Satellite Times®

$3.95 US
$6.25 CAN
A publication of Grove Enterprises
Volume 4
Number 6
April 1998

rld,
One Phone

Satellite Times

Cover Story

Our cover illustrates a young woman using the Globalstar/ Qualcomm satellite handset with an artist's rendition of the orbiting Globalstar constellation superimposed. Cover composite by *Satellite Times* art director John Bailey; photographs courtesy of Globalstar.

One World, One Phone

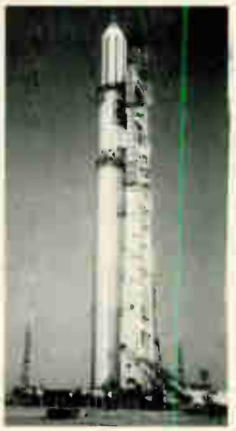
By Philip Chien, ST Staff

Welcome to the future of telecommunications. If everything goes as planned, 1998 and 1999 will probably go down in the history books as the years of the "Personal Communications Satellites." Learn more about the future in this month's cover story starting on page 10.

Vol. 4, No. 6 CONTENTS April 1998

Zenit Launch Vehicle Marks Lucky 13th Year

By Phillip S. Clark

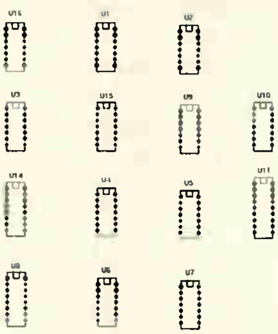


It has been 13 years since the first launch of a Russian Zenit rocket. But the launch vehicle has been under-used compared to the plans which where in place when it was introduced in 1985. The program has suffered major failures with the first and second stages. Will this unreliability carry forward to the new Sea Launch Zenit program? Phillip Clark takes an in-depth look at the Zenit in the story starting on page 16.

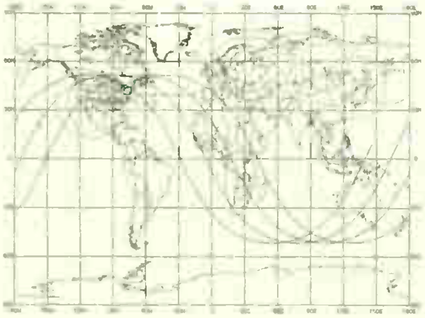
Under Construction:

The KD2BD 9600 Baud Modem, Part III

By John A. Magliacane, KD2BD



More and more, amateur radio pacsats are moving to higher and higher speeds. *ST* staffer John Magliacane offers a low cost, high-performance, construction project to help the ham communicate through the newer amateur satellites. Dust off those soldering irons and turn to page 22 for part three of this three-part series.



One of the most popular monitoring targets of satellite enthusiasts is the Russian *Mir* space station. Simple equipment and antennas are all that is needed to hear and, (if you have an amateur radio license), work the personnel onboard the orbiting space station. Learn more about the *Mir* communications systems and frequencies in this month's *Satellite Technical Forum* starting on page 76.

DEPARTMENTS

SATELLITE TIMES (ISSN: 1077-2278; CPC IPM Sales Agreement #1253484) is published monthly by Grove Enterprises, Inc., Brasstown, North Carolina, USA.

Address: P.O. Box 98, 7540 Highway 64 West, Brasstown, NC 28902-0098
Telephone: (704) 837-9200
Fax: (704) 837-2216 (24 hours)
Web site: http://www.grove.net/~grove/hmpgst.html
Internet Address: steditor@grove.net

Subscription Rates: $23.95 in US and $36.50 in Canada per year. Call for air mail rates for other countries. For more information, please see page 78.

Postmaster:
Send address changes to *SatelliteTimes*, P.O. Box 98, Brasstown, NC 28902-0098.

Correspondence to columnists should be mailed c/o Satellite Times. Any request for a personal reply should be accompanied by an SASE.

DOWNLINK

By Larry Van Horn
Managing Editor
steditor@grove.net

In Memoriam ...

