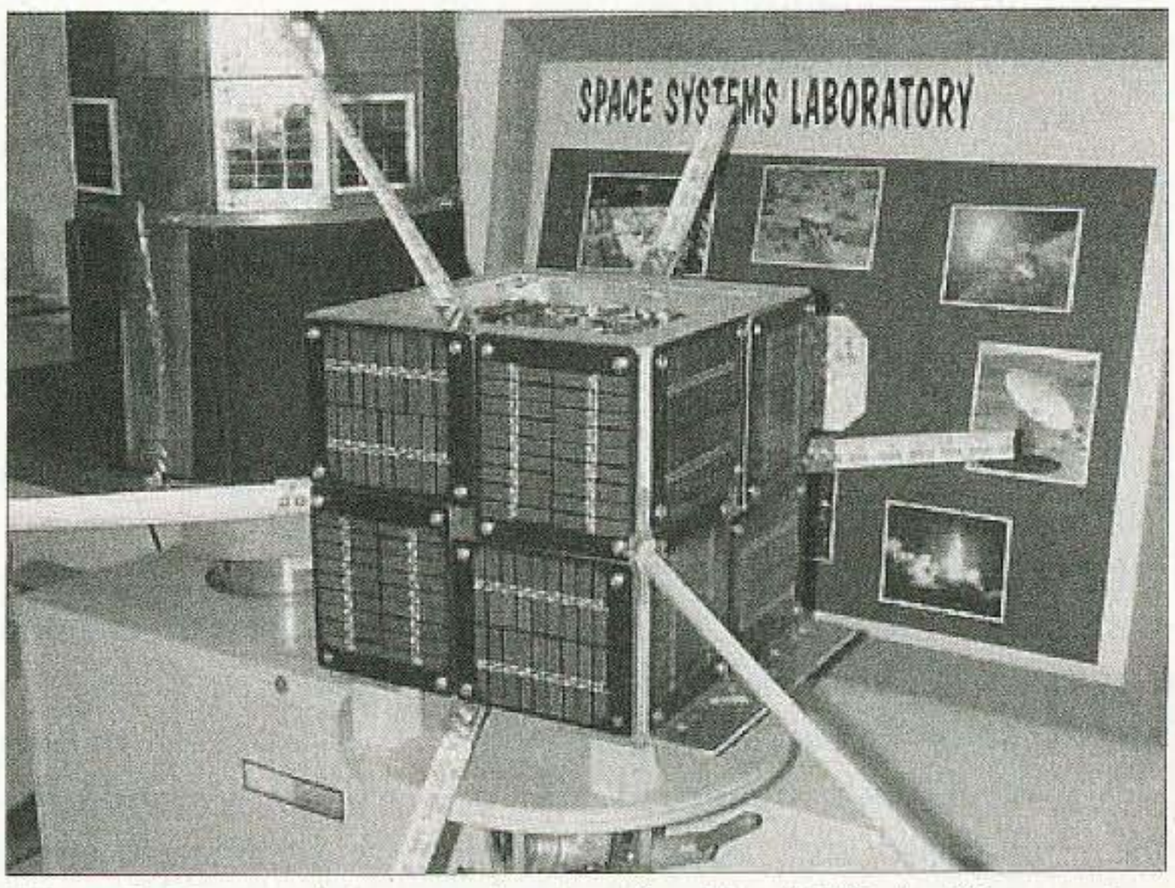

Photo B. *Personal Communications Satellite (PCSat) with antennas.*

Photo C. *Personal Communications Satellite, PCSat and design team.*

Photo D. *Chas Richard W4HFZ's mobile APRS satellite capability (including HF). With an APRS satellite, he can send and receive brief text messages anywhere on the planet a few times a day.*

travelers, expeditions, school projects, or any other travelers who are far from any existing APRS terrestrial tracking infrastructure.

The satellite downlinks from such travelers or remote sites are fed into the existing worldwide Internet-linked ground system by a few permanent ground stations. These APRS satellites would join our own PCSat and other university-built small satellites to provide connectivity to everyone involved in this mission whose birds were not locally in view.

The space segment of PCSat/ASTARS has been demonstrated a number of times in space via *MIR* school tests, the shuttle SAREX, the SPRE mission, AO-16, UO-22, and more recently SUNSAT and ISS. Full details of the PCSat mission can be found at [http://web.usna.navy.mil/~bruninga/pcsat.html] and [http://web.usna.navy.mil/~bruninga/astars.html].

Although the Naval Academy has been in dialog with a number of other satellite owners and designers over the last 7 years to accommodate these concepts into their designs as well (SAREX, SPRE, *MIR*, ASUsat, UO-22, and SUNSAT), PCSat will be the first satellite designed with APRS UI digipeating as the primary mission, with these objectives:

(1) Handheld/mobile live digital tracking and communications in footprint.

(2) Worldwide handheld and mobile position and status reporting (via Internet).

(3) Handheld and mobile message uplink to satellite (then to Internet).

(4) Handheld and mobile message downlink/delivery from Internet.

(5) Nationwide bulletin delivery.

(6) Low-power GPS tracking of buoys, telemetry devices, wildlife, etc.

(7) Other UI digipeating applications.

(8) Worldwide one-line E-mailing.

(9) School demonstrations and satellite lab activities.

All of these mission objectives can be met with just a simple hardware TNC on orbit acting as a UI digipeater. Also, with the sophistication and added I/O of recent TNCs designed for APRS, the TNC itself can be the command and control system. Thus no additional on-orbit CPUs are required. Not only is the satellite hardware simple, but it can be reproduced by other satellite builders to help form a constellation of these relay satellites, all operating on the same frequency to give mobile users extended access beyond what is possible with one satellite alone. This concept of a Builders' Channel for similar-mission spacecraft was presented at last year's AMSAT Symposium.[1]

Background to the mobile satellite need

Modern technology is on the move. Satellite wireless is the leading edge of technology. In the amateur satellite program, it should be a major driver for future amateur satellite missions. In just the last year, there have been many hints at the future of amateur mobile and handheld satellite communications:

(1) Growing popularity of UI digipeating via *MIR* through 1999.

(2) Continuing high popularity of AO-27 for handheld FM voice communications.

(3) Activation of UO-14 for FM voice repeater mode in February 2000

(4) Experimental UI digipeating via the UO-22 satellite.

(5) FM voice repeating via SUNSAT SO-35 throughout 1999.

(6) Recent activation of SUNSAT SO-35 for UI and APRS.

(7) Recent introduction of new TNC/radios (Kenwood and Alinco).

(8) Dayton 2000 introduction of the upgraded Kenwood TH-D7 data HT!

The potential of two-way satellite handheld text messaging (national paging) was serendipitously demonstrated at the Dayton Hamvention during a parking lot demo of the SUNSAT downlink. Due to a scheduling error, there was no success at the expected time, so the HT was placed in a pants pocket and forgotten. But minutes later, the telltale beeping of the TH-D7 alerted me to an incoming APRS message; on inspection, it turned out to be a bulletin from SUNSAT. Thus, amateur satellite message delivery to an unattended obscured handheld transceiver was demonstrated.

ASTARS

To distinguish this APRS satellite communications system from its terrestrial

counterpart, the space segment is called ASTARS for APRS Satellite Tracking and Reporting System. This has evolved through a number of existing and previous satellite communications experiments. First was 1200-baud PSK ASTARS, which was called TRAKNET[2] at the 1998 and '99 AMSAT conferences using AO16, LO-19, and IO-26. It is a very viable capability for stations with PSK TNCs or using more recent soundcard modem uplink capability.[3] But it never became popular due to the rarity of PSK modems among most amateur satellite operators.

Satellite packet experiments using 1200-baud AFSK ASTARS, however, which any TNC can do, were demonstrated many times during experiments with the space station *MIR*[4] packet system and SAREX.[5] These experiments culminated in the June 1999 weeklong experiment via *MIR* that used the new Kenwood TH-D7 handheld with built-in 1200 and 9600 baud TNCs to demonstrate two-way self-contained APRS communications via *MIR* at 1200 baud. During this test,[6] over 55 stations conducted 2-way HT message communications.

Recently, experiments have been conducted with 9600-baud ASTARS using UO-22 and SUNSAT and the new Kenwood 1200/9600-baud APRS data mobile radio, the TM-D700A.[7] This dual-band data radio with built-in TNCs and front panel APRS displays made it possible to send and receive the very short APRS-style communications via any 9600-baud PACSAT that is digipeat-enabled (UO-22). Thus, the TM-D700 radio is an off-the-shelf satellite data terminal ready for ASTARS; it needs no PC or other accessory. Kenwood also followed suit with 9600 baud upgrades to the TH-D7(G) HT with its internal front panel displays. Alinco also now sells another integrated TNC/radio called the DR-135, which can also do both 1200 and 9600 baud built-in, though it needs an external laptop to display the APRS data.

The Internet

Unlike previous amateur satellite designs, APRS satellites can capitalize on the connectivity of the Internet instead of trying to compete with it. The Internet makes possible the linking together of multiple disparate downlink sites which allows a tremendous gain in reliability through space and time diversity reception. Instead of each station requiring their own downlink receiver and then only being able to hear packets within his own footprint, the Internet allows a few stations, called SAT-gates (Satellite Igates) to combine all packets heard into the existing worldwide APRS infrastructure (APRS Internet)[8] for delivery to any APRS operator anywhere.

APRS messages

For satellite operators unfamiliar with APRS messages, it should be understood that an APRS message is a single LINE of text. Most messages stand alone, but are occasionally strung

Photo E. *The front panel of the TM-D700 showing an incoming 15-byte message (messages can be longer up to 64 bytes).*

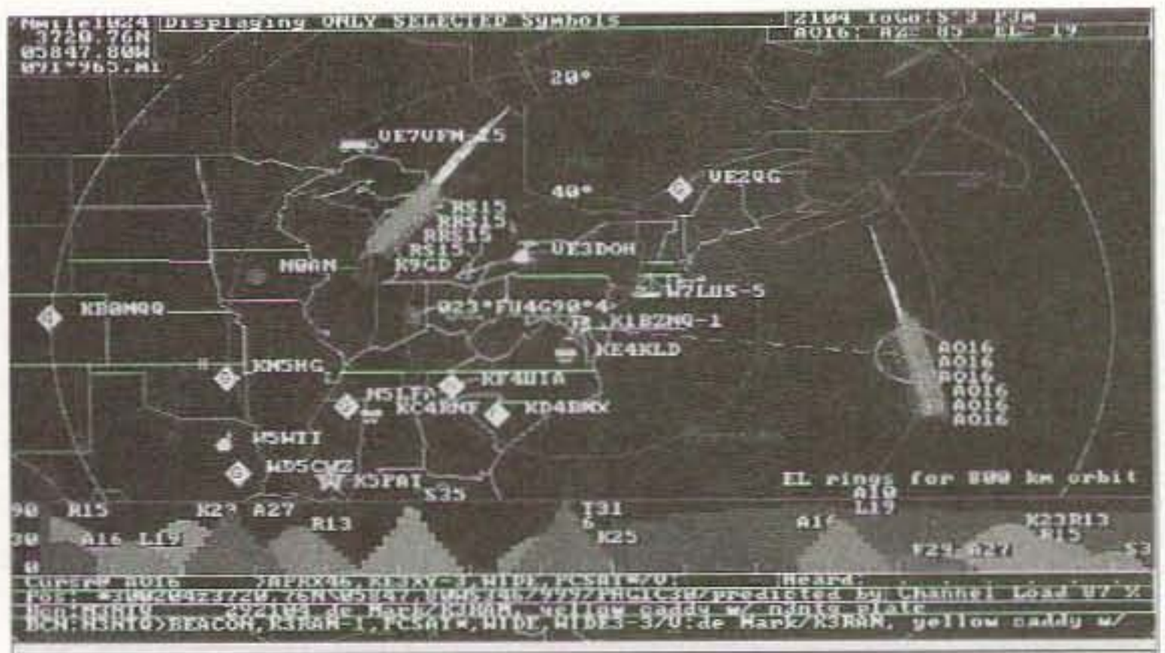

Photo F. *Screenshot of satellite-position display map.*

together if everything will not fit on one line. **Photo E** is a photo of a very brief 15 byte message received on the TMD700 radio. Messages from mobiles are usually quite brief, as they must be entered on the touchtone pad, but longer messages of up to 64 bytes are routinely displayed.

E-mail

Similarly, APRS can send and receive standard E-mail messages via the worldwide Internet-linked APRServe system. This capability is limited, but very useful. The first limitation is that messages are only ONE LINE and the one line includes the full E-mail address. This forces BREVITY! Secondly, although E-mail can be originated under the control of the ham sending it, E-mail replies back from the Internet are only allowed via special Igates with operators who have volunteered to screen such traffic for 3rd-party legality prior to being returned to RF. Here is an E-mail transmitted from my D700 mobile en route to work. Here is how it was entered into the D700:

wb4apr@amsat testing delivery via pacsat from my van en route to work.

Yet, here is how it was received by my E-mail system after being SAT-gated to APRServe, and from there, picked up by the E-mail Engine at WU2Z's and shipped out as regular E-mail:

Date: Mon, 7 Feb 2000 07:58:09 -0500 (EST)
From: WB4APR-9@unknown.net
To: wb4apr@amsat.org
Subject: APRS Message from WB4APR-9

---

testing delivery via SUNSAT
from my van en route to work.

Message received by MacAPRS IGate station WU2Z
Located in NO BRUNSWICK, NJ
APRS path = WB4APR-9>APK101, SUNSAT*:

User ground station equipment

To design an APRS satellite, the link budget and capabilities of the users' mobile stations must be well understood. **Table 1** shows the uplink power and receiver antenna gains for all participating stations in the ASTARS system. The column labeled Standby Receive Gain is for the user who is not aware of, nor optimized for, satellite reception. For example, someone hiking with an HT in his pocket, or mobile parked under trees.

Although a wide variety of power and receiver gains are involved, these values are what form the basis of the APRS satellite design and the architecture of the overall ASTARS System.

Requirements/constraints/design drivers

To design a satellite to meet the HT/mobile communications objective and the Internet links as well, there are a number of factors involved in selecting the frequency band, antenna types, and baud rates for each of the mission objectives. First, there are a number of boundary conditions or assumptions:

(1) Optimum ALOHA channel efficiency is about 20% due to collisions.

(2) VHF links have a 9 dB advantage over UHF links (omni to omni).

(3) 1200-baud AFSK has a 7 dB advantage (measured) over 9600 baud FSK.

	ERP UHF (W)	ERP VHF (W)	Rcv UHF dBi	Rcv VHF dBi	Rcv STBY dBi	Applications
User Stations						
Handhelds	3	5	3	3	–6	Sailboats, hikers, wilderness
Mobiles	70	100	5	5	–6	Remote travelers, boats
Home stations	700	1000	13	13		Not intended for uplink
Network Stations						
I-gate receiver			7	5		Omni Internet receive site
Message node	70	100				Internet-to-user uplink site
Command station	700	1000	13	13		USNA

Table 1. *Uplink power and receiver antenna gains for all participating stations in the ASTARS system.*

(4) T/R delays render 9600 only twice as fast as 1200 for APRS bursts.

(5) UHF uplinks require wideband satellite receivers to avoid Doppler (–4 dB).

(6) UHF downlinks require user-tuning during pass (not desired).

With these design drivers as a guide, the following are some of the first-order alignments of requirements to hardware. From these, then, the optimum trade-offs were made to arrive at the final PCSat design.

(1) MSG delivery to HT in Standby requires best possible downlink (1200-baud VHF). Igate uplink is relatively unconstrained.

(2) MSG receipt from HT requires best possible uplink (1200-baud VHF).

(3) Downlink to Internet is relatively unconstrained.

(4) Continentwide Bulletin Delivery requires existing 144.39 over USA and 1200 baud. The same for Europe will require a common European frequency, too.

(5) HT/mobile real-time messaging requires same up/downlink and baud rates.

(6) GPS HT/mobile tracking is relatively unconstrained.

(7) Low-power GPS tracking devices require best uplink (1200-baud VHF) and the uplink must not be used by any other satellite uplinks to avoid unintentional interference to other systems.

(8) Other UI digipeating applications should be crossband full duplex and should use same up/downlink baud rates.

(9) Multiple uplink receivers to minimize collisions is desired.

(10) Synchronizing of same-band downlink transmissions is desired to maximize the available half-duplex satellite receive time.

(11) Redundancy and backups are desired.

(12) Bundling of packets in bursts amortizes individual TX delays.

(13) UHF downlinks are of little value due to poor link budget and Doppler.

(14) The KISS principle should reign (Keep it Simple, Stupid!).

Hardware alignment and requirements

Using the above criteria, PCSat was designed around two KPC-9612+ dual port TNCs. These TNCs have all the latest APRS generic digipeating advantages and can even cross route packets between ports. By using standard off-the-shelf TNC hardware and FIRMWARE, on-orbit risk was minimized due to the track record of thousands of identical hardware in use all across the country for terrestrial APRS. Thus, the firmware is proven.

Each dual-port KPC-9612+ can cross-relay from either of its two inputs to its two outputs. With only two transmitters on VHF for best downlink budget, PCSat outputs both the 1200- and 9600-baud channels to the same transmitter, one for each TNC as shown in **Fig. 1**. PCSat uses a single VHF half-duplex channel in the ITU satellite subband for its primary uplink and downlink, and one other unpublished VHF uplink. Similarly, there are one published and one unpublished UHF uplink. For the unique APRS paging downlink over North America, PCSat uses the dedicated 144.39 assignment to be able to send urgent messages from the satellite to travelers at any time who may only be monitoring the terrestrial APRS channel.

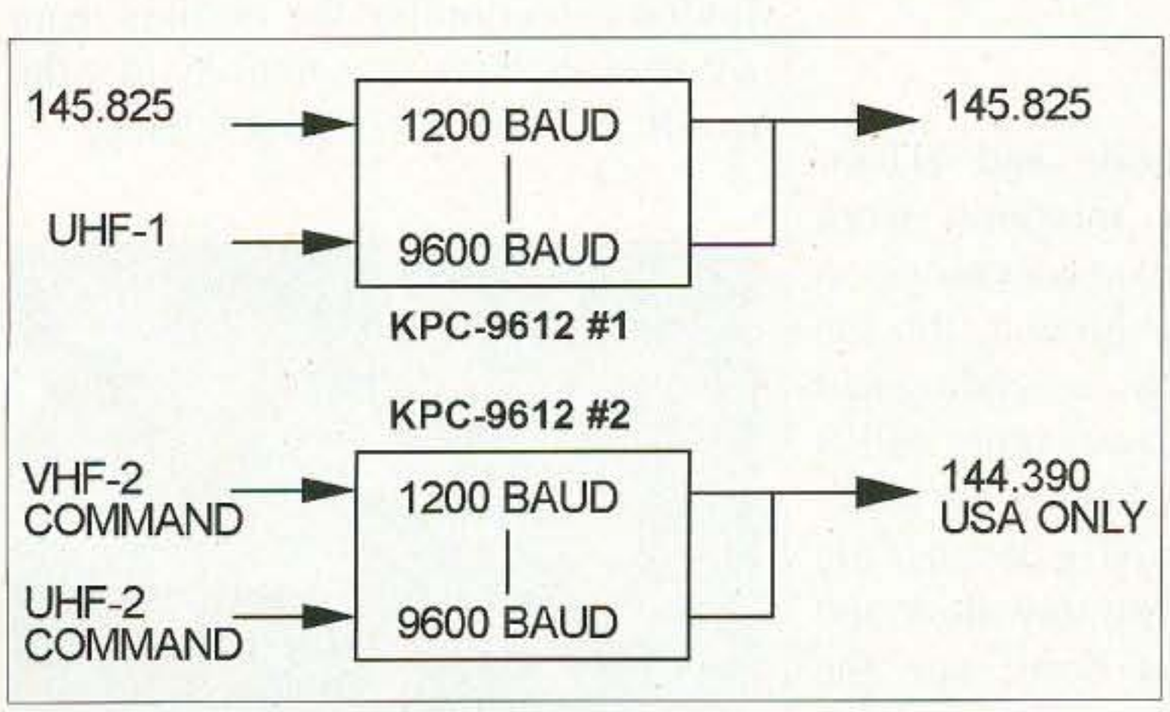

Fig. 1. The communications core of PCSat is a pair of Kantronics KPC-9612+ TNCs. Top: Standard user communications. UHF-1 is 435.250. Bottom: Command and downlink paging.

Failsafe reset

To recover from a lockup condition in these commercial off-the-shelf TNCs, PCSat uses three methods of hardware resets back to launch defaults. First, each TNC has a failsafe RESET circuit that monitors the PTT of each TNC; as long as a transition occurs at least once a minute, then the TNC is assumed to be operating correctly and the TNC remains powered up. If there are no transmissions for over 1 minute, then a one-shot timer removes power from the TNC for 1 second to allow for a complete power-up reset of the TNC.

Second, there is a 72-hour failsafe reset circuit that will reset both TNCs unless the counter is cleared by command from the ground at least once every 3 days. Third, a command bit in each TNC can be commanded to reset the other TNC.

Telemetry

Back in 1995 we defined the APRS five channel telemetry format that Kantronics subsequently has added to their "plus" TNCs. To make this usable on our satellite, the PCSat team added a 16-channel-to-four hardware multiplexer to allow telemetry to read as many as 16 values transmitted in four consecutive telemetry packets.

Link budget

The primary driver of this APRS satellite design was to deliver messages to handhelds and mobiles with only whip antennas. For this, the downlink needed to be at least 12 dB stronger than most existing digital satellites. PCSat accomplishes this by taking advantage of the 9 dB link improvement of 2 meters compared to 70cm and by using a 2 watt transmitter. Further, PCSat operates at a low transmit duty cycle unlike most existing PACSAT, because the amateur satellite population covers only 10% of the earth's surface, and with the low duty cycle of the ALOHA style of APRS operations, less than 4% of PCSat's average power budget is required for the transmitter.

Similarly, to conserve power and bandwidth, the 2-meter uplinks are reserved for only the low-power handheld stations, or stand-alone tracking devices or data collection buoys or remote WX

Mission Element	Uplink	Path	Downlink
HT Uplink of MSGS/POSIT to Internet	145.825@12	UIDIGI	145.825@12
Live HT-to-HT Footprint QSOs	145.825@12	UIDIGI	145.825@12
Live HT-to-Mobile crosslinks	145.825@12	XBAUD	145.825@96
Live Mobile-to-HT crosslinks	435.25@96	XBAUD	145.825@12
Mobile Uplink of MSGS/POSIT to Internet	435.25@96	UIDIGI	145.825@96
Live Mobile-to-Mobile Footprint comms	435.25@96	UIDIGI	145.825@96
Command and Control	All	MYRemote	145.825
Other UI Applications	TBD	UIDIGI	145.825
Low-Power Trackers	VHF2	UIDIGI	144.39 USA
Nationwide Message Delivery	UHF2@9600	MYgate	144.39 USA
Nationwide Bulletin Delivery	UHF2@9600	MYgate	144.39 USA

Table 2. *Channel usage and mission objectives.*

stations such as the one built by Ronald Ross KE6JAB in Antarctica.[9] The mobiles and SAT-gates which have 35 to 50 watt transmitters will be asked to operate only on the UHF uplink frequencies where they can afford the more difficult link budget. The result is the further advantage of having spread out the user base over 4 uplink channels to minimize collisions.

Channel usage and mission scenario

Table 2 maps the mission objectives into the various uplinks and downlinks on the satellite. It matches the strengths and weaknesses of each mission area to the available link budgets and hardware.

Notice the advantage of incorporating the single North American continentwide coordinated APRS frequency into the downlink frequency plan. Although this frequency is in use by over 2,000 users full-time including over 600 wide-area digipeaters, it is a well established universal frequency where ALL APRS operators can be found whether they are aware of a satellite pass or not. Actually, although 90% of the USA ham population is within range of this terrestrial infrastructure; 70% of the land mass is not, so travelers are often out of range of the terrestrial links.

Due to the shared use of 144.39 with the thousands of existing users, this downlink on 144.39 will ONLY be used for the special applications consistent with the national significance of this channel. Such applications might be getting an emergency or priority message to an existing APRS mobile no matter where he is; infrequent bulletins of national interest; and low-power but high-profile tracking of special devices (for example, the Olympic Torch). Due to the low duty cycle channel statistics of an ALOHA TDMA channel like APRS, even though the channel is in full use by thousands of users, still more than 50% of the time, the channel is "clear" as heard by any mobile anywhere at any instant.

SAT-gate operations

The mobile-to-mobile and HT-to-HT communication missions work without any special considerations on the satellite or on the ground. But the more useful application is sending and receiving messages to any other APRS station worldwide by having the packets received by the SAT-gates that are monitoring the satellite downlink and feeding every packet heard into the APRS Internet system. These SAT-gates need to perform the following functions:

Photo G. *Screenshot of the TH-D7 showing the next 80-minute satellite schedule.*

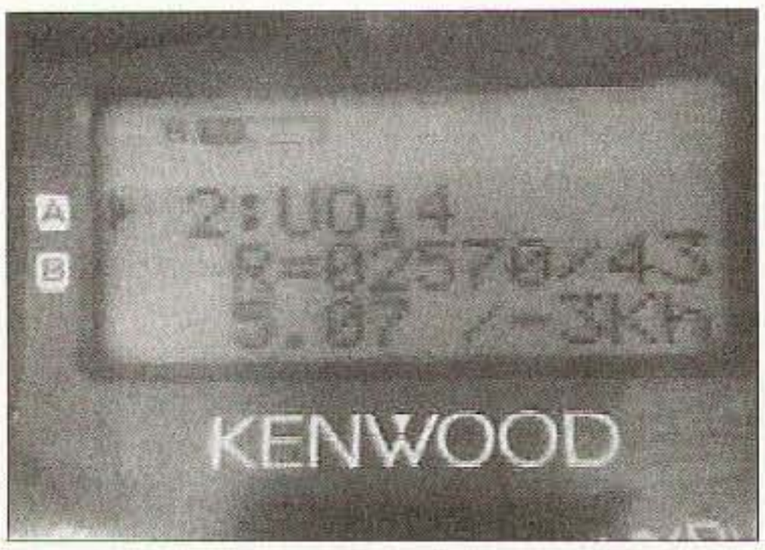

Photo H. *Showing the range and downlink frequency of UO-14.*

(1) Monitor both downlinks and feed ALL packets into the Internet.

(2) Maintain a track on all calls heard via satellite.

(3) Monitor the Internet and capture MESSAGES for these calls.

(4) Deliver these messages at a "fair" rate under these conditions:

a. The satellite is within 1400 km (above 30 deg) to mobile.

b. It sees "QRZ" in the mobile's STATUS text or CUSTOM-3.

c. Deliver these messages until seen in the downlink 3 times.

Omni no-track SAT-gates

Setting up a SAT-gate is trivial, requiring nothing more than a normal packet station and omni antenna. Any APRS station can do the basic feding (#1 above) with existing software which contain the built-in Igate capabilities. Even if the station does not have horizon-to-horizon coverage, they are only contributing their packets to the same worldwide stream as all the other Igate receivers, so any station can help. Unlike any previous amateur satellite activity, PCSat will use the Internet to combine the outputs from a dozen such stations nationwide; the result is over a 99.96% chance of

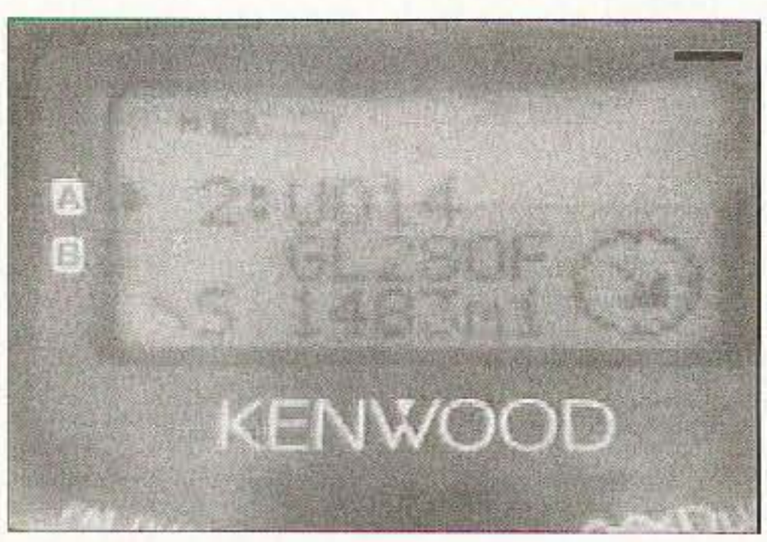

Photo I. *Showing the direction and distance to the satellite.*

capturing every packet over the USA! Even if only 4 stations at any one time have the bird in view of their station and even if they only have a 60% chance of decoding each packet, their combined probability is 98%. But if the original packet is replicated TWICE, then this probability becomes 99.96%! A certainty!

Base station operations

Since the APRS satellites are shared assets with limited bandwidth, this message system should only be used by mobiles who have no other means to communicate from distant locations. For this reason, base station operations are not encouraged other than SAT-gates or for direct contact with a mobile if needed. A Mic-E-style packet from the D700 is only 9 bytes long, compared to a typical WinAPRS 80-byte position report. Thus, base station transmissions are discouraged.

Satellite tracking and pass predictions

To help with satellite tracking for the casual and mobile user, satellite tracking has been added to APRSdos in the form of APRStk.exe. When run within an existing APRSdos file structure (so you get all the maps and other built-in-data), it presents the satellite predictions on the APRS map and will autotune the Kenwood radios, including Doppler. It is available zipped up as a complete system for download from [ftp://tapr.org/aprssig/dosstuff/APRSdos/aprstk.zip].

Distributing live SAT tracking data to mobiles

Another version of the same APRSdos derivative is called APRSdata.exe. It has the unique feature that it can distribute via the terrestrial network sufficient pass information for display on the front panel of the Kenwood radios so that other travelers are aware of pass times long before they drive out into the wilderness. Not only does this put this special satellite pass info directly on the mobiles' radios, but it also posts the satellites in view as objects to the local 144.39 network so that all mobiles can see the range and azimuth to the satellite as well as the up- and downlink frequencies. Thus, our mobile satellite users can get the PASS info they need without lugging along a laptop.

The screen-shots show what the TH-D7 HT will capture and display about the satellites while monitoring the terrestrial network if an APRSdata.exe station is in range.

First is the DX-SPOT list, showing that there are three satellites, UO-22, AO-27. and UO-14 coming up in the next 80 minutes and when.

The next two screens show up when the satellite is in view. They show the range, azimuth frequency, doppler, and distance to the satellite. Just perfect for aiming your handheld antenna. For more details on this resource for non-PC distribution of satellite info, see the Web site: [http://web.usna.navy.mil/~bruninga/satinfo.html].

The power of this on-line, real-time delivery of current satellite pass data to mobiles and handheld users without the need for a laptop is in itself a brand new opportunity for the amateur satellite service. Already it has been expanded to hundreds of other data screens that can be pushed to these radio displays. We call them Tiny Web Pages.[10] Although this application is beyond the scope of this paper, the ability to deliver these Tiny Web Pages to any HT/mobile anywhere on the planet with the combined resources of the existing APRS infrastructure and the ASTARS amateur satellites.

Conclusion

The time is ripe for extending amateur satellite digital communications services to mobile and handheld users. Since packet was first introduced on space shuttle mission STS-35, there have been numerous experiments to test and validate the capability for using UI packet digipeating for real-time digital communications between users. This combined with the recent maturity of the Internet as a global resource for exchanging data worldwide suggests that there is a unique opportunity to join the advantages of the Internet and amateur satellites as a means of tying together SAT-gates throughout the world where the infrastructure exists to extend worldwide amateur communications to mobiles in areas where it doesn't exist. And, rather than starting such a global system from scratch, the APRS protocol and worldwide Internet infrastructure provides a means of packaging and delivering and displaying this type of real-time traffic to users both on the satellite downlink and worldwide via the Internet.

The introduction of the Kenwood and Alinco integrated TNC/radio combinations and the Kantronics TNCs give us off-the-shelf solutions for providing mobile and handheld satellite communications terminals to all users. By encouraging UI digipeating as auxiliary payloads on most small satellites, the amateur satellite service can bring all of these pieces together into the most powerful and far-reaching amateur satellite project to date.

Footnotes

1. Satellite Builders' Channels, 17th Annual AMSAT Symposium, pp. 191–195.
2. [http://web.usna.navy.mil/~bruninga/traknet.html].
3. [http://members.aol.com/dquagliana/upw/index.html].
4. [http://web.usna.navy.mil/~bruninga/mirex.html].
5. [http://web.usna.navy.mil/~bruninga/sarex.html].
6. [http://web.usna.navy.mil/~bruninga/mir-ht.txt].
7. [http://web.usna.navy.mil/~bruninga/TM-D700A.gif].
8. [http://web.usna.navy.mil/~bruninga/www.aprs.net].
9. "Antarctic Expedition," *AMSAT Journal,* Winter 2000.
10. Tiny Web Pages, ARRL/TAPR Digital Communications Conference, 2000. 73

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Carolynn Conley KD5SJO

All Aboard for ARISS ...

Amateur Radio on the International Space Station.

In 1996, after the first International Partners meeting of the newly formed Amateur Radio on the International Space Station (ARISS) team, we all walked away "cautiously optimistic" that we would be able to develop, deploy, and operate a ham radio station on the ISS. This optimistic dream from a handful of internationally-based amateur radio operators has now turned into reality. The year 2001 will go down in history as the year that the ARISS amateur radio station became fully operational.

It was a good thing that those involved in the hardware development and deployment had no idea of the significant challenges that faced them. Otherwise they would have all quit prematurely. The challenges that this international team endured were immense. We were the first "payload" to fly on ISS and no one — USA's NASA or the Russian Space Agency — really knew how we should be qualified. We repeated several flight qualification tests 2 and 3 times to satisfy all the different organizations' requirements — the Shuttle, the USA ISS team, and the Russian ISS team. We also had to overcome the cultural differences and hurdles that result from working as a fully integrated international team. A couple of weeks prior to the launch of the initial ISS ham radio hardware, we were still hanging on the edge of a precipice. The issue this time was that we had not satisfied the Russian EMI requirements. But we persevered, we made it happen.

This article will provide an overview of the equipment currently on board the ISS, the hardware currently in the queue for deployment over the next 12 months, and our long-term vision for the future. We will also provide ground-based hams the information they need to hear and work the ISS crew.

Human spaceflight and amateur radio — a perfect pair

The Amateur Radio on the International Space Station (ARISS) represents a melding of the teams that have pioneered the development and use of amateur radio equipment on human spaceflight vehicles. The Shuttle/Space Amateur Radio Experiment (SAREX) team enabled Owen Garriott W5LFL to become the first astronaut ham to use amateur radio from space. Calling "W5LFL from the Space Shuttle *Columbia,*" Owen made hundreds of QSOs on the STS-9 space shuttle mission in 1983. Since then, amateur radio