It was learned recently that B.J. Arts WT0N, known as BJ to all of his friends, passed away in February at a hospital in his home town of Hibbing, Minnesota. BJ, who was 37 years old and had suffered for a number of years from acute diabetes, reportedly succumbed to flu soon after being taken to the hospital Sunday evening.

BJ had been acting as AMSAT's weekly ANS bulletin editor for several years and had been doing an exemplary job in that important volunteer position, commented Bill Tynan W3XO, AMSAT-NA President, on hearing the shocking news.

BJ had been very active on the satellites and the VHF bands. He will be missed by all of his friends around the world.

BJ's family has requested that any memorials in BJ's name be made to the AMSAT Phase 3D fund as a fitting tribute to WT0N. You can send those memorials to AMSAT, 850 Sligo Avenue, Suite 600, Silver Springs, MD 20910.

On behalf of the entire staff here at Grove Enterprises and the worldwide magazine staff of *Satellite Times* magazine, I want to send our deepest condolences to BJ's family and the entire AMSAT organization on the loss of an outstanding ham, friend and supporter of satellite monitors/operators everywhere. We will miss his weekly contributions that have meant so much to so many in the satellite hobby worldwide.

Military LEO System

I am a money manager with a large stake in Loral Space & Communications. They have mentioned in passing, when discussing Globalstar, that they have made a LEO communication system for the military. Do you know anything about this? Thanks for your input.

Kevin Spellman, DVM Asset Management

I'm not aware of any U.S. military low earth orbit (LEO) communications constellations. The Russians, however, have had an operational military LEO system for years. The current generation of military LEO communications satellites are launched under the Cosmos satellite cover name. These 500 kg satellites are manufactured for the Russian Ministry of Defense by the Applied Mechancis/SmolSat Consortium in Moscow. They are launched three at a time along with three of their commercial variants (Gonets) on a Tsyklon launch vehicle from the Plesetsk cosmodrome. That is the closest system I could find that might fit the bill.

Enjoying Natural Radio

Excerpt from a recent email to author Steve McGreevy:

I first read about the BBB-4 in *Satellite Times* magazine (see Nov/Dec 1997). I have built this unit and am having a ball with it! I am a ham radio operator and have listened and operated from 1800 MHz all the way up to 3 GHz, and listening down in radio's basement is equally as fascinating! I am in the process of building a second unit. Thank you for your time and help. This is very fascinating!

*Brian J. Miller Email: **byron1m@aero.net***

Likes the Monthly Format

Congratulations on going monthly, it's a big step! I've enjoyed the magazine for the last two years, and look forward to future issues.

Paul Willmott, VP9MU AMSAT-BDA

Loved the February Issue

The February 98 issue of *ST* was ABSOLUTELY THE BEST ISSUE EVER!!!!

*Doug Johnson, KF6ENV Email: **djohnson@skfcm.com***

And finally...

From an unknown author via the internet:

The top ten changes at NASA and to the space shuttle to accommodate 76 year-old John Glenn's return to space:

10. All important devices on the shuttle will now operated by the Clapper.
9. The shuttle's thermostat will be set at 80 degrees.
8. A shufflle board has been installed in cargo bay.
7. "Early Bird" specials from Morrison's Cafeteria now included on menu.
6. One monitor will be specifically designated for *Matlock* reruns.
5. Little bowls of candy will be scattered randomly about the shuttle.
4. Top speed of shuttle will be set at 25 miles per hour.
3. Technicans have installed a new bifocal windshield.
2. Space pants now go up to armpits.
1. Left-blinker left on for entire mission.

SATELLITE MONITOR

By Wayne Mishler, KG5BI

Prospector revives hope for water on moon

Although not confirmed, new data from NASA's Lunar Prospector satellite indicates that previous reports of ice on the moon from a Pentagon satellite may have been correct, according to the *Houston Chronicle.*