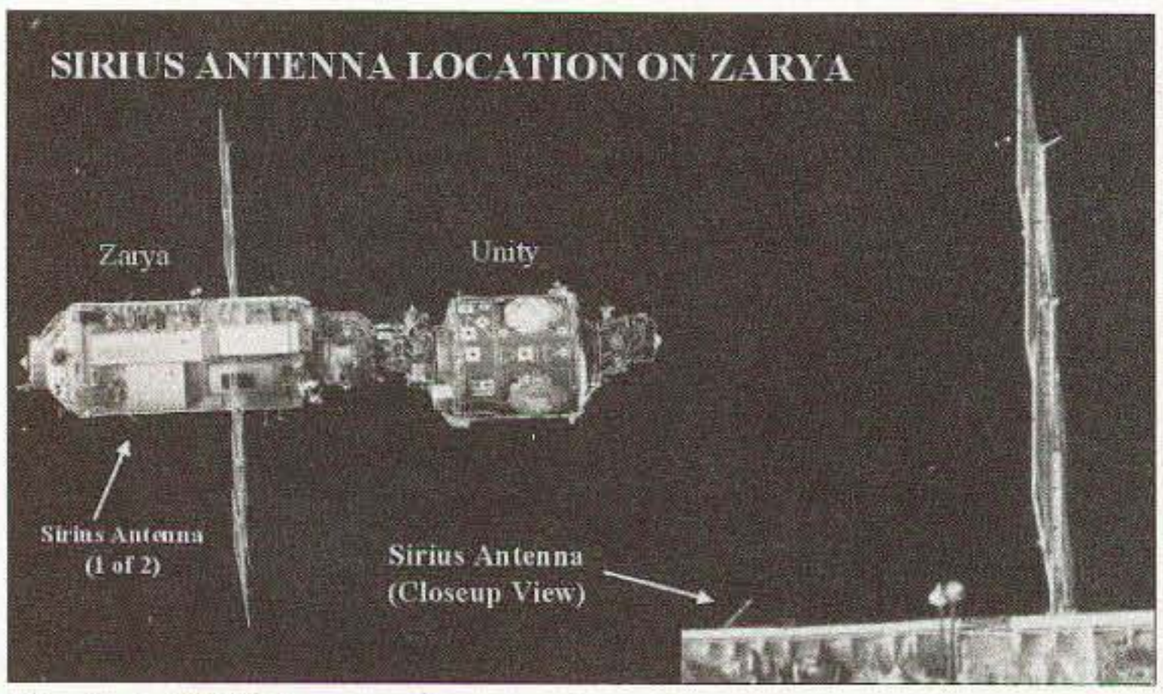

Photo A. *FGB 2-meter antenna locations.*

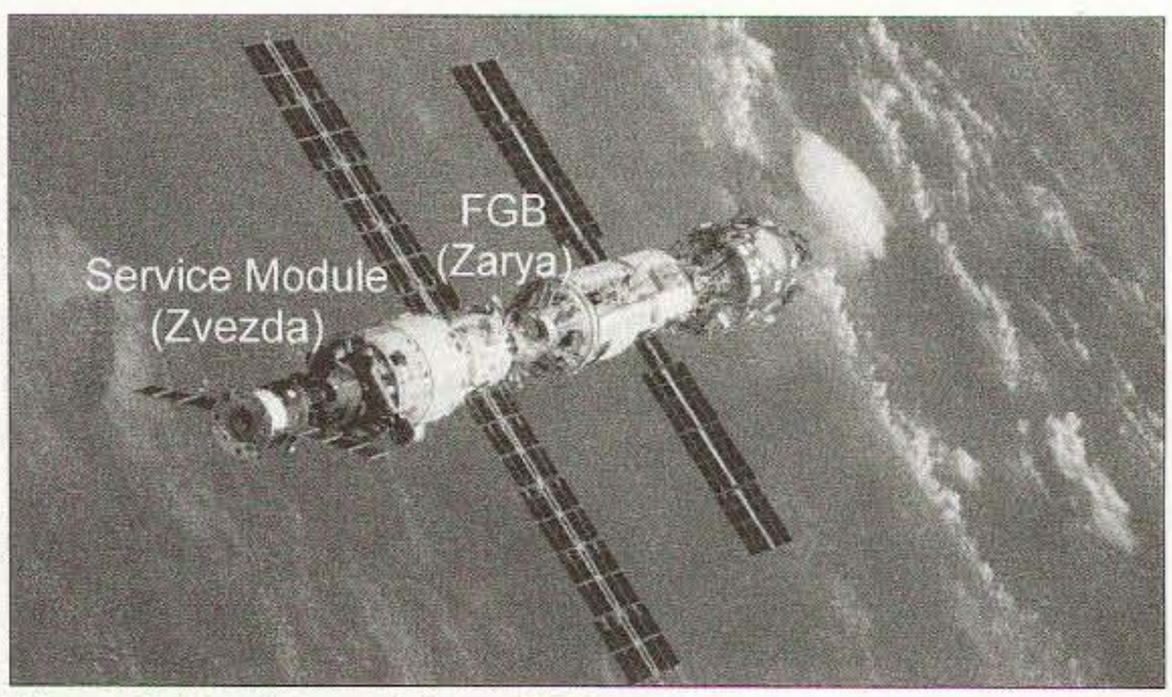

Photo B. *Service module and FGB.*

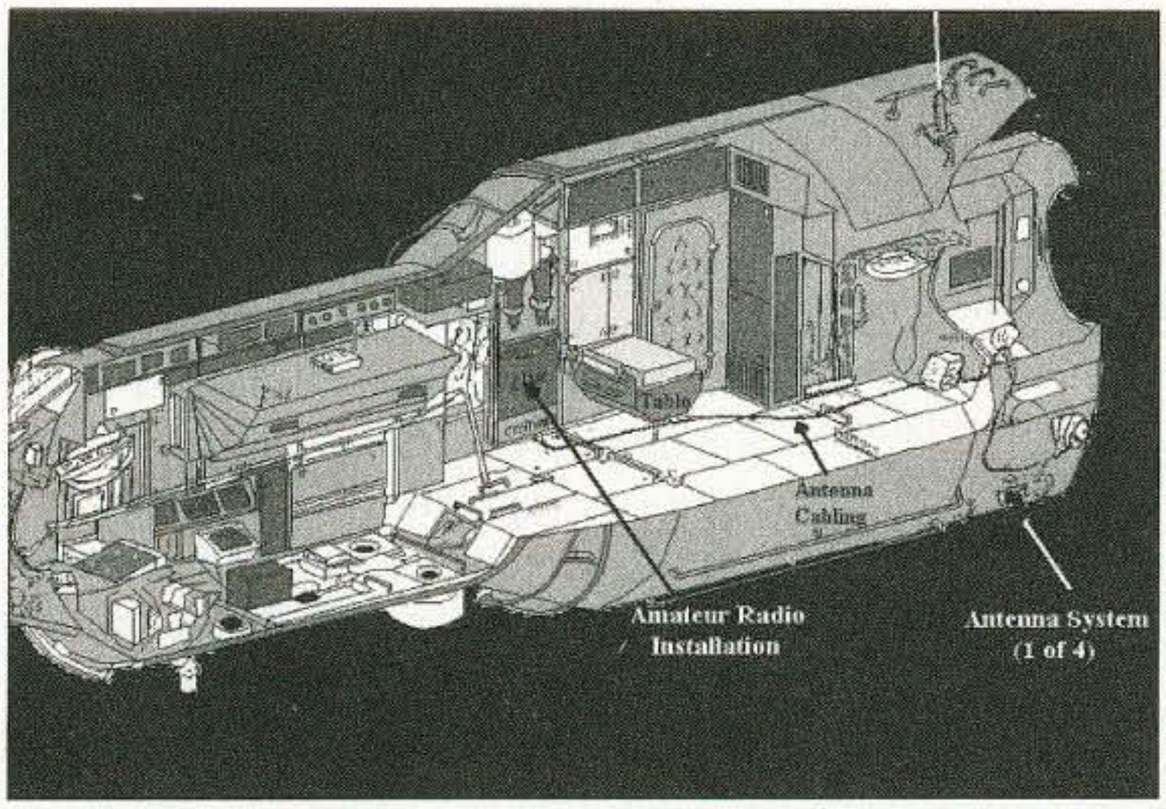

Photo C. *ISS ham hardware location in service module.*

teams in the U.S. (SAREX), Germany (SAFEX), and Russia (Mirex) have led the development and operation of amateur radio equipment on board NASA's Space Shuttle and the Russian *MIR* space station. The ARISS team, a delegation of 10 countries, was formed in 1996 to develop, fly, and operate ham radio equipment on the International Space Station.

Through ARISS, the ham radio community can talk to the astronauts and cosmonauts on board the ISS. The primary goals of ARISS operations are fourfold:

(1) educational outreach through crew contacts with schools;

(2) random contacts with the amateur radio public;

(3) scheduled contacts with the astronauts' friends and families; and

(4) ISS-based communications experimentation.

A few schools are selected from around the world for scheduled contacts with the orbiting ISS crew. At least ten students at each school ask the astronauts questions, and the nature of these contacts embodies the primary goal of the ARISS program — to excite students' interest in science, technology, and amateur radio. More than 200 schools have participated in a scheduled contact since the first amateur radio equipment was flown on the Space Shuttle.

Ham shack location

The ISS ham equipment will reside in two locations. 2-meter operations will primarily be conducted in the Russian Functional Cargo Block (FGB) named *Zarya,* using Russian antennas used to dock the FGB. These antennas, designed for use near the 2-meter band (see **Photo A**), are no longer used by the Russians and can be used by the ISS ham team permanently. This is the current location of the ISS ham radio station.

In late 2001, a set of 4 antenna systems developed by the ISS ham team are expected to be deployed. Once these antennas are deployed and checked out, the primary location of the ham shack will reside in the Russian Service Module (SM) named *Zvezda*. See **Photo B**. The ham station will be installed at location 426 in the SM, right next to the dining table. See **Photo C**. Simultaneous multiband operation can be conducted with these two ham shack locations.

Hardware overview

The initial ISS ham radio system was launched on board the STS-106 Space Shuttle *Atlantis* on September 8, 2000. The initial ISS ham radio hardware consists of two handheld Ericsson transceivers, a power adapter, an adapter module, an antenna system, a packet module, a headset assembly, and the required cable assemblies (see **Fig. 1** and **Photo D**). The ham radio station is capable of operating in either the voice or data (packet) mode with amateur stations within line-of-sight of the ISS. This configuration can be operated in the attended mode for voice communications and either the attended or automatic mode for packet communications. The function of each of the components that comprise the ISS ham radio is summarized below:

1. Handheld Ericsson (M-PA Series) transceivers — There are two transceivers on board: A VHF radio that receives and transmits FM voice or packet radio signals in the two-meter (144 to 146 MHz) amateur band, and a UHF radio that receives and transmits FM voice or packet radio signals in the 70 centimeter (435-438 MHz) amateur band. Both radios are Ericsson M-PA-series commercial-grade radios. These radios look identical in size and features, but are specially tuned to support the different bands. Each radio is

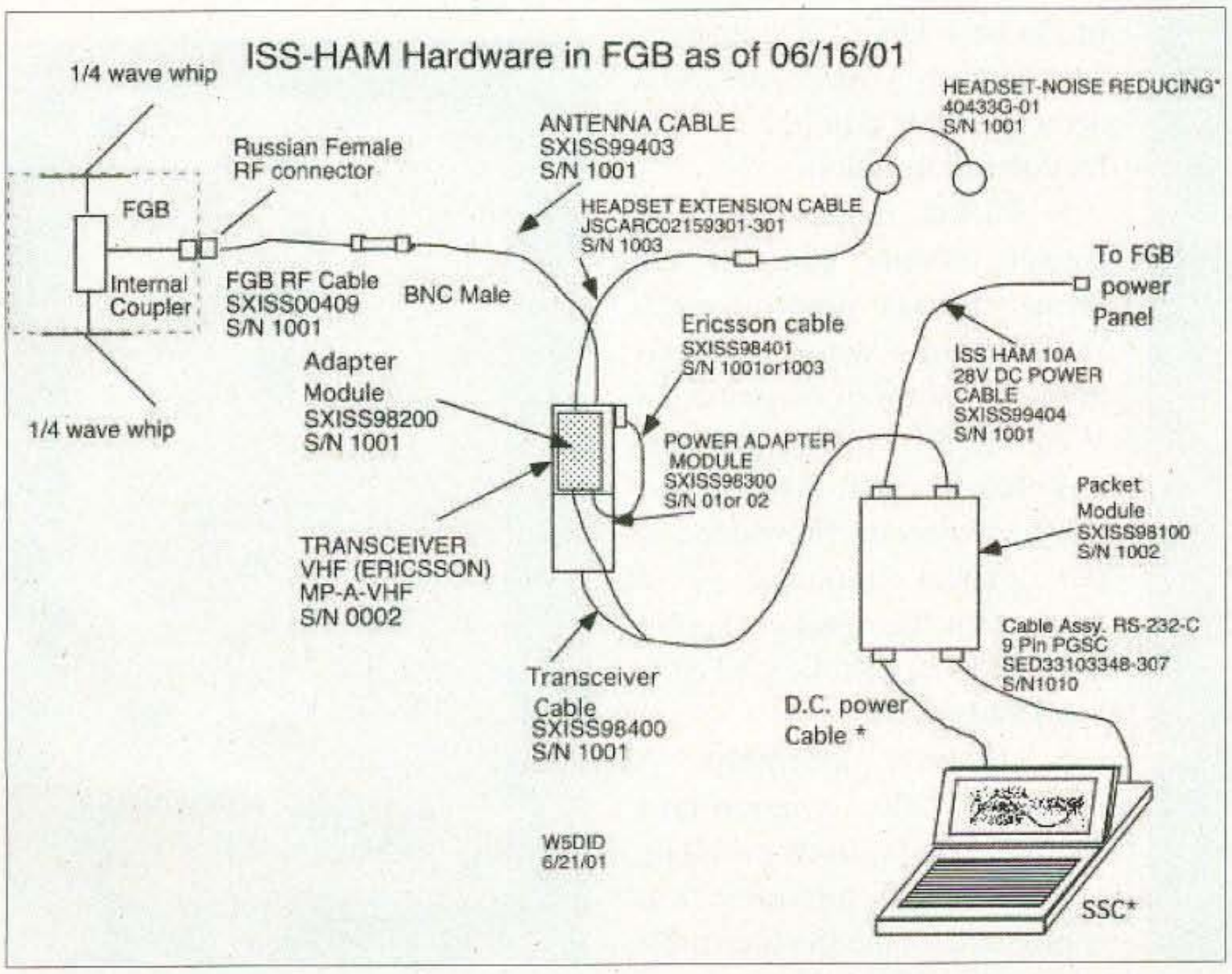

Fig. 1. *ISS ham hardware configuration.*

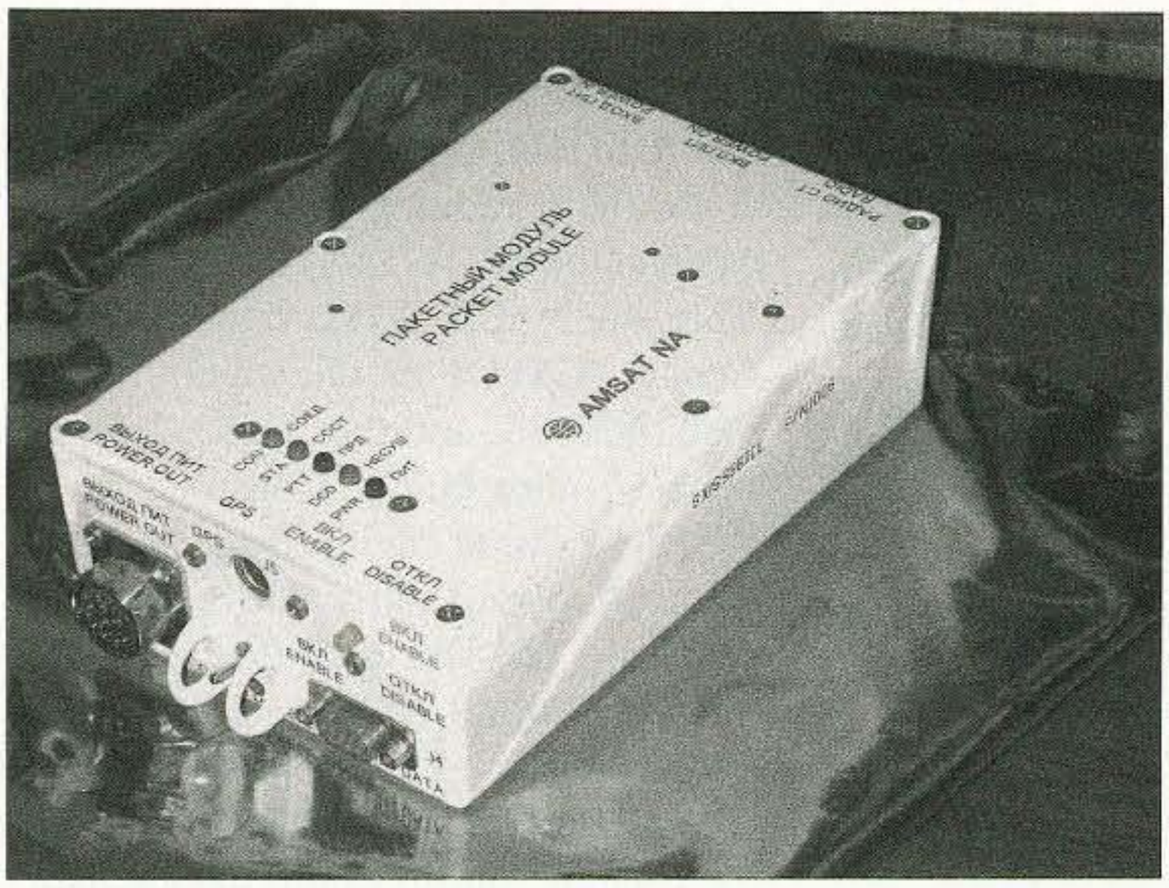

Photo G. *Packet module.*

Photo H. *Headset assembly.*

Future hardware deployments:

Packet module upgrade

To date, the packet system has not been connected to an SSC laptop due to the lack of sufficient laptops on ISS. Also, shortly after the packet system was turned-on for general use, it was discovered that the battery used to backup the RAM had died. Because of these two events, the packet system has been operating in digipeat mode using the ROM defaults (including the NOCALL callsign). An upgraded packet module is expected to correct these problems and add new capabilities. The new TNC will include a specially developed ROM with the standard ISS ham defaults, Russian and USA labels, a new battery, and extended memory (up to 1 meg). Since the packet module serves as the power supply for the station, the ARISS team has decided to leave both packet modules onboard ISS. The older version will serve primarily as a power supply for one of the stations (FGB or SM). The newer version will provide the packet radio capability. The new packet module was launched on the STS-105 *Discovery* mission on August 10th, 2001.

Antenna assemblies

The specially designed ISS ham antenna assemblies will permit operations on HF (20 meters, 15 meters, 10 meters), VHF (2 meters), UHF (70cm), and the microwave bands (L and S band). The dual-use antennas also permit the reception of the Russian Glisser EVA video signals (2.0 GHz). This dual-use capability is the primary reason the ARISS team received access to 4 antenna feedthroughs located on the outside of the service module. A

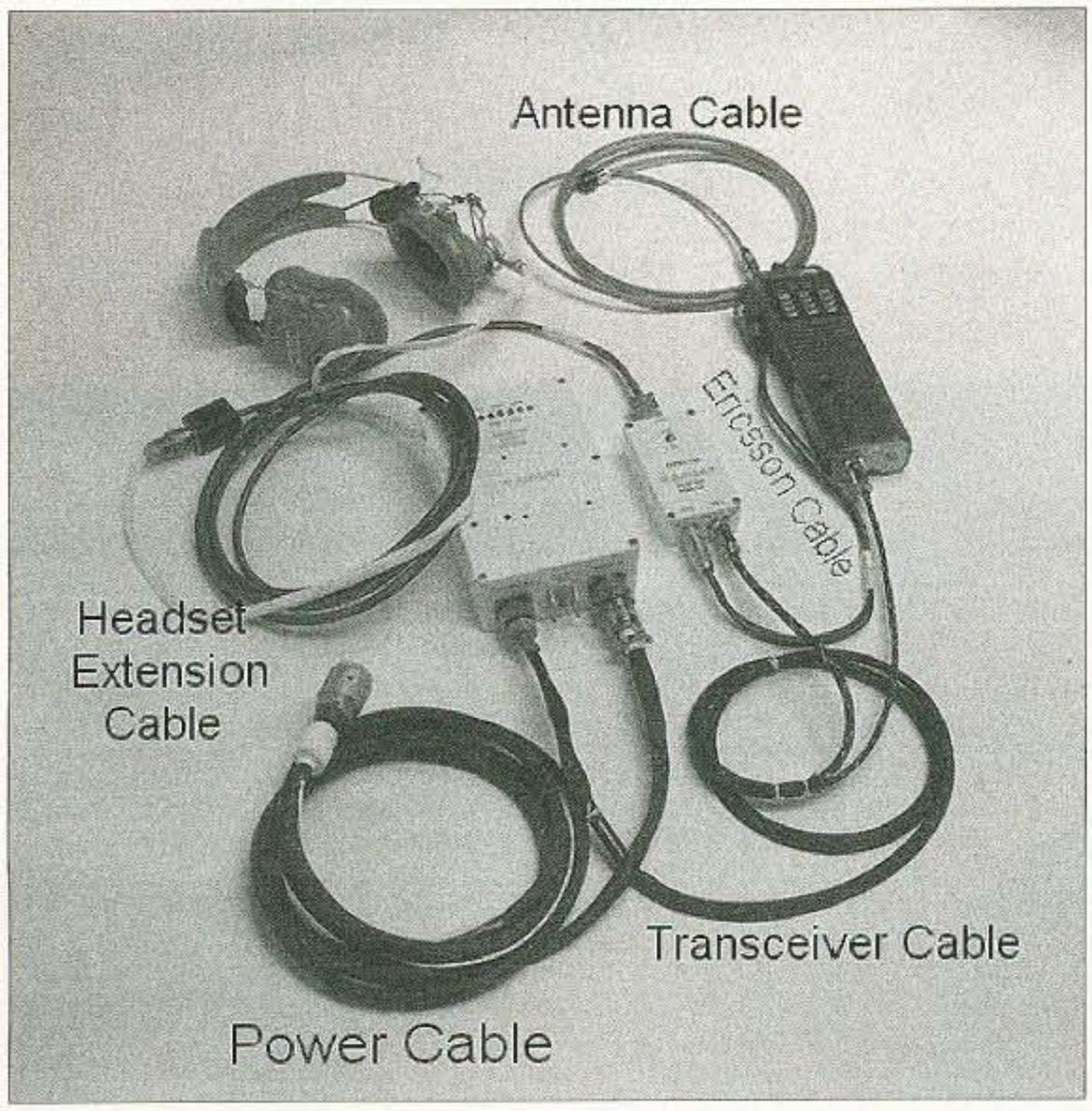

Photo I. *Equipment cables.*

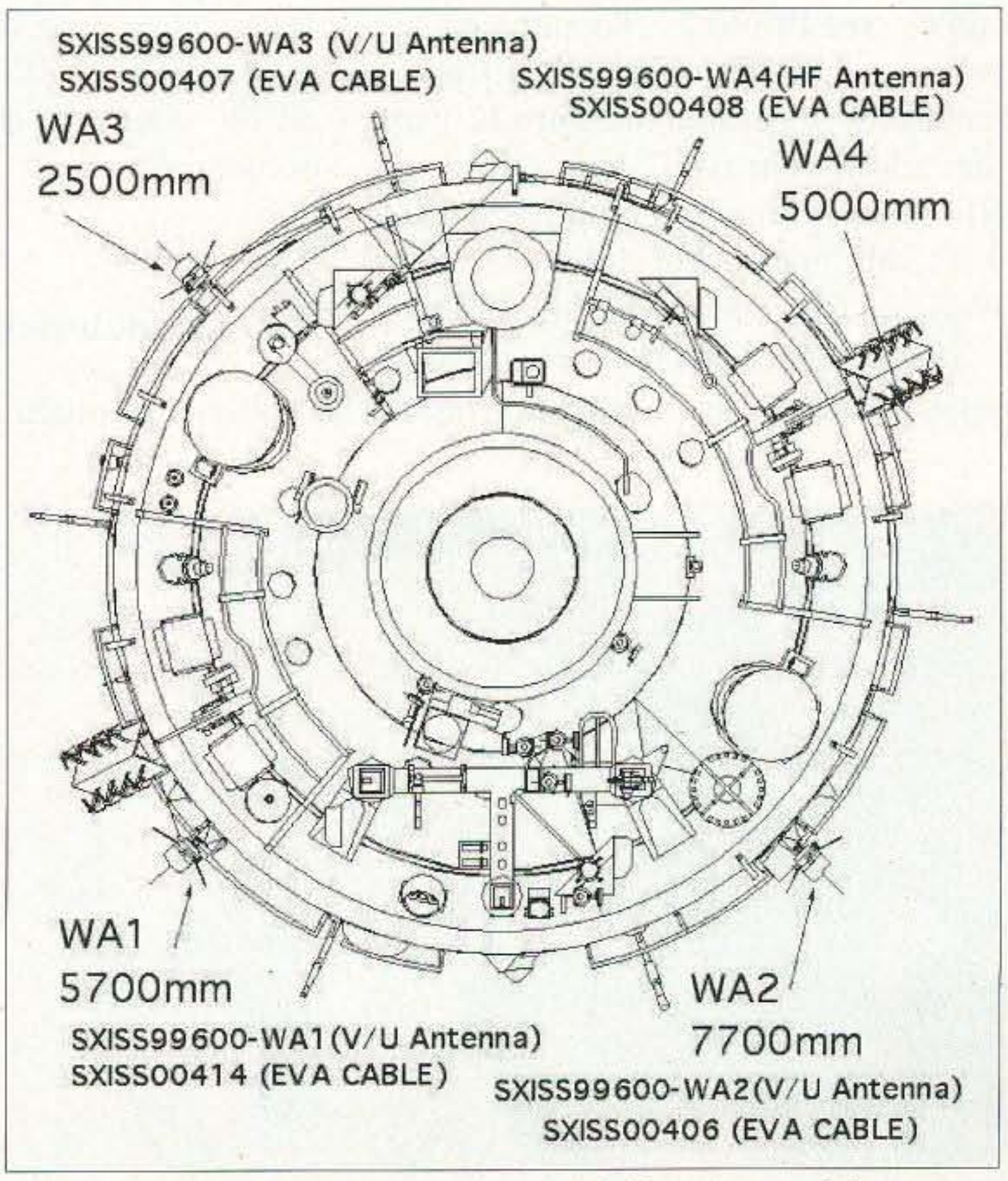

Fig. 2. *Antenna location view from end of service module.*

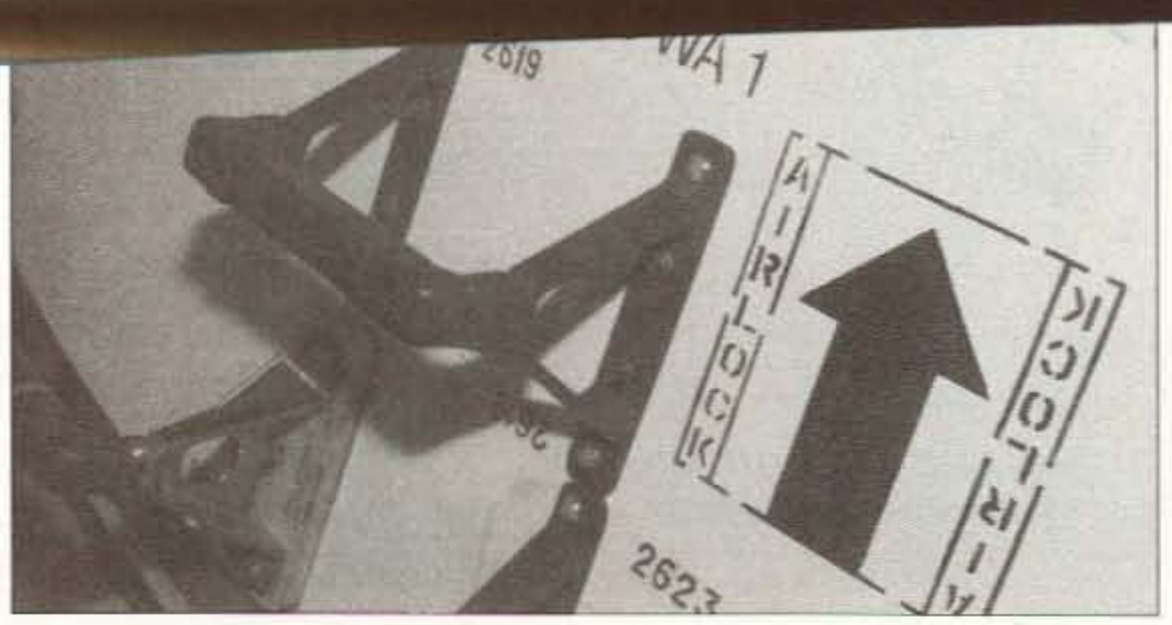

Photo K. *Antenna handrail WA1.*

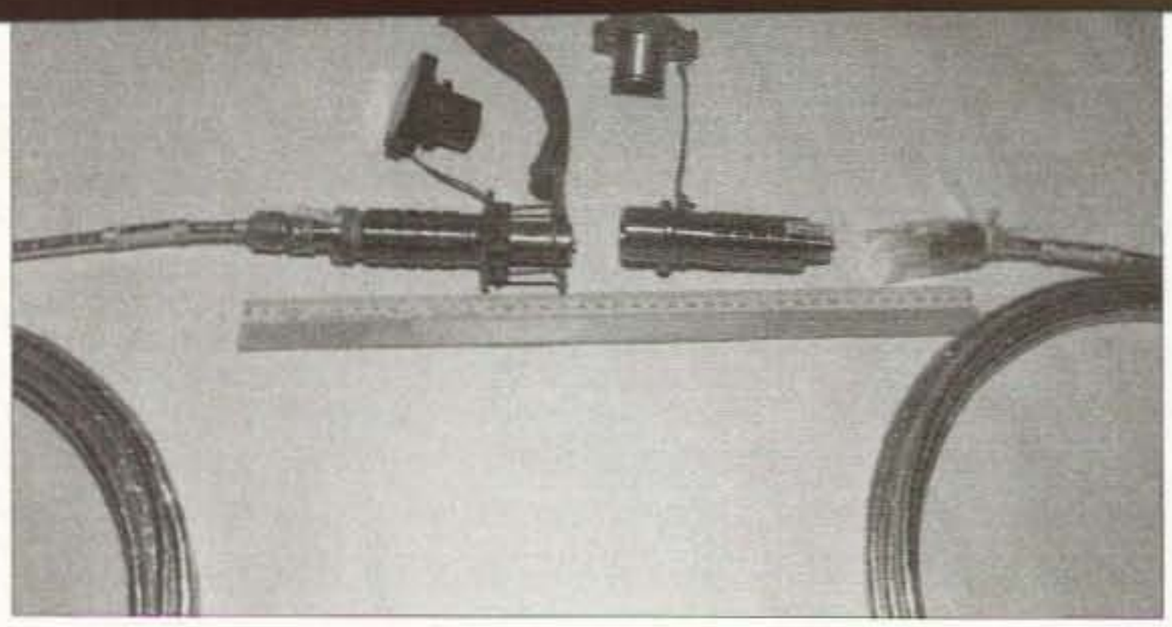

Photo L. *Russian EVA connectors.*

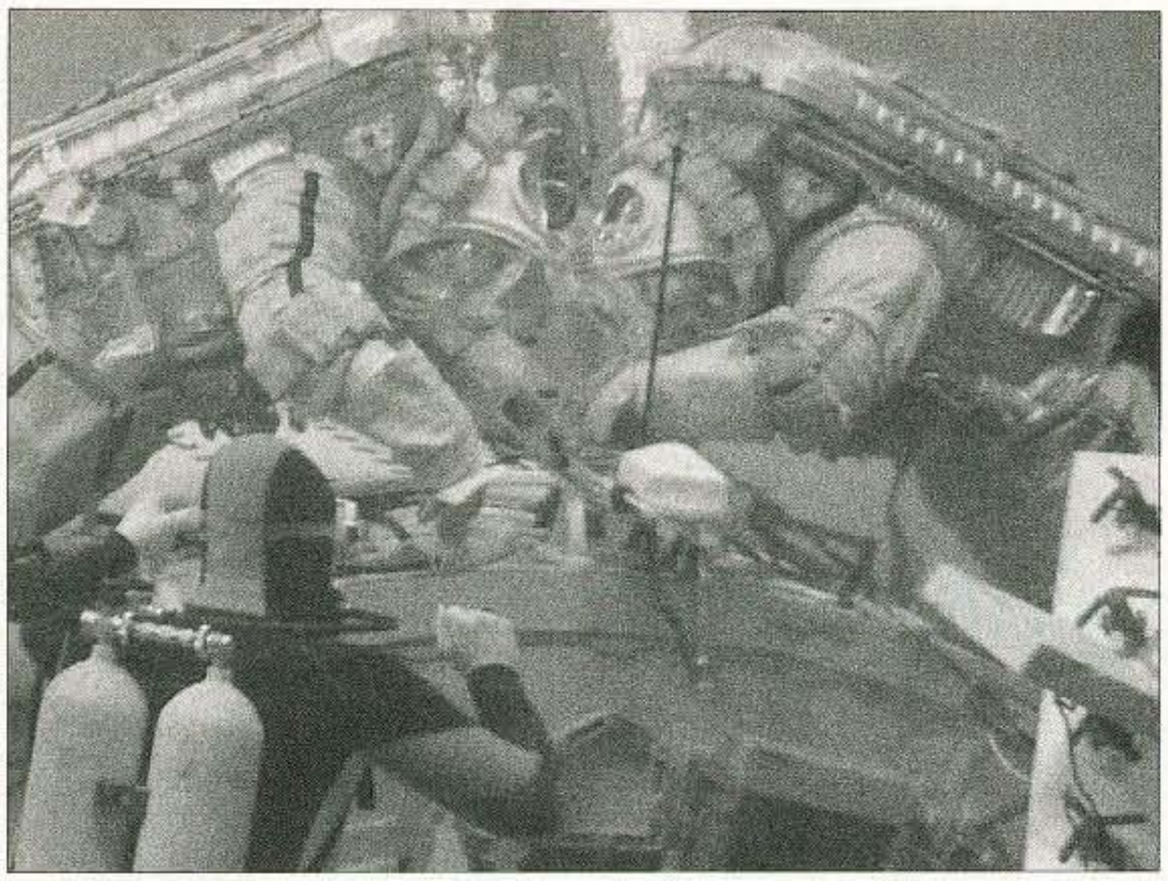

***Photo M.** EVA training for antenna installations.*

somewhat the "luck of the draw." However, with careful planning and a good ground station, your chances of operation are significantly improved. Several hams have made contact with the ISS using an HT. However, a directional antenna using a radio capable of producing at least 25 watts of power is recommended. The crew is usually awake from 7:00–22:00 UTC. They only operate the station in voice mode during their "off" time, so lunch time or early morning/late evenings are good times to listen. Packet operation is available almost continuously. Check [http://ariss.gsfc.nasa.gov] and [http://www.ariss.net] for information about operating the ISS packet and the current status.

The ISS ham station uses the following callsigns: U.S voice operations, NA1SS. Russian voice operations, RSØISS. Packet operations, RSØISS-1 (as of August 19th, 2001, NOCALL was still in use).

The frequencies of operation are all split. The following frequencies are used for ISS general QSO operations: Worldwide downlink, 145.80 MHz. Voice uplinks: 144.49 MHz — Regions 2 & 3 (Americas, Australia, Asia); 145.20 MHz — Region 1 (Europe, Africa, Middle East). Packet uplink: 145.99 MHz (worldwide).

Expedition 2 astronaut Susan Helms KC7NHZ, has been extremely active on the ham radio station. Her outstanding efforts as the first Field Day contester from space infused a lot of enthusiasm into the worldwide amateur radio community — making this a Field Day that many will remember for the rest of their lives.

Astronaut Frank Culbertson KD5OPQ has now assumed the role as the ISS Expedition 3 commander. Remember that the Expedition 3 crew will be very busy, and it will probably take them some time to get comfortable enough on board the

Continued on page 59

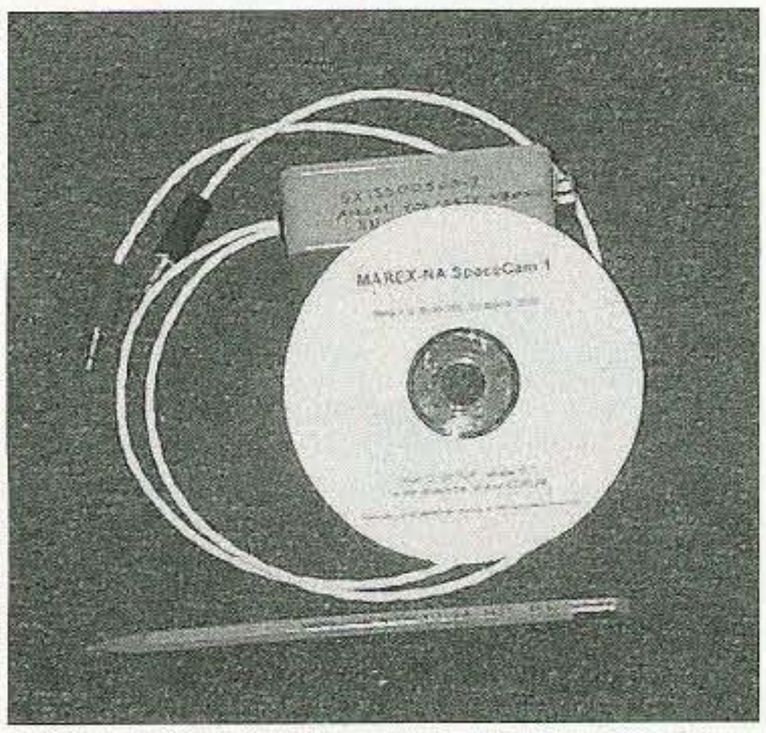

***Photo N.** SSTV hardware and software.*

***Photo O.** SSTV computer interface.*

Bruce Paige KK5DO
AMSAT & ARRL Awards Manager
P.O. Box 310
Alief TX 77411

Hamsats Awards

Join the fun!

...ite is a lot of fun. Not only do you get to speak with people all over the ... collect a lot of interesting QSL cards. With those confirmed QSL cards, ... a few pieces of wallpaper. Actually, you can collect a lot of wallpaper.

... in many different satellite contact. This is the only total of 60. The Oscar Century Award is

Fig. 3.

Fig. 4.

AO-21 (no longer operational), AO-27 and RS-10/12/15. The costs for this award are the same as the previous AMSAT Awards and are also sent to the AMSAT Awards Manager.

The next AMSAT award is the W4AMI Satellite Operator Achievement Award. This award requires no confirmed QSL cards but does take a bit of record keeping. You get credit for each 1,000 satellite QSOs up to 5,000. Please submit your log (computer generated or handwritten) to W4AMI, Awards Manager at AMSAT Headquarters. The cost is the same as the previous awards.

The ARRL sponsors several awards. They are the Worked All States (WAS) Award with Satellite endorsement, the VHF/UHF Century Club (VUCC) Award, the DX Century Club (DXCC) Award, and the Worked All Continents (WAC) Award.

For Worked All States, you must work someone in each of the 50 states through any amateur satellite in any mode. For the VHF/UHF Century Club Award, you must work someone in 100 different grid squares. Endorsements are available for every 25 grid squares after the first 100. The final award, DXCC, requires you to make a satellite QSO with 100 different DXCC countries. For Worked All Continents, you work someone on each of the 8 continents. More information on these awards can be found on the ARRL's Web site. [http://www.arrl.org], then click on Operating Awards.

Finally, I would like to introduce the newest AMSAT Award. It starts with contacts on or after November 1, 2001. The award is the AMSAT Elmer Award. The complete rules for this award are as follows.

New AMSAT Elmer Award

This award has 3 levels: Beginner, Intermediate, and Expert.

Beginner Level

Work 1 School Club Station
Work 4 YL Ops
Work 4 Young Ops (16 and younger)
Work 10 Ops that have had their license for less than 2 years at the time of contact

Continued on page 61

Fig. 5.

Callsign	Date	UTC	Satellite	Category
ZZ2ZZ	05 Nov 2001	0300Z	UO-14	YL
ZZ1ZZ	06 Nov 2001	0415Z	UO-14	YL
ZZ1ZY	06 Nov 2001	0425Z	AO-10	Teen
ZZ1ZX	07 Nov 2001	0530Z	AO-10	First
ZZ3ZX	07 Nov 2001	0530Z	AO-10	New
ZZ4AA	08 Nov 2001	0400Z	UO-14	School

Table 1. *Sample award submittal.*

Montgomery ARC
Montgomery Hamfest
Garrett Coliseum at
Fair grounds located
the North Eastern section of
Montgomery. Admission $5. Free
inside flea market setup 3 p.m.–8 p.m.
evening, November 9th; and 6 a.m.–8
November 10th. Doors open to the public
9 a.m.–3 p.m. CST. VE exams on site beginning

general
You can also
AC-ARTS, Fort Wayne
P.O. Box 10342, Fort Wayne IN
or visit the Web site at *[http://www.acarts.com]*.

to Exit
Dunkin
go right at the lights. The
one mile on the right. Vendor set
up from 6 a.m.–8 a.m. Admission $10 at 6 a.m., $3 at 8 a.m. For table reservations call *Paul* at *(603) 883-3308*, or E-mail to *[K1NL@juno.com]*. VE exams 9 a.m.–Noon. Reservations suggested. For more info call *Bill* at *(603) 424-2857;* or E-mail to *[BILLS@AAIOC.ORG]*.

NEWTONVILLE, MA The Newtonville Amateur Radio and Electronics Auction, sponsored by the Waltham ARA and the 1200 R.C., will be held 11 a.m.–4 p.m. at the Newton Masonic Hall, 460 Newtonville Ave., in Newtonville. Talk-in on 146.640. Seller set up starts at 9 a.m. Admission $2. Door prizes, snack bar. For directions and more info check the Web site at [http://www.wara64.org/wara/auction.htm]. Contact *Eliot Mayer W1MJ, 24 Hamilton Rd., Belmont MA 02478*. E-mail *[w1mj@amsat.org;* or tel. *(617) 484-1089*.