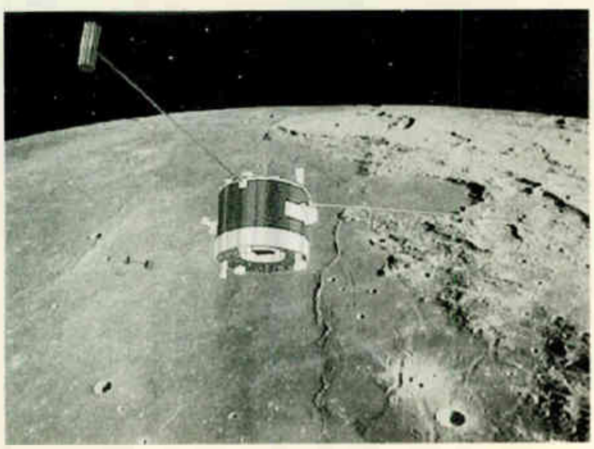
Prospector is equipped with instruments capable of detecting even minute traces of water in lunar soil from an altitude of 60 miles or more. Some astronomers say that data radioed back to Earth in February suggests that Prospector is seeing tons of water on the moon. Others argue that no proof of lunar water exists.

NASA has neither denied nor confirmed the reports of lunar water, but one source close to the mission indicated there may be truth to Prospector's findings. If so, the possibilities of lunar colonization and perhaps even the installation of some sort of refinery for converting lunar water to rocket fuel just took a giant step forward.

Water of course consists of hydrogen and oxygen. Separate them and you have rocket fuel. A ready source of water on the moon, with its minimal gravity, conjures up thoughts of turning the moon into a launching and refueling station for spacecraft.

One theory suggests that water could have been deposited on the moon by meteors or chunks of space ice impacting the lunar surface.

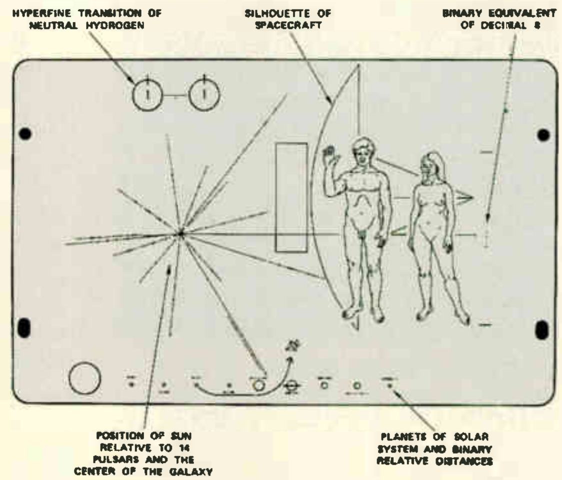
The surface of the 38 mile (60 km) thick lunar crust is covered with a layer of powdery dust called regolith. The Moon's terrain is a combination of highlands with deep craters and smooth areas called maria.



Voyager 1 reaches outer edge of solar system

In a dark, cold, vacant neighborhood near the edge of our solar system, Voyager 1 spacecraft just weeks ago became Earth's most distant traveler.

At 5:10 p.m. EST on Feb. 17, 1998, Voyager 1, launched more than two decades ago, was to cruise beyond the Pioneer 10 spacecraft and become the most distant human-created object in space, at 6.5 billion miles (10.4 billion kilometers) from Earth.



The famous plaque aboard the Pioneer spacecraft, demonstrating who we are and where we're from—just in case ...

For 25 years, the Pioneer 10 spacecraft led the way, pressing the frontiers of exploration. "Now the baton is passed from Pioneer 10 to Voyager 1 to continue exploring where no man has gone before," says Dr. Edward C. Stone, Voyager project scientist and Director of NASA's Jet Propulsion Laboratory (JPL), Pasadena, CA.

"At almost 70 times farther from the Sun than the Earth, Voyager 1 is at the very edge of the Solar System. Sunlight there is only 1/5,000th as bright as here on Earth, so it is extremely cold, and there is very little solar energy to keep the spacecraft warm or to provide electrical power.

"The reason we can continue to operate at such great distances from the Sun is because we have radioisotope thermal electric generators (RTGs) on the spacecraft that create electricity and keep the spacecraft operating," Stone says.

The fact that the spacecraft is still returning data is a remarkable technical achievement."

Voyager 1 was launched from Cape Canaveral on Sept. 5, 1977. It reached Jupiter on March 5, 1979, and Saturn on Nov. 12, 1980.