NOV 17–18

FORT WAYNE, IN The 29th Annual Fort Wayne Hamfest & Computer Expo, sponsored by the Allen County Amateur Radio Technical Society (AC-ARTS), will be held at the Allen County War Memorial Coliseum at the corner of Indiana 930 (Coliseum Blvd.) and Parnell Ave. Open to the public 9 a.m.–4 p.m. EST on Saturday, and 9 a.m.–3 p.m. EST on Sunday. Vendor setup is Friday evening and Saturday

NOV 18

BENSON, NC The 13th Annual JARSFEST will be held Sunday, November 18th at the American Legion Complex in Benson NC. Talk-in on 147.27(+600). Dealers, tail gate section, VE exams, food. The Club Web site is at *[www.jars.net]*. For more info please call *(919) 894-3352* or *(919) 894-3100* evenings 7 p.m.–10 p.m. E-mail *[blambert1@mindspring.com]*.

NOV 24

EVANSVILLE, IN The 9th Annual E.A.R.S. & Ham Station Evansville Winter Hamfest will be presented Saturday, November 24th, 8 a.m.–2 p.m. Central Time, at Vanderburgh Co. 4-H Center Fairgrounds Auditorium. Talk-in on EARS Wide Area Repeater Network 145.150(-) Evansville / 146.925(-), and 443.925(+) Vincennes. Alternate: EARS rptr. 145.110(-). Use 107.2 CTCSS on all frequencies listed. Free parking, free tailgating (weather permitting). Indoor flea market. Commercial dealers. Great food. For table reservations and info, contact *Neil WB9VPG* at *(812) 333-4116;* or write *Neil Rapp, 2744 Pinehurst Dr., Bloomington IN 47403*. E-mail *[ears@w9ear.org]*. Vendor set up 5 p.m.–9 p.m. Friday; 6 a.m.–8 a.m. Saturday, Central time. 8 ft. flea market tables $8 each. Wall spaces $10 if money is received by November 15th. Add $2 each after November 15th. Admission $5. Check the Web site at *[http://w9ear.org/hamfest.htm]*. 73

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A Modest Proposal

Prophesied nearly a decade ago, S-band has come of age with the Oscar-40 spacecraft. With some revealing insights, here's why.

Government health warning: Facts can seriously damage your health. This article contains facts.

I have never been given much to arguing matters of a speculative nature. If I don't know about something, I keep quiet. If I do know, I say what I know. I will tenaciously defend any proposition that is a demonstrable fact, that can be supported and extended by reasonable analysis. So …

In this article, I want to make a case for abandoning 145 MHz Phase III satellite downlinks. I will show why S-band (2400 MHz) is an infinitely better proposition. I will dispel the myths that S-band requires special knowledge, enormous expense, huge dishes, and a "techie" mentality. These are totally untrue. S-band in practice is far simpler and cheaper, and far more efficient than 145 MHz. I will not make my case with airy-fairy hypotheses. I will do it from practical experience. Show and tell.

Please don't read this article with a cynical smile and an "Oh, here's just another wirehead evangelist on his soap box showing off." Read it and think about it. I have seen the future, and it works! Now it's your turn.

Originally published in *Oscar News (*UK), October 1992. 2001 updates at the end.

Brain ON

Time for a thought experiment. Consider this: Oscar-13 carries a mode-S transponder plus beacon. The transmitter outputs 1 watt to a 5-turn helix. That makes an e.i.r.p. of 10 watts. This is peanut power. Given that, what size antenna do you think is needed to receive the beacon comfortably? As comfortably as at 145 MHz. A 2-meter dish? 4 meters? Several 55-element loop yagis? No idea?

Skip the arithmetic until later. Will you believe that the answer is a puny little two-foot-diameter dish! Yes, it surprised me too. So, to prove it, I built a 60cm dish antenna from a spun aluminum lampshade I picked up when a local furniture store closed down. Cost me a couple of quid. OK, four quid; I bought two of them.

Sure enough, the Oscar-13 mode-S beacon was at least as strong as the 145 MHz beacon. And the transponder signals effortless copy, noisefloor included. And will you also believe me when I tell you that this little dish still worked excellently indoors, through a closed window?

A straight choice

Now, answer this question honestly. If you had to choose between your huge 145 MHz downlink antenna, and a tiny 60cm lightweight, compact, suitcase-size, no-tune, elegant dish that you could genuinely hitch to a balcony; which would you have? No contest, is there?

What noise annoys?

What's the reason for this surprising result? The answer is simple. Noise.

145 MHz is noisy. In many places, it's so noisy as to be totally unusable. I don't think there is much disagreement about this. Noise arises from almost everything electrical you can think of. Transport, illegal taxis, defective appliances, weather, sun, sky, QRM, splatter, teleswitches, computers; the list is endless. And it's getting worse every year. I haven't even included noise of the receiver; it's usually swamped by the foregoing.

A measure of 145 MHz noise

To quantify noise, we use a measure called noise temperature. Higher is worse. It's the temperature of a 50-ohm resistor that, if connected to the radio instead of the antenna, would make the same racket. The noise temperature on 145 MHz is of the order of 1,000K

to 1,500K. In some conditions it may be less, but usually it's a lot more. Let's just use 1,200K for now.

By the way, K means kelvins. Zero kelvin is total silence, water freezes at 273K, boils at 373K, and 300K is a nice day.

The important thing to grasp is that there is nothing you can do about this noise. You cannot reduce it. Even with a hypothetical zero-noise preamp, you will still have 1200K of noise.

2.4 GHz noise is rather different

Now, let's look at noise on 2400 MHz. Sky noise, nil. Environmental noise, nil. Cable losses, nil (no cable). FT-736R noise, nil; there's a preamp/converter at the antenna. Antenna noise, almost nil; just some pickup of the warm earth from the side lobes, 20K maybe.

The only real source of noise is the 2400 MHz to 144 MHz downconverter. And this noise is totally under the control of the equipment designer.

A converter consists of a low-noise preamplifier stage followed by a mixer. The mixer is driven by a 2256 MHz local oscillator, usually a 94 MHz crystal with x24 multiplier. Very simple. Very cheap.

The noise level of a typical low-cost converter is about 100K. Let's assume this, although lower is achievable, and add 20K for antenna side lobes. That makes a total of 120K of noise for 2400 MHz. Guaranteed, every time, everywhere, worst case.

The big payoff

So, where does that get us? We have established that 145 MHz noise = 1200K, and on 2.4 GHz, it's 120K. That's a factor of 10x quieter at least.

It means that for a given spacecraft transmit power, your ground station antenna on S-band can be 10 times smaller than for the 2-meter band. Why? Because less noise means less signal needed. Received signal strength is directly proportional to the capture area of the antenna. Capture area is proportional to physical size.

That "10 times smaller" means less mechanical engineering, less windage, less cost, less maintenance, less environmental impact, greater portability, and so on and on.

Just as important, the noise level is controllable by the user (you), not by external influences beyond your control. Isn't that just what we want from a satellite communications system? I think so.

Exploding 2.4 GHz myths

1. S-band is for "techies."

Complex, a mystery, deep stuff. Three days before writing this article, I knew nothing about 2.4 GHz. I still know nothing. I don't need to know. And I don't know much about 145 MHz, either. Do you? Do you, honestly?

I made a small dish from materials I had on hand using no more than simple dish formulas available from the *ARRL Handbook* and elsewhere. I made a 2-1/4-turn helix feed from a bit of H100 solid coax inner wound around an 40mm socket spanner from my car toolkit. I soldered it to the pip of an N-type panel connector, which was mounted on the 125x125mm reflector of 1.6mm aluminum sheet. I bought an SSB Electronic UEK-13 S-band converter from a regular advertiser, coupled it directly to the N-type, and fixed the whole assembly to a 1/2"-square aluminum boom with two elastic bands! The boom ran through the hub of the "lampshade" dish, with overhang for mounting purposes. The RG-174 coax (3mm diameter) and 12 volt feed ran neatly back inside the hollow boom.

"Scrap" it may be, but it looks professional enough to me. The most technical thing I used was a hand drill. Or was it a hack saw? Took 5 hours to build from a heap of bits to being on the pole ready to test with AO-13. And I was designing as I went. I did no electrical alignment of the helix feed. Like most, I have no test facilities for 2.4 GHz; probably never will have.

If this story labels me a "techie," heaven help blacksmiths!

2. S-band is expensive.

Successful 145 MHz downlinks require a large antenna and a preamplifier. If the system is used for transmitting, as is usually the case, it also needs low-loss coax.

An S-band converter costs about the same as a good 2m preamp. The dish I described cost almost nothing. A commercial version (if it were available) would doubtless cost no more than a KLM14C. Coax can be RG-58 or smaller.

So, at commercial rates there is probably no difference. But build your own antenna which, as I have shown, is almost too easy, and S-band is a lot cheaper.

3. S-band requires a huge dish.

As already explained, this is not the case. The size of a receive antenna is dictated by the size of signal you want to receive. This is dictated by what signal-to-noise ratio you want. This is constrained by the noise level. So, let's do an exercise for a very small lampshade dish and the "120K" converter mentioned. Fear not; what follows is arithmetic only! Calculators out, now.

Calculator ON

Suppose the satellite transmits Pt watts. This spreads out in all directions over an imaginary sphere of radius R, say 40,000 km for AO-13. The energy is intercepted on this huge sphere by a tiny antenna of effective diameter D, say 40cm for a typical 60cm dish. So the power it picks up, Pr, is just the ratio of antenna area to the sphere area, that is:

$$Pr = Pt * (\pi D^2/4) / (4\pi R^2)$$

If you plug in the numbers for AO-13 with Pt =10 watts, you get Pr = 6.3×10^{-17} watts.

Now, let's calculate the noise power Pn received. This is easily found from the standard noise formula:

$Pn = KTB$

where:

$K = 1.38 \times 10^{-23}$ W/Hz/K, Boltzmann's constant.

T is the noise temperature in kelvins which for this article we took to be 120K on 2.4 GHz.

B is the receiver bandwidth; assume 2.7 kHz for a typical SSB receiver.

Plug in the three numbers, and the received noise power is $Pn = 4.5 \times 10^{-18}$ watts.

So, the signal-to-noise ratio, SNR = Pr/Pn. Dividing the signal and noise powers just calculated, you get, for AO-13's beacon at 40,000 km on a 60cm dish in an SSB bandwidth, SNR = 14 or 11.4 dB.

And believe me, it IS just that; I measured it. No tricks, no bull. Just simple arithmetic. So much for the "big dish" theory. A modest antenna is all that's required.

Outline transponder budget

You can extend these figures to a transponder downlink design by scaling.

Assume 40 users (100 kHz bandwidth), a 20 dB SNR (6 dB more, x4) and you need 40 x 4 = 160 times as much satellite e.i.r.p. That makes 40 real watts to a 16 dB gain spacecraft antenna, say, a 15-turn helix or 25cm dish. Extremely practical. And remember, the ground station is still a 60cm dish.

The ability to realize large 2.4 GHz gain on the satellite with physically small spaceborne antennas, a task that's virtually impossible at 145 MHz, means that we have the ability to design a system free from the constraints of the Ariane rocket third-stage envelope. That's a priceless advantage.

More bunkum

By the way, I hope you noticed that this systems analysis failed to speak of "path loss," "noise figure," and "antenna gain"!

Nor should it have; these terms are just obscurations. There is no such thing as "path loss"; space is loss-free. The term was invented by nomograph manufacturers as a convenient stepping-stone on their gadgets.

"Noise figure" (in dB) is another meaningless number invented by preamp manufacturers to increase sales. Daft! If they used noise temperatures instead, they would sell rather more, because those numbers are far more impressive. They are certainly more intuitive.

"Gain" is useful only when talking about transmitting or if you are trying to sell antennas. For receivers, capture area is a direct measure and again, far more meaningful. For reference, $G = 4p\,\text{Area}/\text{Wavelength}^2$.

Disadvantages of S-band downlinks

So far as I have been able to discover, the only impediment to S-band signals is tree foliage. This seems to me to be a rather trivial drawback. I should like to hear if there is anything else technically negative. Perhaps some of the real techies (not the armchair ones), who have all the answers but never tell, could come forward!

Disadvantages of 145 MHz downlinks

I don't want to labor the point! The honest truth is that AO-13's 145 MHz downlink does have serious shortcomings. Noise is high, and big antennas and highest quality receive technique are required. Many fail at this hurdle and give up. Others reach for their wallet. It is nothing like as easy as it was envisaged all those years ago. It doesn't have to be like this.

Phase 3D

We don't have to repeat the mistake with P3D. Cranking up the 145 MHz downlink power is no solution. It's a short-term delusory crutch that will simply hobble us for another decade.

Isn't it time we took a careful, unbiased look at the options? And surely, before jumping to contusions, budding analysts should at least try AO-13 mode-S?

I promise that you will be astounded at its simplicity and at its performance. You don't have to habitually use it for ever after. Indeed, its experimental hard limiting design won't support hoards of users. Just try it, so help me! The equipment can be put by for the future, or lent to others. It won't be wasted. Are you willing to stand up and be counted?

Well?

[End of original article; the following added August 2001.]

2001 footnote: Oscar-40

The foregoing was written in September 1992. I'd gone from zero S-band understanding to total conversion in the space of 24 hours. Staring up at a huge, tower-mounted 2m yagi, and a diminuitive S-band antenna giving the same performance, sent me straight to the keyboard in a blaze of inspiration. I have not changed a word.

Things have improved. Oscar-40 has an S-band transmitter capable of 40–50 watts output, connected to a 5-turn helix, with gain 10 dBic. This is a lot of radiated power; beacon signals and voice signals are predictably very strong indeed, greatly surpassing the experimental system of Oscar-13.

S-band receive technology has evolved rapidly, and whilst surplus converters are available, generally having early '90s performance of 170K (2 dB), off-the-peg contemporary equipment boasts noise temperatures of 40K to 50K (0.6dB), which is commensurate with the baselines of irreducible sky noise and antenna sidelobe pickup. You get what you pay for; the performance difference between the old and new just cited is about 4 dB, and is not a margin to be squandered lightly.

S-band antenna design and construction continues to exercise mind and body for many hams, with predictably mixed results! Commercial offerings are also available, which was scarcely the case a decade ago.

S-band is now mainstream hamming; plug 'n' play, and there is now no excuse for holding back. Oscar-40 beckons seductively.

Just do it! 73

Russ Tillman K5NRK
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Vicksburg MS 39183-1203

Risky Business

That's one way to describe designing our next radio amateur satellite.

What do you want the next amateur radio satellite to do? Ask that question of 100 hams who are interested in amateur radio satellites and you will probably get 100 different answers — some from folks who are very vocal and strongly animated about their opinions. Also, ask these same folks how to build this satellite and you will also get 100 different opinions. Such is amateur radio satellite-building, such is AMSAT.

This article presents efforts to-date in planning and designing AMSAT's next satellite and how some of the tough choices and decisions are being made for the benefit of the amateur radio community. In this article, "AMSAT" refers to the worldwide alliance of AMSAT organizations that contributed to designing, building, launching, controlling, and funding Phase 3D/AO-40.

Learning from the Phase 3D/AO-40 experience

After many years of hard work, Phase 3D successfully soared into orbit on November 17, 2000, via an Ariane 5 rocket. The day after launch, AMSAT-NA Chairman Bill Tynan W3XO, who is responsible for numbering amateur radio satellites, christened Phase 3D "AO-40" as it began its extensive and interesting commissioning process towards eventual operation. While the road to a successfully operating AO-40 spacecraft has been long, bumpy, and difficult, users are now starting to see the fruits of builders' efforts with an extremely operational AO-40. As most hams know, this long and interesting process tested and stretched the capabilities of the numerous organizations that were involved in designing, constructing, testing, launching, and commissioning Phase 3D/AO-40. This project also tested and stretched the support and perhaps patience of the amateur radio community, whose generous contributions funded development and launch expenses. Whether AMSAT will undertake another Phase 3D/AO-40 project is certainly debatable; however, the opportunity to place 650 kilograms of amateur radio mass into a highly elliptical orbit appears to be a once-in-an-organization opportunity. That is, AMSAT will probably never get the opportunity to do that again. So we made the best of it and the results of our efforts are beginning to pay good dividends. And, there are many on-the-ground benefits that we are continuing to derive from the Phase 3D experience. For example, AMSAT and its sister organizations have developed a network of experienced satellite builders, many of whom have cut their teeth on the construction of Phase 3D. As a result, the experience gained from the Phase 3D project is already proving that it will be beneficial to AMSAT for many years to come, starting with the design of the next AMSAT satellite.

Life after Phase 3D

Even before Phase 3D went into orbit, the AMSAT-NA Board of Directors was already discussing plans for the next endeavor. One of the first items of discussion at the October 2000 AMSAT-NA Annual Meeting and Symposium in Portland, Maine, was life after Phase 3D. At that meeting, the Board of Directors resolved the need for AMSAT to begin defining the next project. Their intent was to capture and keep the momentum and experience gained from the development of Phase 3D and carry that momentum over to their next project. The Board established and charged an AMSAT-NA Project Committee with the responsibility of coming up with a proposal for the next AMSAT satellite. The composition of this committee is a Who's Who in the Amateur Satellite community and includes: Bill Burden WB1BRE (AMSAT-NA Vice President for Strategic Planning); Ed Collins N8NUY (Special Assistant to the AMSAT-NA President); John Conner NJØC (Ground support); Art Feller W4ART (AMSAT-NA Treasurer); Bdale Garbee KBØG (Satellite software and digital designer, including participation

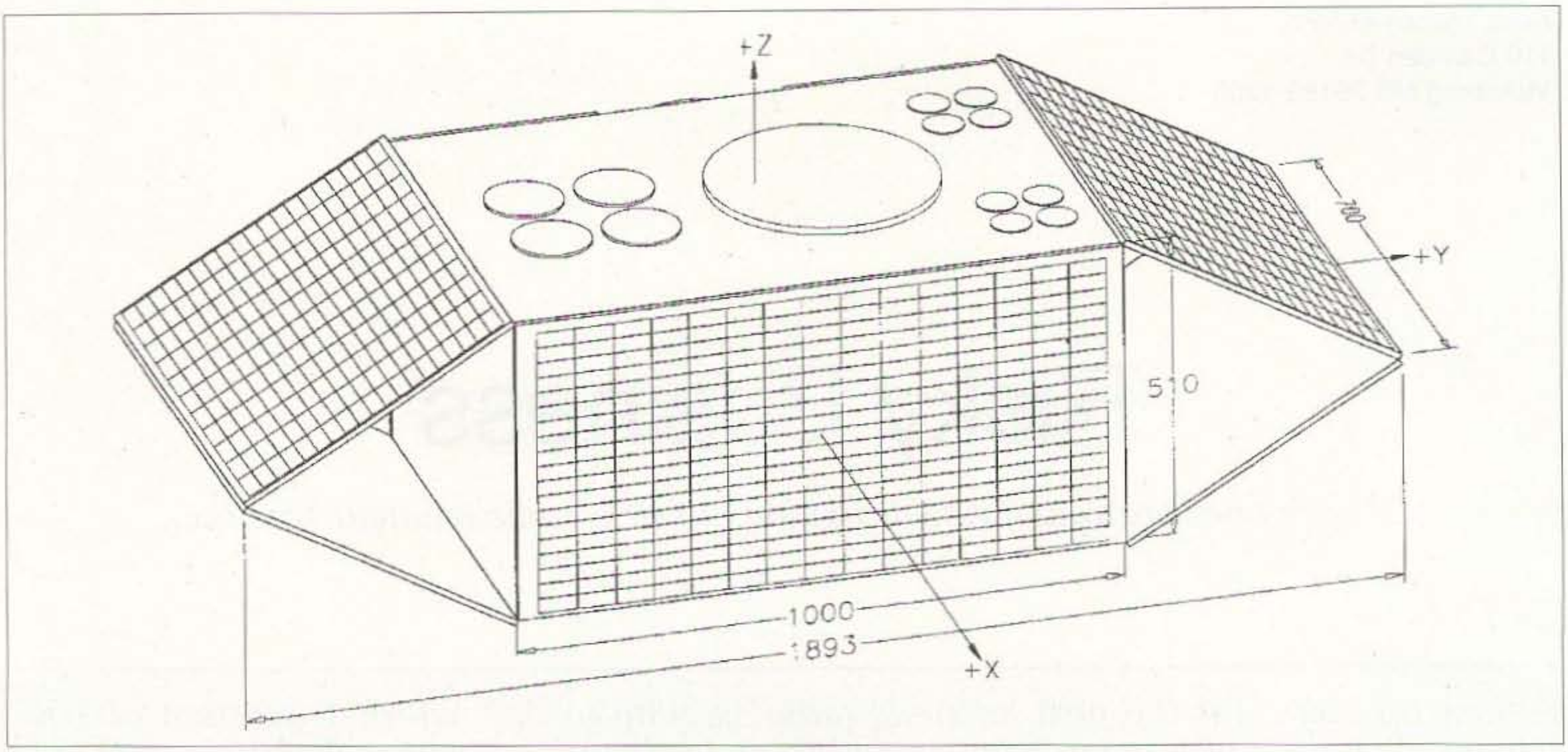

Fig. 1. *Two amateur satellite proposals were considered at the AMSAT-NA Project Committee Denver workshop. While these satellites varied in physical design, they are functionally identical. Fig. 1 shows a diagram of the mechanical design proposal for an orbit-plan spin axis satellite that was developed and proposed by Dick Jansson WD4FAB. This proposed satellite is designed for launch into a geostationary-transfer orbit as a tertiary payload on an Ariane 5 launcher.*

in Phase 3D RUDAK); Chuck Green NØADI (Designer and integrator of numerous Phase 3D modules and launch campaign deputy director); Robin Haighton VE3FRH (AMSAT-NA President and Board of Directors member); Rick Hamby W2GPS (Digital software data communications); Dick Jannson WD4FAB (Phase 3D structural and thermal designer); Lyle Johnson KK7P (Space flight computer designer); Mark Kanawati N4TPY (Satellite design and integration); Phil Karn KA9Q (Internet protocol); Jan King W3GEY (Founding AMSAT member and builder of numerous amateur radio satellites); Michael Kingery KE4AZN (Mechanical designer); Lou McFadin W5DID (Phase 3D Integration Laboratory Manager; Stacey Mills W4SM (AO-40 Command Station); Jim Sanford WB4GCS (Digital communications); Dan Schultz N8FGV (Satellite operations); Ray Soifer W2RS (International coordination); Brian Straup N5YC (Ground station development); Tomas Svitek (Systems engineering and launch); Russ Tillman K5NRK (Technology transfer/ fund raising); Paul Williamson KB5MU (Software systems and electronic information); Jim White WDØE (Systems engineering, software design, and command station); and Stan Wood WA4NFY (AMSAT-NA Vice President of Engineering and Phase 3D antenna designer).

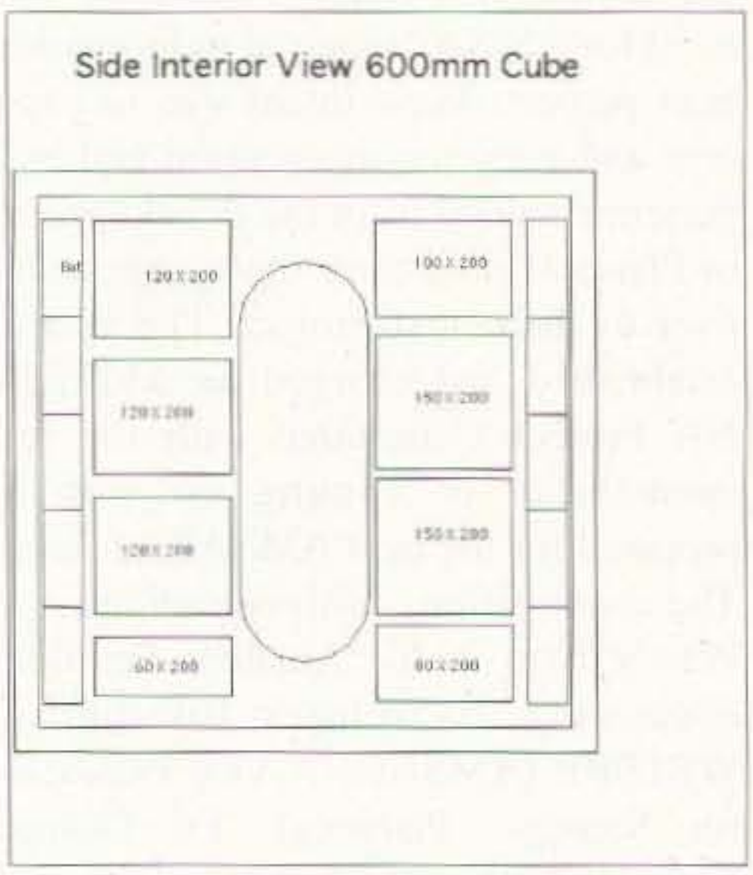

Fig. 2. *A mechanical design proposal for a Y-spin satellite was presented by Stan Wood WA4NFY at the Denver workshop. The cube-design of this satellite could be launched on the Ariane 5 as a tertiary payload or via other launch vehicles.*

Two very interesting satellite project proposals emerged from this committee (see **Figs. 1** and **2**). Both of these credible proposals were well thought out and addressed numerous difficult engineering and design challenges that would allow them to accomplish their respective missions. The challenge was for the Project Committee to consider the merits of each proposal and then agree to undertake a project that was technically feasible, followed sound engineering principles, and was in the best interest of AMSAT. Also, the recommended project would require the final approval of the AMSAT-NA Board of Directors and, more importantly, the continued support of the total AMSAT membership as expressed in both financial contributions and willingness to work on the project. To accomplish this task, the AMSAT-NA Project Committee held a weekend-long workshop in Denver, CO, in July 2001, where they attempted to resolve these difficult issues.

The Denver Workshop challenge: defining the design considerations of a radio amateur satellite

Physical and Mission Considerations: Various types of design considerations must be met when building an amateur radio satellite. Unfortunately, depending on what you want your satellite to do, some of these considerations may not be compatible with each other (while other considerations may be very supportive of one another). As a result,

design consideration interactions must be understood and address ways that support the mission of the satellite. (In fact, because of their complex intricacies, the impact that some relationships have on a satellite's mission may never be completely understood until after launch!) For example, a satellite experiences numerous physical conditions that may be functions unique to its orbit and the spacecraft's attitude in relationship to the earth and sun. As a result of these characteristics, thermal dynamic issues may arise that must be understood and addressed in the design of the satellite. As these issues are addressed, they may impact the satellite's ability to accomplish its primary mission — in this case, effective amateur radio communications and other related fun. As a result, design trade-offs on power reduction may have to be made in order to satisfactorily meet physical considerations such as temperature issues. Other times, very innovative solutions may emerge that can be applied to satisfactorily address both physical and mission considerations (i.e. win-win situations). Science rapidly becomes an art when exploring and resolving these design stage issues.

Technical and User Considerations: The first amateur radio satellites were built in small workshops and designed, constructed, tested, and launched in a relatively short period of time. Compared to today's amateur radio satellites, these early satellites were very inexpensive — built by two or three people — and did not even require modest financial contributions from the amateur radio community. They were also not as technically complicated as today's satellites. Over the past few years, universities and foreign governments have emerged as new and welcomed builders of amateur radio satellites. Within the ham community, every satellite that is launched by these new participants is openly welcomed as an exciting new venture and opportunity. As a result of these new participants, there has been a significant increase in the number of available analog and digital amateur satellites, allowing satellite operators to become

Photo A. *Members of the AMSAT-NA Project Committee in attendance at a workshop in Denver CO. From left to right (with area of expertise in parentheses): Russ Tillman K5NRK (Technology Transfer); Jim White WDØE (Systems Engineer, Software Design, and Command Station); Chuck Green NØADI (Design and Integration & Workshop Moderator); Lou McFadin W5DID (Design and Integration); Stan Wood WA4NFY (Design, Integration, and Antennas); Ed Collins N8NUY (Special Assistant to the President); Michael Kingery KE4AZN (Mechanical Design); Dan Schultz N8FGV (Operations); Paul Williamson KB5MU (Software Systems and Electronic Publications); Lyle Johnson KK7P (Spacecraft Flight Computer Design); Tomas Svitek (Guest by invitation of Jan King); Bdale Garbee KBØG (Software and Digital Design); Rick Hamby, W2GPS (Digital Software Data Communications); Dick Jansson WD4FAB (Mechanical and Thermal Design); John Conner NJØC (Ground Support); Phil Karn KA9Q (Internet Protocol); Robin Haighton VE3FRH (President & Board of Directors); Brian Straup N5YC (Ground Station); Mark Kanawati N4TPY (Satellite Design and Integration); Arthur Feller W4ART (Treasurer). (Photo by Mark Kanawati N4TPY)*

accustomed to using several now-common operating frequency modes such as modes A, B, and J. While the majority of all satellite users have equipment in their shack (and now on their belts via HTs and Arrow Antennas) to work these more common mode satellites, other frequency modes have been identified and proposed that offer the potential to expand satellite design capabilities and enhance efficiencies of satellite and ground operations. (For discussions on some of these innovative modes, read James Miller G3RUH's article in this issue titled "A Modest Proposal.") As a result, a key challenge facing AMSAT is to get the membership to support using and experimenting with other modes when most are comfortable with the status quo. Because of existing equipment investments and current knowledge, this can become a heated and sensitive debate. However, this challenge is not something new, as AMSAT faced this dilemma many times when satellites employing new frequencies and associated technologies advanced from Mode A to Modes B, J, L, and S. As a partial solution to this dilemma (and perhaps a stress reliever), most university and foreign government amateur satellite builders are developing Mode J and B satellites that operate using existing technology. As a result, these satellites meet a large portion of membership demand. This also allows AMSAT some room to pursue other modes such as Mode L/S. (And — who knows? — perhaps by AMSAT pushing the design envelope, one day Mode L/S will be a common or standard mode among users.)

Designer Considerations: Designers and builders of amateur satellites enjoy a technical challenge. That is, few if any want to rebuild an existing satellite, as designs can always be improved. While there are certainly lots of reasons why folks donate their time to build satellites, most enjoy the challenge of improving the design, pushing the envelope, or just doing something entirely new and innovative. As a result, a dilemma exists between the designers and users; the designers want to construct something new or better, while most users seem content happily using the existing satellite technology — they just want more of them. As mentioned earlier, the fortunate increase of amateur satellite suppliers

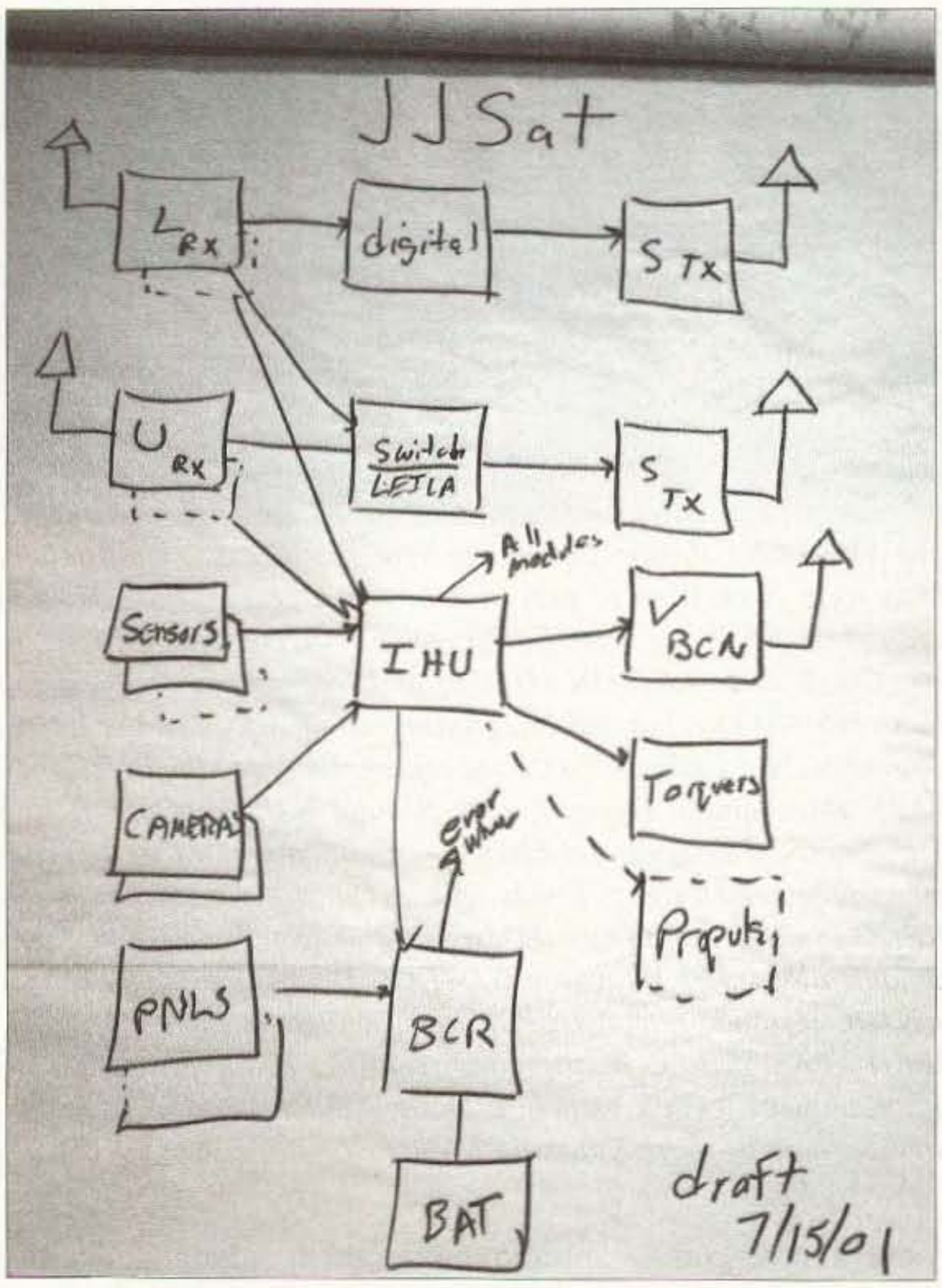

Photo B. *In the tradition of designing the next satellite on the back of a cocktail napkin, workshop members used an easel scratchpad to identify the next satellite's components and their associated relationship. (Photo by Mark Kanawati N4TPY)*

and associated available launches allows some of the existing demand to be met. As a result, this allows a bit of wiggle room for experimentation in new designs, technology, and operating modes that may become tomorrow's common operating modes.

The Final Consideration: Given the above considerations, the challenge is to identify and clearly understand all design considerations, stir them all together and let them simmer, correctly address their impact, and come up with an achievable and realistic design that will challenge both the builders and users of the proposed satellite. Nearly all of the time that is easier said than done, but that is probably one of the main challenges that makes hams want to build or use amateur radio satellites. Also, because design considerations often conflict, it is a tough, and perhaps impossible task to design the perfect amateur radio satellite. While it is a noble goal to build the perfect satellite, in reality, compromises or trade-offs amongst design considerations have to be made in order to accomplish the mission. And, to top it off, this all accumulates with the significant risk associated with placing your carefully designed and built satellite on top of a rocket in hopes that you achieve a successful launch. However (thankfully?), builders, sponsors, and users all have very little control over a launch. Add all the components of this process up and you have a very risky business that is accomplished entirely with members' donated time and dollars! However, the results continue to be stunning; just look at the number of amateur radio satellites in orbit!

So what's the bottom line? What is AMSAT's next satellite project?

So, given all of these design considerations, what did the Project Committee do at their Denver workshop? In a nutshell, the committee did what past AMSAT designers and builders of satellites did; they got down in the technical weeds and forged a satellite design that would accomplish a specific mission, be technically challenging, meet membership needs, and be worthy of financial support. Is the design of this workshop perfect and complete? Certainly not. There were compromises, and components of this proposed design will continue to evolve and be improved up until the day of the launch. However, that is the nature and reality of the satellite design business; all of the answers are not on the table upfront. As a result, continual improvements are always being made to enhance the mission.

The key points of the proposed satellite design that was forged at the Denver Workshop are best summarized by portions of an open letter that AMSAT-NA President Robin Haighton VE3FRH, provided AMSAT-NA members after the workshop:

Greetings:

It is with great pleasure that I write to you this month and talk about the progress being made with our next satellite project, currently known as "Project JJ." [Tentatively named for Dick Jansson WD4FAB and Lyle Johnson KK7P, who proposed the two initial satellite designs (**Figs. 1** and **2**) that were the basis for further discussion and analysis at the workshop.]

Recently, a meeting was held in Denver, Colorado — attended by twenty of AMSAT-NA's designers and officers. Their main objective was to begin implementation of this project, as mandated by the AMSAT-NA Board of Directors. While it is not my intention in this letter to go into every detail about the meeting, it is important to note that one very significant decision made was to make every aspect of this new satellite (as it is being designed) completely available to the AMSAT community. By every aspect I mean every drawing (including schematics), every piece of code, and all telemetry details, etc. The only details that will not be released are those that would possibly endanger the security of the spacecraft when in orbit (should hackers become active on the bird), and any proprietary commercial data (which I don't think that there will be much, if any, of). In other words, Project JJ will be your satellite!

Yes, this new project will be an "open concept" design and the project committee will welcome your constructive feedback as the project progresses. In fact, I am pleased to announce that Paul Williamson KB5MU will be posting project information on the AMSAT-NA WWW page and Russ Tillman K5NRK will be writing an initial article for *The AMSAT-NA Journal*

— with more articles planned as we progress. I am also pleased to announce that Lyle Johnson KK7P and Chuck Green NØADI have agreed to act as joint managers at the start of this project.

As with any project it is always wise to review, and learn from, previous projects. Accordingly, at the Denver meeting a review of the Phase 3 series of satellites was undertaken. Discussion took place on advantages and disadvantages, things we want to repeat and things we can improve on. Such a review is a very valuable part of the design process.

Some of the decisions made at the meeting included:

• Sideband uplinks on L- and U-bands with an S-band downlink;

• Digital communications (TDMA) L-band uplink with S-band downlink;

• V-band telemetry beacon;

• Gain antennas for U-, L-, and S-bands;

• Omnidirectional antennas (for initial commands in the lower part of the orbit);

• Propulsion system only if absolutely necessary. This is a function of yet-undetermined launch dynamics and we may require some form of simple system for perigee adjustment. A decision on this will be made on the need of a propulsion system in the near future.

Now to the important question of finance. It is quite apparent that the days of inexpensive launches are over, especially if we want a good, reliable launch, which I'm sure we all do. Therefore, it is imperative that we immediately commence a fund-raising effort — for a launch (currently estimated) in early 2004.

Again, this will be your satellite!