Then, because its trajectory was designed to fly close to Saturn's large moon, Titan, Voyager 1's path was bent northward by Saturn's gravity, sending the spacecraft out of the ecliptic plane, in which all planets except Pluto orbit the Sun.

The Pioneer 10 mission was launched on March 2, 1972. Although the mission officially ended on March 31, 1997, NASA's Ames Research Center, Moffett Field, California, intermittently receives science data from Pioneer as part of a training program for flight controllers of the Lunar Prospector spacecraft now orbiting the Moon.

"The Voyager mission today presents an unequalled technical challenge. The spacecraft (Voyager 1 and its twin, Voyager 2) are now so far from home that it takes nine hours and 36 minutes for a radio signal traveling at the speed of light to reach Earth," said Ed B. Massey, project manager for the Voyager Interstellar Mission at JPL.

"That signal, produced by a 20 watt radio transmitter, is so faint that the amount of power reaching our antennas is 20 billion times smaller than the p[illegible] of a digital watch battery."

The Voyager spacecraft.

Having completed their planetary explorations, the Voyager spacecraft are now studying the environment of space in the outer Solar System. Although beyond the orbits of all the planets, the spacecraft still are well within the boundary of the Sun's magnetic field, called the heliosphere. Science instruments on both spacecraft sense signals that scientists believe are coming from the outermost edge of the heliosphere, known as the heliopause.

The heliosphere results from the solar emission of a steady flow of electrically charged particles called the solar wind. As the solar wind expands supersonically into space in all directions, it creates a magnetized bubble, called the heliosphere, around the Sun. Eventually, the solar wind encounters the electrically charged particles and magnetic field in the interstellar gas. In this zone the solar wind abruptly slows down from supersonic to subsonic speed, creating a termination shock. Before Voyagers 1 and 2 travel beyond the heliopause into interstellar space, they will pass through this termination shock.

"The data coming back from Voyager now suggest that we may pass through the termination shock in the next three to five years," Stone said. "If that's the case, then one would expect that within 10 years or so we would actually be very close to penetrating the heliopause itself and entering into interstellar space for the first time."

Reaching the termination shock and heliopause will be major milestones for the mission because no spacecraft have been there before. Encountering the termination shock and heliopause has been a long-sought goal for many space physicists, and exactly where these two boundaries are located and what they are like still remains a mystery.

Science data are returned to Earth in real-time to the 34-meter, Deep Space Network antennas, located in California, Australia and Spain. Both spacecraft have enough electricity and attitude control propellant to continue operating until about 2020, when electrical power produced by the RTGs will no longer support science instrument operation. At that time, Voyager 1 will be almost 150 times farther from the Sun than the Earth–almost 14 billion miles (more than 20 billion kilometers) away.

Shock wave sheds new light on fading supernova

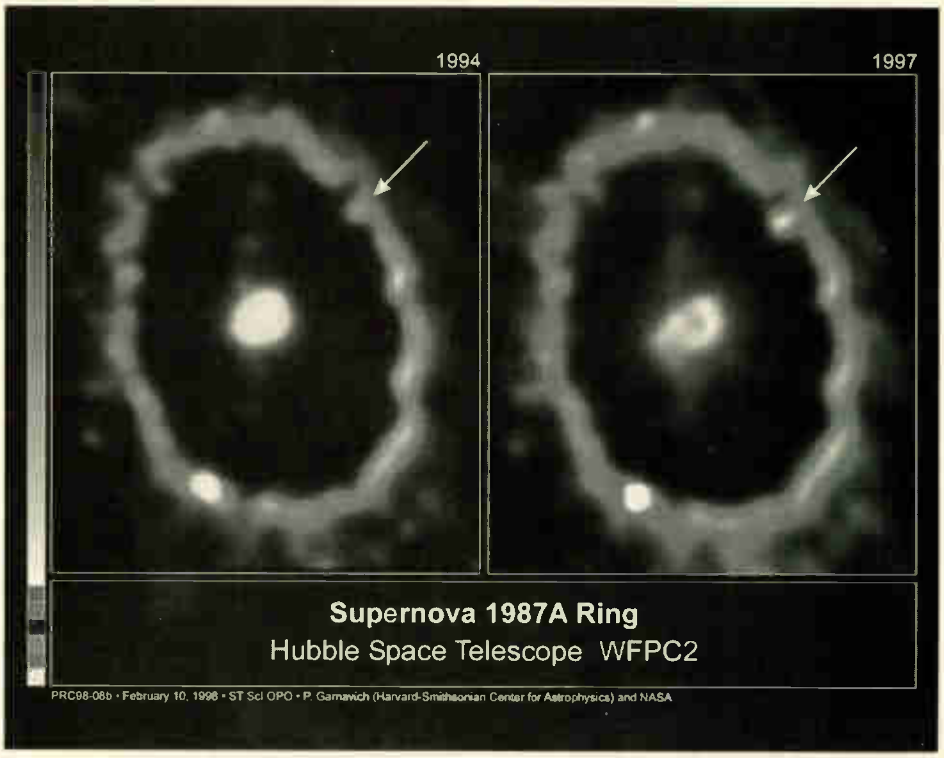
For the first time ever, astronomers are watching via Hubble Space Telescope the titanic collision of a supernova shock wave with space gas.