73,
Robin Haighton VE3FRH
President, AMSAT-NA

At the workshop, an overall decision was also made to proceed with spacecraft design (module sizes — volume and mass, electrical connectors and interfaces, module identification, preliminary power budget, specifications for each identified module) and have this ready for a preliminary design review by the end of 2001. A critical design review will follow the preliminary design review a few months later. Every module will require a detailed test plan as part of its design. To expedite this process, Lyle Johnson KK7P and Chuck Green NØADI agreed to co-manage the project to bring it to this point.

By the end of 2001, Robin Haighton VE3FRH (working with Jan King W3GEY and others) will identify a launch opportunity. Meanwhile, Shep Shepard AA7MH will oversee an AMSAT-NA Business Development Committee to decide what funding can realistically be raised for the project.

It is proposed that the new satellite will then be built, tested, and integrated during 2002. It was also proposed that all modules will be tested individually and then tested as part of and after integration during 2003. The shipment of the satellite to (a presently undetermined) launch agency can occur by the end of 2003, with a potential launch as early as the first part of 2004.

At the Denver Workshop, the following responsibilities were assigned:

Mechanical (launch-dependent decisions): Dick Jansson WD4FAB, Lyle Johnson KK7P, Stan Wood WA4FNY, and Chuck Green NØADI.

Mechanical (designs, drawings, etc.): Dick Jansson WD4FAB and Mike Kingery KE4AZN.

Antennas: Stan Wood WA4NFY.

Thermal Design: Dick Jansson WD4FAB.

Digital Communications: Phil Karn KA9Q.

Digital Ground Hardware: Brian Straup N5YC.

Computers & Related Sensors: Lyle Johnson KK7P.

Navigation Sensors: Lou McFadin W5DID.

Propulsion (launch-dependent): Tomas Svitek.

Command Team Leader: Stacey Mills W4SM.

Power System: John Conner NJØC.

Launch Availability: Robin Haighton VE3FRH, Jan King W3GEY, and Tomas Svitek.

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AMSAT, Where to Next?

The prez tells us.

Since amateur radio's conception, its experimenters have frequently led the way in innovation and new ideas for the Amateur Radio community as well as for both civilian and military users. AMSAT is certainly no stranger to this concept, having led the way for microsat usage, assisted launch agencies with the design and implementation of secondary payload rings as well as search and rescue ideas, and come up with many other innovations.

The future of AMSAT depends, to a great degree, on the continued ability of the AMSAT technical designers and engineers to devise new techniques and to inspire the membership to continue to experiment with science in space. This in turn depends on the willingness of the membership to support the AMSAT activities.

Amateur Radio enthusiasts are, by their very nature, people who are interested in the science of radio and communications. Many of us have been fascinated with radio since our earliest days and have experimented with devices such as crystal sets, tubes, transistors, and integrated circuits even before we could understand their function. We are often the "early users" when new devices hit the marketplace and are always on the lookout for that new device or item at the ham flea market. This is particularly true of those who work the amateur satellites, and we are anxious to try out the "new bird" with its latest bands, new devices, and unique functions. AMSAT, comprising many national and individual AMSAT organizations and a worldwide membership, has been a leading proponent of space communications and experimentation. The results of this effort by thousands of satellite operators have benefited communications and science experiments in commercial, military, and amateur satellites. Since the early days of OSCAR 1 in 1961, forty-two satellites have achieved the designation of OSCAR (Orbiting Satellite Carrying Amateur Radio), and more are anticipated this year. Many of these satellites have had unique experiments on board which proved a new design or technique. Often by the life of the satellite we are able to evaluate the effectiveness, in space, of a material or radiation-hardened electronic components. The success of the satellite programs has been such that several major manufacturers are producing transceivers which are directly usable in the satellite service as well as in the HF service, and include CAT ports for Doppler frequency correction, as well as the capability to track both forward and reverse between the frequency bands, with full duplex communication.

With all this said, there are several questions that keep being asked, and they are very important, because they affect the investment that you have made or are going to make in equipment and support of your local AMSAT.

Question 1: "With all the new ideas and innovations that I hear about, will my existing equipment be of any use?"

Answer: Yes — definitely — yes! Although new ideas will be tried and developed, existing systems using your current equipment will be around for many years to come. For example, the next satellite built in AMSAT-NA will have standard SSB capability as well as a new digital modulation system. It is also most likely to have a 70cm uplink and a 2-meter downlink (Mode B) as well as higher frequencies.

Question 2: "SSB has been with us for over 50 years — should we be looking at newer and more efficient modulation techniques?"

Answer: Yes, on the new AMSAT-NA satellite, it is proposed to have a digital modulation system which could eventually replace SSB as our main modulation system, particularly in satellite work. The digital system would be more efficient with power, and more accurate with communications, resulting in less AM interference. Built-in Forward Error Correction

(FEC) would provide greater reliability. However, while such systems are readily available on your digital cell phone, they have not been applied to amateur satellites — yet!

Question 3: "OK, so we know what AMSAT-NA proposes, but who is doing any thing else?

Answer: There are many satellite programs applicable to Amateur Radio being constructed for launch at the present time (late August). These include:

- AMSAT-CE CESAR-1, a microsat 2m, 23cm uplink and 70cm, 13cm down. Possibly to be launched in 2001.
- AMSAT-VU, 2M and 70 Cm. Details being discussed.
- AMSAT-DL, an amateur radio mission to the planet Mars providing telemetry to radio amateurs on amateur bands as described briefly at the AMSAT-UK colloquium July 2001. (Details in the *AMSAT-DL Journal* in German).
- PCSAT by Bob Bruninga WB4ARP, an APRS satellite — due to have launched in September 2001.
- Starshine by Gil Moore N7YTK, an educational satellite — due to have launched in September 2001.
- Many Cubesats, comprising 4-inch cubes to be launched late in 2001 or early in 2002. These are educational satellites in the amateur satellite bands.

These listed satellites should be fully available to the ham community, and will use technology which is applicable to existing equipment in the 2-meter and 70cm bands.

So what is the long-range plan for AMSAT-NA? Our current thinking is that as amateur radio hobbyists we will continue to design, build, and operate satellites, while developing new ideas and leading technology. We believe that by advancing the state of the art while still maintaining the opportunity to use existing equipment, we will increase our new membership and continue to satisfy those existing members who enjoy the more traditional means of communication through satellites.

We are therefore proposing to have a new satellite launched into orbit about every 3 to 4 years as adequate funding becomes available. Each one in turn will have some advancement, but there will be some of the traditional operating means available on some of the satellites. All of this takes funding, chiefly provided by the Amateur Radio Satellite community. So let me ask the next and last questions:

Is the amateur satellite community prepared to support the principles that I have laid out above? Are you willing to join your national or international AMSAT organization? Are you prepared to financially contribute and/or be an active participant in the organization?

Don't leave it to others — do it now! 73

Microwave Antennas for AO-40

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had fun in the process. I hope this taster of an article will encourage you to have a go and build your own AO-40 antenna array.

Good luck, and see you on AO-40!

Further reading and resources

AMSAT — [http://www.amsat.org]
AMSAT DL — [http://www.amsat-dl.org]
AMSAT UK — [http://www.amsat-uk.org]
ARRL — [http://www.arrl.org]
G3PHO — [http://www.g3pho.free-online.co.uk]
G3RUH — [http://www.jrmiller.demon.co.uk]
G6LVB — [http://www.g6lvb.com]
RSGB — [http://www.rsgb.org.uk] 73

Modifying the TranSystem 3733 for Mode S

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I'm not that worried about what numbers appear on the display of the radio.

There are some other mods being performed on the unit. I have not had a need for these, but they may fit your needs. Several people have added a thermistor to the crystal to act as an oven. You can see this mod at [http://members.aol.com/k5gna/PTCthermistor.jpg]. Another mod is to remove and/or replace the first-stage filter. This should provide even better performance, but it is not an operation for the faint of heart. It is very easy to damage the front end of the downconverter with static, and optimizing this filter requires some fancy test gear. Adapters are available to replace the integrated antenna with a type "N" connector. This would allow for experimenting with other antennas. Jerry K5OE has a mod to power a preamp ahead of the unit. You can see it at [http://home.swbell.net/k5oe/3733_12Vdc.jpg].

I would like to close this article with a few comments on operating with the 3373. The unit will drift in frequency a bit. It is best to power it up an hour or two before you intend to use it. Remember, it was designed to run 24 hours a day 7 days a week, so there is nothing wrong with leaving it on. The integrated dish reflector with the stock integrated dipole is easy to set up and hard to beat. You can see mine in **Photo F**. Several people have reported that their units survived very short accidental transmissions. That's good to hear, but take care and try not to transmit into the unit. If I have a complaint, it is that the downconverter has too much gain. I have 10 dB of attenuation between my power inserter and my radio. The bottom line is that Mode S is easy and fun! I hope to work you soon on AO-40! 73

All Aboard for ARISS ...

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ISS to begin using the ham radio station.

Conclusion

The year 2001 will long be remembered as the year that the ARISS team pioneered a new facet of amateur radio — permanence on the International Space Station. In the future, there will be new equipment, new modes of operation, and exciting QSOs. Enjoy the QSOs, experimentation, and school group contacts. And remember the international team that made it happen — ARISS.

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PROPAGATION

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Erratic

Conditions throughout November will be erratic as sunspot numbers remain high and solar activity fluctuates from low to moderate levels. Numerous minor flares and recurring coronal holes will continue to plague operators through increased signal absorption, auroral echo, and shortwave fadeouts.

Tropical storms will also add their share of atmospheric noise to the higher bands, but on the whole this month should be one of the better ones for DXers this year. I've picked 15 days as Good (G) or Fair-to-Good (FG), so everyone should have a shot at making some interesting long distance contacts.

Although no Poor (P) days appear on the calendar, you can still expect ionospheric or geomagnetic disturbances to occur during about one-third of the days at lower latitudes and almost one-half the days at more northerly locations. Those days I've earmarked as Fair-to-Poor have the greatest potential for troublesome events to materialize on the sun.

Events such as Coronal Mass Ejections (CMEs), disappearing filaments, and major flares, can have two effects on communications: immediate and delayed. Immediate effects, termed Sudden Ionospheric Disturbances (SIDs), occur within 8 to 10 minutes and can cause moderate to severe fading or total blackouts lasting up to several hours. Delayed effects arrive within 24 to 48 hours in the form of geomagnetic storms that can disrupt communications for up to several days. These delayed storms are not reflected on my calendar due to their less predictable nature, so keep this in mind when wondering why the conditions do not match the forecast.

Next time, I will expand on this theme of forecast vs. actual conditions by explaining some of the methods and pitfalls of long-range forecasting. Until then, Happy Thanksgiving!

Band-by-Band Summary

10–12 Meters

Good to excellent propagation conditions can be expected on Good (G) days starting shortly after sunrise and continuing up to

November 2001

SUN	MON	TUE	WED	THU	FRI	SAT
				1 F-P	2 F	3 F
4 F-G	5 F-G	6 F-G	7 F-P	8 F-P	9 F	10 F-P
11 F-P	12 F-G	13 F-P	14 F-P	15 F-G	16 G	17 F-G
18 F-P	19 F-G	20 G	21 G	22 F-P	23 F-P	24 F-G
25 G	26 F-G	27 F-P	28 F-P	29 F-G	30 F-G	

EASTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
Central America	15/17	17/20	17/20	17/20	17/20	15/17	15/17	10/12	10/12	10/12	17/20	10/12
South America	15/17	15/17	20	30/40	30/40			10/12			12/15	12/15
Western Europe	30/40	30/40	17/20	17/20				10/12	10/12	12/15	17/20	17/20
South Africa	20/30	40	20/30	20/30					10/12	10/12	12/15	12/15
Eastern Europe	17/20	30/40	40/80	40/80	30/40			15/17	10/12	15/17	15/17	17/20
Middle East	20	20	20						10/12	10/17	15/17	15/20
India/ Pakistan	17/20	17/20						15/17				
Far East/ Japan	10/12		17/20				17/20	17/20			15/17	10/12
Southeast Asia	15/17		17/20	17/20			17/20	15/17	10/12			15/17
Australia	10/12	17/20	20	20	20	30/40	30/40	17/20				10/12
Alaska	10/12		20				17/20	20			15/17	10/12
Hawaii	10/12	12/15	17/20	17/20	20/30	20/30	17/20	17/20				10/12
Western USA	20/30	20/30	20/30	30/40	30/40			10/12	10/12	10/12	15/17	17/20

CENTRAL UNITED STATES TO:

Central America	15/17	15/17	17/20	17/20	20/30			10/12	15/17	10/12	10/12	10/12
South America	15/17	15/17	20/30	20/30	17/20			10/12			10/12	12/15
Western Europe								12/15	12/15	12/15	17/20	17/20
South Africa			17/20	17/20					12/15	12/15	15/17	17/20
Eastern Europe	30/40	30/40	30/40						12/15	12/15	17/20	17/20
Middle East	20	20							15/17	15/17	15/17	
India/ Pakistan	15/17	17/20						12/15	12/15			
Far East/ Japan	10/12	12/15	17/20	17/20	17/20		17/20	17/20				10/12
Southeast Asia	10/12		15/20	17/20					10/12	10/12		
Australia	10/12	15/17	15/17		17/20	20/30	30/40	17/20			12/15	10/12
Alaska	10/12	12/15	17/20	17/20	20		17/20	17/20				10/12
Hawaii	12/15	15/17	15/17	17/20	17/20	20/30	30/40	17/20		10/12	12/15	12/15

WESTERN UNITED STATES TO:

Central America	10/12	12/15	15/17	17/20	30/40				10/12	10/12	10/12	12/15
South America	10/12	12/15	15/17	17/20	17/20						10/12	10/12
Western Europe	17/20				17/20			17/20	17/20	20	20	20
South Africa	17/20	20		20						10/12	12/15	12/15
Eastern Europe	17/20	17/20							15/17	15/17	17/20	17/20
Middle East	20									15/17	15/17	20
India/ Pakistan		15/17	17/20						12/15	15/17		
Far East/ Japan	10/12	10/12	12/15	17/20	17/20	17/20			17/20			15/17
Southeast Asia	10/12	10/12						17/20	15/17	17/20		
Australia	10/12	12/15	15/17	15/17	17/20	17/20	17/20		17/20			
Alaska	10/12	10/12	15/17	17/20	17/20	17/20		17/20	17/20			15/17
Hawaii	10/12	10/12	12/15	15/17	20/30	20/30	30/40		12/15	10/12		
Eastern USA	20/30	20/30	30/40	30/40	30/40			10/12	12/15	12/15	15/17	17/20

Table 1. *Band, time, country chart. Plain numerals indicate bands which should be workable on Fair to Good (F-G) and Good (G) days. Numbers in parentheses indicate bands usually workable on Good (G) days only. Dual numbers indicate that the intervening bands should also be usable. When one number appears in parentheses, that end of the range will probably be open on Good (G) days only.*

two hours past sunset. Work toward Europe and Africa before noon, Central and South America from late morning to mid-afternoon, and the Pacific, Australia, and Southwest Asia in the late afternoon or early evening. Short-skip will vary between 1,000 and 2,000 miles on most days.

15–17 Meters

Good to Excellent daytime openings will be workable on Good (G) days. As always, follow the progress of the sun by working to the east in the morning, to the south around midday, and to the west in the afternoon through mid-evening. Look for especially long paths to the southern hemisphere with short-skip effective between 800 and 2,100 miles.

20 Meters

Good to excellent daytime propagation and Fair to Good nighttime conditions will allow around-the-clock activity. In general, work toward the east in the morning, the south at midday, and the west in the afternoon and evening. Be sure to check the Time-Band-Country Chart for additional openings, notably the Middle East and Africa in the afternoon. Short-skip will vary between 1,000 and 2,200 miles.

30–40 Meters

Good to excellent propagation conditions may exist on Good (G) days provided that atmospheric static is low. The best opportunities will occur during the hours of darkness, but early mornings and late afternoons can also be fruitful. Work toward the east and southeast before midnight and to the west, northwest, and southwest between midnight and sunrise. Short-skip at night will average between 500 and 2,000 miles, while during the day it is limited to under 1,000 miles.

80–160 Meters

Fair conditions can be expected on Good (G) days with atmospheric noise due to storms being the primary limitation. Grayline propagation during the morning and evening twilight hours will provide the best long distance opportunities with a short-skip distance of up to 2,000 miles. In general, work to the east and southeast before midnight, and to the southwest through northwest after midnight. If 40 meters is open, 80 and 160 could be, too. 73

All Aboard for ARISS ...

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For more information on the ARISS program, you are welcome to surf the ARISS Web page at: [http://ariss.gsfc.nasa.gov]. 73

Hamsats Awards

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Intermediate Level (includes contacts from Beginner Level)

Work 2 School Club Stations

Work 8 YL Ops

Work 8 Young Ops (16 and younger)

Work 15 Ops that have had their license for less than 2 years at the time of contact

Work 2 Ops as their "1st Satellite Contact" (ever, not just on a particular satellite)

Expert Level (includes contacts from Intermediate Levels)

Work 3 School Club Stations

Work 12 YL Ops

Work 15 Young Ops (16 and younger)

Work 25 Ops that have had their license for less than 2 years at the time of contact

Work 4 Ops as their "1st Satellite Contact" (ever, not just on a particular satellite)

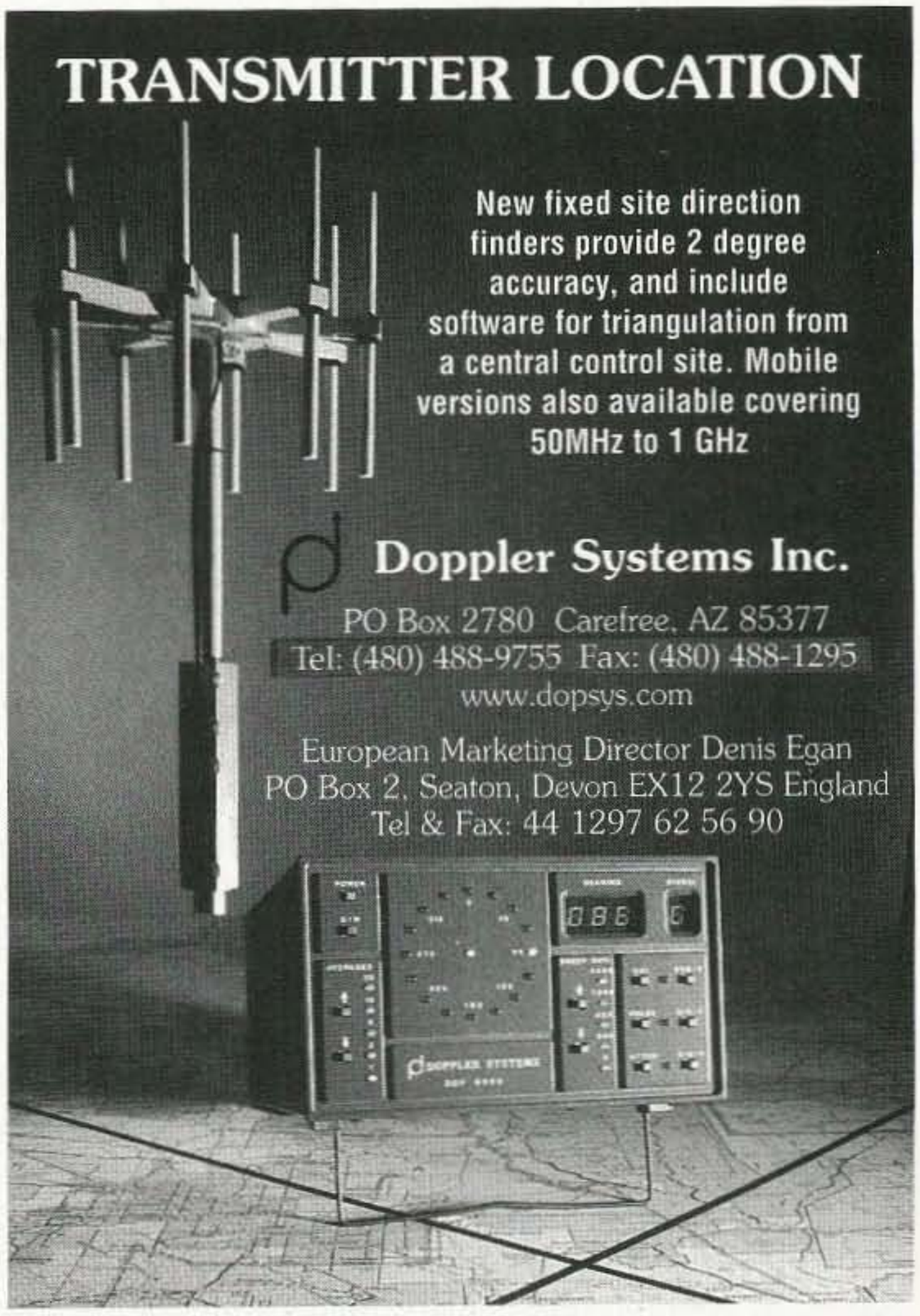
Any satellite may be used for these contacts, but contacts must be made by voice or CW. No packet contacts allowed. Contacts with the ISS, shuttle, or any other manned spacecraft are not to be used for this award.