The shock wave is from Supernova 1987A, the brightest stellar explosion seen since 1604. It is located about 167,000 light-years from Earth in the Large Magellanic Cloud (see the *Space Watch* column on page 72 for photos).

Although this supernova was detected Feb. 23, 1987, astronomers are just now beginning to witness its tidal wave of energy reaching the "shoreline" of the immense light-year wide ring.

Energized by the 40-million mile per hour sledgehammer blow, a 100-billion mile wide knot of gas in one area of the ring has already begun to glow as its temperature surges from a few thousand degrees to a million degrees Fahrenheit.

"We are beginning to see the signature of the collision, the hammer hitting the bell. This event will allow us to validate ideas we have built up over the past ten years of observation," says Robert Kirshner of the Harvard-Smithsonian Center for Astrophysics (CfA) in Cambridge, Massachusetts.



A Supernova collides with space gas—and now scientists are watching the show. See Space Watch on p. 72 for full color reproductions.

By lighting up the ring, the supernova is exposing its own past, Kirshner explained. He expects the entire ring to become ablaze with light as it absorbs the force of the crash.

Data from the event may answer vital questions of the supernova. Astronomers want to know: What was the progenitor star? Was it a single star or binary system? Are a pair of bizarre outer rings attached to an invisible envelope of gas connecting the entire system?

"We have a unique opportunity to probe structure around the supernova and uncover new clues to the final years of the progenitor star before it exploded," says Richard McCray of the University of Colorado in Boulder, Colorado.

Though scientists may never solve the paradox of what happens when an irresistible force meets an immovable object, the supernova collision is the closest real-world example yet.

"We'll see new physics of shock interactions," says McCray.

The gas ring was formed 20,000 years before the star exploded. One theory is that it resulted from stellar material flung off into space as the progenitor star devoured a stellar companion. The ring's presence was given away when it was heated by the intense burst of light from the 1987 explosion. The ring has been slowly fading as the gas cools.

In spring of 1997 the Space Telescope Imaging Spectrograph (STIS) measured for the first time the speed of the supernova debris pushing along the shock wave.

"The STIS lets you see the invisible stuff," says George Sonneborn of Goddard Space Flight Center in Greenbelt, Maryland. "We see the shock happening everywhere around the ring."