Contacts must be made on or after November 1, 2001.

Callsigns may be used only once. Therefore, if a callsign fits multiple categories, it is your choice as to which category you claim it for (e.g., Mahana W5BTS, could be claimed for YL op, Young Op, and Op licensed less than 2 years). School Club callsigns count only towards the School Club category.

No QSL cards are required, however,

Continued on page 62



Hamsats Awards

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random checks with the operators listed will be performed.

To submit for the award, send a list in date/time order with Callsign/Date of Contact/Time of Contact/Satellite/Category to the AMSAT Awards Manager, KK5DO.

For category please use:
YL for YL ops contact
Teen for Young ops
First for 1st Contact
New for ops less than 2 years
School for School Club Station
For sample submittal, see **Table 1**.

A certificate is available for $3.50 for AMSAT members and $5 for non-AMSAT members. Two units of postage are required for return of your certificate.

Various magazines, countries and ham groups have other awards. There is even one from Russia, the Cosmos Award. So you may have to check around to find them. Should you have any questions about any of the AMSAT or ARRL awards, I would be happy to answer them. Please send them to me via snail-mail or the preferred method, E-mail, at [kk5do@amsat.org].

73, and good luck in chasing your favorite award! 73

Risky Business

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Cameras — Lens: Lou McFadin W5DID.

Cameras — Detector: Lyle Johnson KK7P.

Regulatory: Dick Daniels W4PUJ.

Magnetorquors: Lou McFadin W5DID.

Chief Information Officer (Electronic): Paul Williamson KB5MU.

Project Co-Managers (until launch details have been decided): Lyle Johnson KK7P and Chuck Green NØADI.

The real challenge:
What can *you* do?

Lots of good things came out of the Denver Workshop. The next AMSAT satellite has a proposed design and direction. In addition, preliminary time lines for constructing and testing the satellite have been identified, along with assignments for responsibility of developing a variety of satellite modules. An innovative and simple-design digital operating mode has been proposed to fly on the satellite that will allow more hams to access the satellite via low-cost satellite ground stations.

Lots of challenges also came out of the Denver Workshop. With this ambitious project comes a hefty price tag; it will be a challenge for AMSAT to raise the necessary funds. Also, the need for new builders, ground station hardware designers, and command and control stations to come forward and help with this task was apparent. There will be plenty of opportunities for interested hams to work on this project. One benefit of the proposed open design concept is that it will enhance members' awareness of ongoing developments. As a result, more opportunities will exist for locating and employing much-needed assistance during the development and testing of the satellite.

As AMSAT-NA's next satellite project matures, there will be many opportunities for involvement and participation. So, if you are interested in participating in the next AMSAT satellite project, the first step is easy: Stay abreast of developments of this project. It does not matter where you live in this world, as AMSAT communicates via E-mail, WWW, fax, telephone, and (you guessed it) amateur radio. There are several first steps you can do to Support this project, namely:

• Join AMSAT-NA! Membership and financial support should be your first step in participating in this project. Among many benefits, AMSAT members receive *The AMSAT Journal*, which continually chronicles the development and use of many amateur satellites.

• For the latest developments, monitor [http://www.amsat.org] and weekly AMSAT News Service bulletins.

• Subscribe and participate in discussions on amsat-bb, an E-mail list that openly discusses a variety of evolving amateur satellite issues. (Complete subscription details are available via [http://www.amsat.org].)

• Get on the air and use the satellites! It is a great way to understand existing and emerging technology. It's a great way to learn, lots of fun, and you will enjoy the comradeship!

As calls for help or assistance arise during this project, they will be posted via the above sources. So, get prepared to jump in and have fun!

Russ Tillman K5NRK *has been editor of* The AMSAT Journal *for six years. He's a member of the AMSAT's Project and Business Development committees and Vice President of Publications. When not doing AMSAT business, he enjoys pursuing DX whether via satellites, HF, E-mail, or eyeball-to-eyeball.* 73

QRX

continued from page 6

"As part of the worldwide amateur radio community, Australian amateurs have many friends and relatives in the U.S., and many of us are wondering how these friends are faring.

"I note with pride, however, that in this as in many other such situations, amateurs have already offered their services through the ARRL and its various emergency service organizations to provide assistance to both individuals and the wider community affected by this disaster. This spirit is especially significant in this the International Year of the Volunteer.

Our thoughts and best wishes go out to all American amateurs involved in the valiant rescue efforts currently underway. I feel sure that all amateurs in Australia will be watching the developments in the U.S. carefully over the next few days and many of us wish that we were better placed to provide assistance to those in need at this time."

Shortly after the terrorist attacks on the World Trade Center and the Pentagon, FCC Special Counsel Riley Hollingsworth asked radio amateurs to keep their ears open and report any suspicious or clandestine communications to him.

If you do happen across something that needs to be reported, you will need to know where to take your information. Those who have been watching TV or reading newspapers already know that a Federal Bureau of Investigation task force is assigned to head up the domestic aspect of the investigation. It has also requested all media outlets let the public know that it would like any leads reported directly to it. To accomplish this, the FBI has set up a toll-free number area code (866) 483-5137. Information can also be sent via a special Web site at [www.ifccfbi.gov]. The FCC's Hollingsworth can be contacted by E-mail to [fccham@fcc.gov]. All these addresses and other resources are at the very top of the Amateur Radio Newsline Web page at [www.arnewsline.org].

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Wise Up!

Here are some of my books which can change your life (if you'll let 'em). If the idea of being healthy, wealthy and wise interests you, start reading. Yes, you can be all that, but only when you know the secrets which I've spent a lifetime uncovering.

.....Wayne

The Secret Guide to Health: Yes, there really is a secret to regaining your health and adding 30 to 60 years of healthy living to your life. The answer is simple, but it means making some serious lifestyle changes. Will you be skiing the slopes of Aspen with me when you're 90 or doddering around a nursing home? Or pushing up daisies? No, I'm not selling any health products, but I can help you cure yourself of cancer, heart trouble, or any other illness. Get this new, 2001 expanded edition (156p). $10 (#05)

The Secret Guide to Wealth: Just as with health, you'll find that you have been brainwashed by "the system" into a pattern of life that will keep you from ever making much money and having the freedom to travel and do what you want. I explain how anyone can get a dream job with no college, no résumé, and even without any experience. I explain how you can get someone to happily pay you to learn what you need to know to start your own business. $5 (#03)

The Secret Guide to Wisdom: This is a review of around a hundred books that will boggle your mind and help you change your life. No, I don't sell these books. They're on a wide range of subjects and will help to make you a very interesting person. Wait'll you see some of the gems you've missed reading. You'll have plenty of fascinating stuff to talk about on the air. $5 (#02)

The Bioelectrifier Handbook: This explains how to build or buy ($155) a little electrical gadget that can help clean your blood of any virus, microbe, parasite, fungus or yeast. The process was discovered by scientists at the Albert Einstein College of Medicine, quickly patented, and hushed up. It's curing AIDS, hepatitis C, and a bunch of other serious illnesses. It's working miracles! The circuit can be built for under $20 from the instructions in the book. $10 (#01)

My WWII Submarine Adventures: Yes, I spent from 1943-1945 on a submarine, right in the middle of the war with Japan. We almost got sunk several times, and twice I was in the right place at the right time to save the boat. What's it really like to be depth charged? And what's the daily life aboard a submarine like? How about the Amelia Earhart inside story?If you're near Mobile, please visit the Drum. $5 (#10)

Wayne's Caribbean Adventures: My super budget travel stories – where I visit the hams and scuba dive most of the islands of the Caribbean. You'll love the special Liat fare which let me visit 11 countries in 21 days, diving all but one of the islands, Guadeloupe, where the hams kept me too busy with parties. $5 (#12)

Cold Fusion Overview: This is both a brief history of cold fusion, which I predict will be one of the largest industries in the world in the 21st century, plus a simple explanation of how and why it works. This new field is going to generate a whole new bunch of billionaires, just as the personal computer industry did. $5 (#20)

Cold Fusion Journal: They laughed when I predicted the PC industry growth in 1975. PCs are now the third largest industry in the world. The cold fusion ground floor is still wide open, but then that might mean giving up watching ball games. Sample: $10 (#22)

Julian Schwinger: A Nobel laureate's talk about cold fusion—confirming its validity. $2 (#24)

Dowsing. Yes, dowsing really does work. I explain how and why it works, opening a huge new area for scientific research with profound effects for humanity. $2 (#84)

Improving State Government: Here are 24 ways that state governments can cut expenses enormously, while providing far better service. I explain how any government bureau or department can be gotten to cut it's expenses by at least 50% in three years and do it cooperatively and enthusiastically. I explain how, by applying a new technology, the state can make it possible to provide all needed services without having to levy *any* taxes at all! Read the book, run for your legislature, and let's get busy making this country work like its founders wanted it to. Don't leave this for "someone else" to do. $5 (#30)

Mankind's Extinction Predictions: If any one of the experts who have written books predicting a soon-to-come catastrophe which will virtually wipe most of us out are right, we're in trouble. I explain the various disaster scenarios, like Nostradamus, who says the poles will soon shift (as they have several times in the past), wiping out 97% of mankind. Okay, so he's made a long string of past lucky guesses. The worst part of these predictions is the accuracy record of some of the experts – like Hapgood, Einstein, Snow, Noone, Felix, Strieber. $5 (#31)

Moondoggle: After reading René's book, *NASA Mooned America*, I read everything I could find on our Moon landings. I watched the NASA videos, looked carefully at the photos, read the astronaut's biographies, and talked with readers who worked for NASA. This book cites 45 good reasons I believe the whole Apollo program had to have been faked. $5 (#32)

Classical Music Guide: A list of 100 CDs which will provide you with an outstanding collection of the finest classical music ever written. This is what you need to help you reduce stress. Classical music also raises youngster's IQs, helps plants grow faster, and will make you healthier. Just wait'll you hear some of Gotschalk's fabulous music! $5 (#33)

The Radar Coverup: Is police radar dangerous? Ross Adey K6UI, a world authority, confirms the dangers of radio and magnetic fields, including our HTs and cell phones. $3 (#34)

Three Gatto Talks: A prize-winning teacher explains what's wrong with American schools and why our kids are not being educated. Why are Swedish youngsters, who start school at 7 years of age, leaving our kids in the dust? Our kids are intentionally being dumbed down by our school system — the least effective and most expensive in the world. $5 (#35)

Aspartame: a.k.a. NutraSweet, the stuff in diet drinks, etc., can cause all kinds of serious health problems. Multiple sclerosis, for one. Read all about it, two pamphlets for a buck. (#38)

$1 Million Sales Video: The secret of how you can generate an extra million dollars in sales just by using PR. This will be one of the best investments you or your business will ever make. $40 (#52)

Reprints of My Editorials from *73*. Very few things in this world are as we've been taught, and as they appear. I blow the whistle on the scams around us, such as the health care, our school system,. our money, the drug war, a college education, sugar, the food giants, our unhealthy food, fluorides, EMFs, NutraSweet, etc.

1996 Editorials: 120 pages, 100 choice editorials. $10 (#72)

1997 Editorials: 148 fun-packed pages. 216 editorials. $10 (#74)

1998 Editorials: 168 pages that'll give you lots of controversial things to talk about on the air. $10 (#75)

1999 Editorials: 132 pages of ideas, book reviews, health, education, and anything else I think you ought to know about. $10 (#76)

2000 Editorials: 76 pages (thinner magazine as a result of our slowly dying hobby) $5 (#77)

Silver Wire: With two 5-in. pieces of heavy pure silver wire + three 9V batteries you can make a thousand dollars worth of silver colloid. What do you do with it? It does what the antibiotics do, but germs can't adapt to it. Use it to get rid of germs on food, for skin fungus, warts, and even to drink, Read some books on the uses of silver colloid, it's like magic. $15 (#80)

Silver Colloid Reprint. April 97 article on a silver colloid maker, history, and how to use the stuff. $5 (#98).

Colloid Kit. Three 9V battery clips, 2 aligator clips & instructions. $5 (#99).

Wayne's Bell Saver Kit. The cable and instructions enabling you to inexpensively tape Art Bell W6OBB's nightly 5-hr radio talk show. $5 (#83)

73 Writer's Guide: It's easy, fun, can pad your résumé, and impress the hell out of your friends. $0 (#78)

Cold Fusion Six-Pack: Six Cold Fusion Journal back issues to bring you up to speed. $20 (#19)

NASA Mooned America: René makes an air-tight case that NASA faked the Moon landings. This book will convince even you. $30 (#90)

Last Skeptic of Science: This is René's book where he debunks a bunch of accepted scientific beliefs – such as the ice ages, the Earth being a magnet, the Moon causing the tides, etc. $30 (#91)

Dark Moon: 568 pages of carefully researched proof that the Apollo Moon landings were a hoax—a capping blow for René's skeptics. $35 (#92)

Dark Moon Video: 222-minute exposé nailing NASA with their own photos. If you've watched the NASA films of the astronauts walking on the Moon you wondered at their weird gait. Wait'll you see it speeded up. It looks exactly like they're running on Earth! They catch NASA in dozens of giveaways that the photos and films had to have been faked. $46 (#93)

Barter 'n' Buy

Turn your old ham and computer gear into cash now. Sure, you can wait for a hamfest to try and dump it, but you know you'll get a far more realistic price if you have it out where 100,000 active ham potential buyers can see it, rather than the few hundred local hams who come by a flea market table. Check your attic, garage, cellar and closet shelves and get cash for your ham and computer gear before it's too old to sell. You know you're not going to use it again, so why leave it for your widow to throw out? That stuff isn't getting any younger!

The *73* Flea Market, Barter 'n' Buy, costs you peanuts (almost) — comes to 35 cents a word for individual (noncommercial!) ads and $1.00 a word for commercial ads. Don't plan on telling a long story. Use abbreviations, cram it in. But be honest. There are plenty of hams who love to fix things, so if it doesn't work, say so.

Make your list, count the words, including your call, address and phone number. Include a check or your credit card number and expiration. If you're placing a commercial ad, include an additional phone number, separate from your ad.

This is a monthly magazine, not a daily newspaper, so figure a couple months before the action starts; then be prepared. If you get too many calls, you priced it low. If you don't get many calls, too high.

So get busy. Blow the dust off, check everything out, make sure it still works right and maybe you can help make a ham newcomer or retired old timer happy with that rig you're not using now. Or you might get busy on your computer and put together a list of small gear/parts to send to those interested?

Send your ads and payment to: *73 Magazine*, Barter 'n' Buy, 70 Hancock Rd., Peterborough NH 03458 and get set for the phone calls. The deadline for the January 2001 classified ad section is November 10, 2001.

220 MHz Award; see W9CYT on WWW.QRZ.COM for information. BNB645

K8CX HAM GALLERY [http://hamgallery.com]. BNB620

TELEGRAPH COLLECTOR'S PRICE GUIDE: 250 pictures/prices. $12 postpaid. **ARTIFAX BOOKS**, Box 88, Maynard MA 01754. Telegraph Museum: [http://wltp.com]. BNB113

New miniature oscillator modules are now available ... all under $20 ... plus our great reference book is still for sale. Write to **RMT Engineering**, 6863 Buffham Road, Seville OH 44273 or see our Web site at **[www.ohio.net/~rtormet/index.html/].** BNB640

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Exotic 2002 Caribbean Hamboree -- Join us in meeting with Caribbean hams, visiting interesting Georgetown, Guyana, operating from great DX location. March 29-31/02. For information contact KK4WW, 8R1WD or [www.public.usit.net/dlarsen]. BNB640

QRX

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Thanks to Henry Feinberg K2SSQ, the ARRL, WB3GXW, the FBI, CGC Communicator, Radio World, *Andy Jarema N6TCQ, and* Q-News, *all via* Newsline, *Bill Pasternak WA6ITF, editor.*

During this time of crisis and particularly of national giving and thanksgiving, *73* would like to urge our readers to consider using the *Newsline* Web site to make a donation to *Newsline,* surely one of amateur radio's great unsung assets — in peacetime and otherwise. 73

Never Say Die

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his lawyers don't want to be bothered, but I bet Steve will.

Now, if you'll send a letter to Steve Jobs, Apple, 1 Infinite Loop, Cupertino CA 95014, and tell him that Wayne wants to talk with him (603-588-0107), maybe a whole bunch of letters will break through this protective wall. You'll do that for me, won't you? 73

Real Performance for the Real World!

Today's elite-class operators demand the best RF weaponry available. Yaesu's exciting new MARK-V FT-1000MP answers the call, with an expanded array of receiver filtering, 200 Watts of power output, and Class-A SSB operation capability for the cleanest signal on the band. Enhanced front-panel ergonomics on the front panel save you seconds in a pile-up or a contest "run," and Yaesu's HF design and manufacturing know-how ensures that no short-cuts have been taken in our effort to bring you the best HF transceiver money can buy. For more QSOs in your log, and more awards on your wall, there is only one choice: the MARK-V FT-1000MP from Yaesu!

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VSPC (Variable Side Pressure Control)

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* The FT-1000/-1000D/-990/-840 do not support the illumination of the TX LED during transmission.

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Expand Your DX Horizons With The FTV-1000 50 MHz Transverter!

- 50 MHz Transverter with 200 W PEP Power Output
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Specifications

Frequency Range:	50-54 MHz
Antenna Impedance:	50 Ohms
Power Output:	200 Watts PEP
Spurious Emissions:	At least 60 dB down
Power Source:	DC 30 V and 13.8 V (supplied by FP-29 Power Supply of MARK-V)
Dimensions:	9.6" x 5.4" x 13" WHD (243.5 x 136.5 x 331 mm)

200 W 50 MHz Transverter

FTV-1000

For the latest Yaesu news, visit us on the Internet: http://www.vxstd.com

Specifications subject to change without notice. Some accessories and/or options may be standard in certain areas. Frequency coverage may differ in some countries. Check with your local Yaesu Dealer for specific details.

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[1] Note that certain frequencies are unavailable. [2] 5W output

"Specifications subject to change without notice."

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TH-F6A

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