Astronomers study strange glow in the Universe

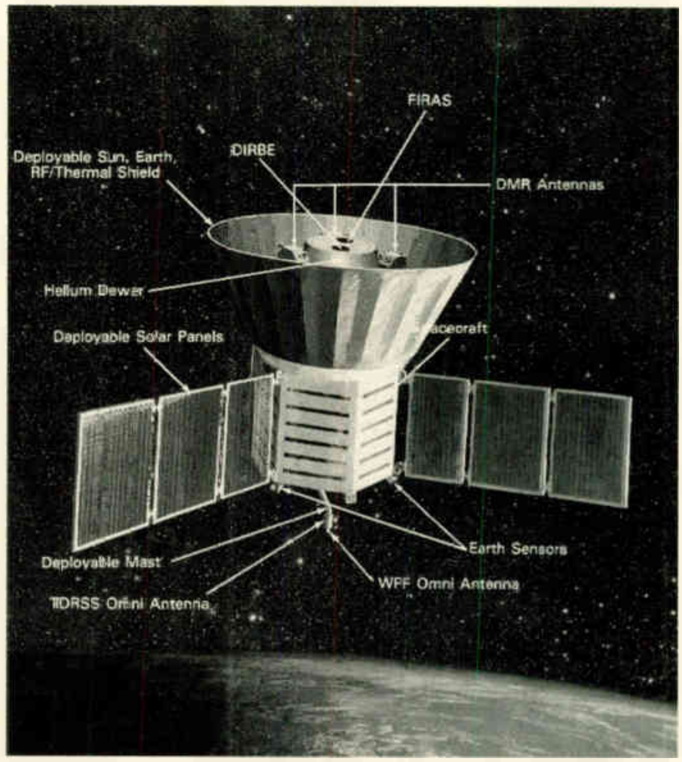
Astronomers are studying a strange infrared glow in space believed to be radiating from dust warmed by all the stars that have existed from the beginning of time.

They call it "fossil radiation." And it may help to explain how stars and galaxies were born.

The discovery culminates several years of data analysis from the Diffuse Infrared Background Experiment aboard NASA's Cosmic Background Explorer (COBE), launched in 1989.

"This is another big step in bringing cosmology to a science based on observation as well as theory," says Michael Hauser of the Space Telescope Science Institute, Baltimore, Maryland, principal investigator on the Diffuse Infrared Background Experiment.

The discovery of unknown starlight in the Universe implies that stars may have been missed in previous studies of the Universe, such as the Hubble Deep Field. The missed stars may have been obscured in space dust. Or they may have been born in the very early Universe not yet reached by telescope.



NASA's Cosmic Background Explorer (COBE), launched in 1989.

Their existence is now revealed by telltale dust that absorbs and re-radiates their light at infrared wavelengths.

Finding the infrared background was not easy. It is masked by infrared light from dust in our solar system, stars, interstellar dust of the Galaxy, and, for ground-based instruments, emission from the Earth's atmosphere and from the instrument itself.

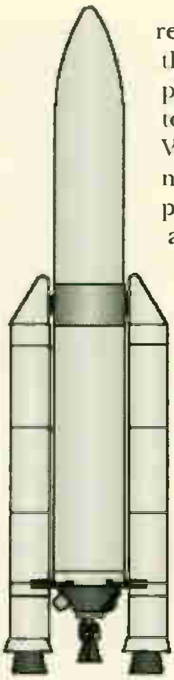
The discovery was made through observations from space, using instruments cooled to within a few degrees of absolute zero.

Astronomers first had to identify and subtract the infrared glow from objects in our Galaxy. Galactic dust has a telltale structure and varies in appearance. Solar dust varies in brightness as Earth orbits the Sun. Stellar light was isolated through a model based on stars in the Galaxy. Astronomers subtracted the light from these sources and found a smooth background of residual infrared light previously unknown. It was found in the 240 and 140 micrometer wavelengths, in "windows" near the poles of the Milky Way with a clear view across billions of light-years.

The discovery will bring further studies of the early formation of stars and galaxies, using infrared telescopes on new space missions, hopefully reaching beyond interplanetary dust.

ARIANE 502 rolls uncontrollably in tests

Engineers are searching for solutions to the mystery that sent Ariane 502 into an unexpected roll during a recent test flight. The ship began rolling (about 5



revolutions per minute) at the end of main-stage propulsion, presumably from torque generated by the Vulcain engine. Preliminary tests revealed unexplained vibrations and anomalous temperatures in the engine.

A special device is being developed to measure roll torque during future Vulcain firing tests.

Meanwhile, engineers plan to install a second attitude control system on the Ariane 503 launcher, on the lower part of the vehicle equipment bay, to counter roll torque in flight.

ESA unveils XMM spacecraft

Looking like a black pillar more than 10 meters tall, Europe's largest scientific spacecraft stands in a European Space Agency (ESA) test bay in the Netherlands where it is being prepared for launch sometime in 1999.

European scientists say the XMM (X-ray Multi-Mirror) promises to revolutionize the study of X-rays coming from the Universe. Its innovative telescopes are designed to capture more X-rays per hour than ever before, and to enable astronomers to quickly analyze sources of cosmic X-rays previously beyond their reach.

Cosmic X-rays originate in places like black holes, exploding stars, stars interacting with each other, and the central regions of clusters of galaxies.

The XMM will combine X-ray telescopes and optical monitoring devices to uncover the secrets of gamma-ray bursters: extraordinary explosions in space that mystify astronomers.

As seen at ESTEC today, the spacecraft stands upside down in the test bay. Its front end, where the mirror modules of the X-ray telescopes pass through the satellite's service module, is closest to the ground. At the top is the section containing detectors at the focus of the X-ray telescopes. A pair of cones will carry heat away from the detectors.

The ship's appearance is dominated by a long tube that spans the telescopes' focal length, and by the black thermal blanket that will protect the spacecraft from unequal heating on the sunny and shaded sides.

"You have to imagine the big tube filled with focused X-rays en route to the detectors," says Robert Laine ESA's project manager for XMM. "That's the whole purpose of the mission, and our chief preoccupation has been with the three multi-mirror modules that accomplish it. Critics thought we were too ambitious, trying to nest 58 precisely formed mirrors together in each module.

"No one had ever attempted such a feat before. It wasn't easy, but XMM's telescopes are even better than we had hoped."

Focusing is achieved by glancing X-rays off a carefully shaped mirror, like a bucket without a bottom. In a single-mirror telescope, most of the incoming X-rays miss the mirror. To catch more of them, designers nest multiple mirrors inside one another.

Before XMM, astronomers had to choose between many mirrors with relatively poor focusing, or a very few mirrors with sharp focus. With 58 precision-made mirrors in each of its three X-ray telescopes, XMM combines enormous gathering power with accurate focusing.

In flight, XMM will travel more than 100,000 kilometers to clear the Earth's radiation belts, and will be controlled by ESA's satellite operations centre (ESOC) from Darmstadt (Germany) and Villafranca (Spain) via ground stations in Perth (Australia) and Kourou (French Guiana).

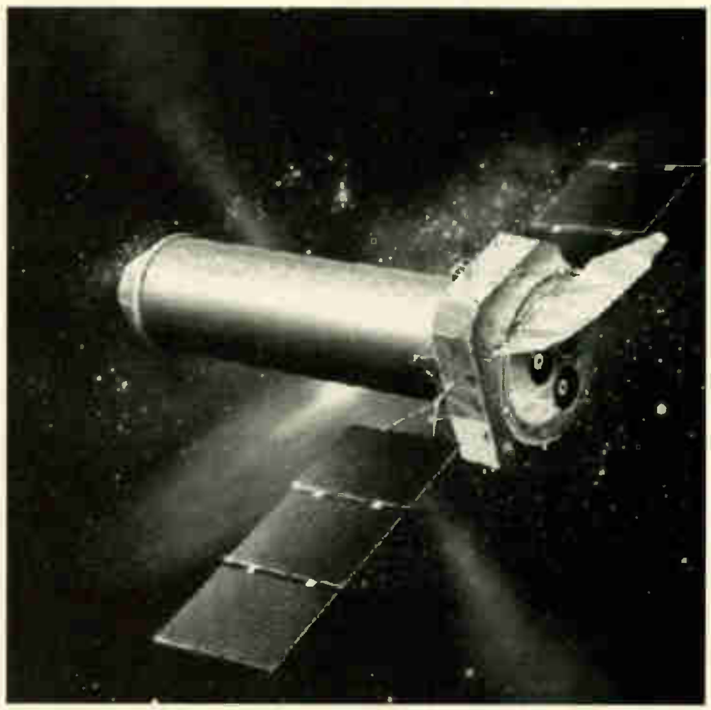
And finally...

A new development in the so-called dumbing down of America: A man apprehended by police in Key West, Florida, has accused NASA of stealing his brain waves.

The man reportedly was arrested for refusing to pay his hotel bill. He argued with police that he could not come up with the money because NASA's satellites had tapped his thought processes and rendered him unable to earn a living.

And all this time we thought that NASA's smarts came from scientists and engineers. ST

Sources: European Space Agency, *Houston Chronicle*, *Key West Citizen*, NASA



European Space Agency's XMM spacecraft.

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Unlike the Mobilefone, the Compact-M can operate in both global and spot beam transmission modes and is not limited to the lower bandwidth restrictions of the mini-M systems. It also works with first, second, and third generation satellites (spot beam models only work with third generation). The result is greater coverage area, better voice quality and higher data throughput. Relies on proven technology—the only Inmarsat-M terminal utilizing pre-paid smart cards!

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One World, One Phone

Globalstar and Iridium are Poised to Launch Competing Worldwide PCS Satellite Systems

By Philip Chien

Welcome to the future of telecommunications. The countdown is on, and if everything goes as planned, 1998 and 1999 will probably go down in the history books as the years of the "Personal Communications Satellite" (PCS).

The first two big contenders for the "Big LEO" PCS market–Iridium and Globalstar–are poised to begin on-orbit operations of their satellite systems in 1998 and 1999 providing personal satellite communication capability worldwide.

Both PCS systems will use similar concepts, a large number of small, low altitude satellites to cover most of the world and provide cellular phone services to unserved areas.

Iridium will require 66 satellites in 11 orbital planes with six satellites per plane, and that will be enough to provide global coverage. Globalstar will use only 48 satellites, arranged as eight planes with six satellites per plane. Globalstar's satellites have a lower inclination than Iridium and can only service areas between 70 degrees north and south. The Globalstar consortium has purposely decided to ignore the far polar regions, considering them to be uneconomical at the present time.

The Iridium constellation will have an orbital altitude of 780 km while Globalstar will orbit at a higher altitude of 1,414 km. Higher altitude orbits require more powerful launch vehicles for a given size satellite and require more sensitive receivers and more powerful transmitters. The benefits of higher altitude satellites include larger footprints, therefore a smaller number of satellites.

One of the key differences between Iridium and Globalstar lies in the operating philosophy. Iridium will be highly dependent on cross-satellite links while the Globalstar constellation will use none. Cross-satellite links permit a smaller number of ground stations and lower operational costs, but more expensive satellites.

Globalstar satellites will only communicate with the user's handsets and the gateway stations. Globalstar will depend on its planned network of 38 worldwide ground stations, but this requires much less sophisticated satellites. While the gateway stations will require continuous operation and maintenance costs it's always easier to upgrade systems on the ground than systems in space. Each gateway will have four tracking antennas and will be operated by a local Globalstar partner, typically the local cellular phone company or the country's telecommunications authority.

The Globalstar satellites will operate in the "bent pipe" mode–whatever is received by the satellite on its uplink is amplified and retransmitted with minimal onboard processing on the downlink. In effect users are connected to the gateway stations with a long wireless "extension cord." The gateway stations will interface the user with existing public telephone networks, minimizing those costs.

Consider this unusual senario. If somebody uses a Globalstar telephone to contact another Globalstar user in the same town, then the call's routing would go from the user's handset to an orbiting satellite, down to a ground station, back up to the same satellite, and then to the other user. If the other user is at a distant location which isn't served by the same ground station then the gateway-to-gateway routing would be through conventional phone network links.

The more likely scenario is that somebody calls from a Globalstar phone to a landline location (or vice versa) where the user's call goes through a satellite to the gateway station and then via the phone networks to its ultimate destination.

Besides voice, the Globalstar system will be capable of handling data transmissions, faxes, position reporting, paging services, and other similar medium-bandwidth applications. Globalstar satellites will be intelligent enough to determine a handset's location to within a mile.

In many countries phones are strictly regulated (e.g. who's allowed to own phones, who is and isn't permitted to make international phone calls, etc.). Each country's telecommunications authority will determine what is and isn't allowed within its borders.

The Primary Marketplace

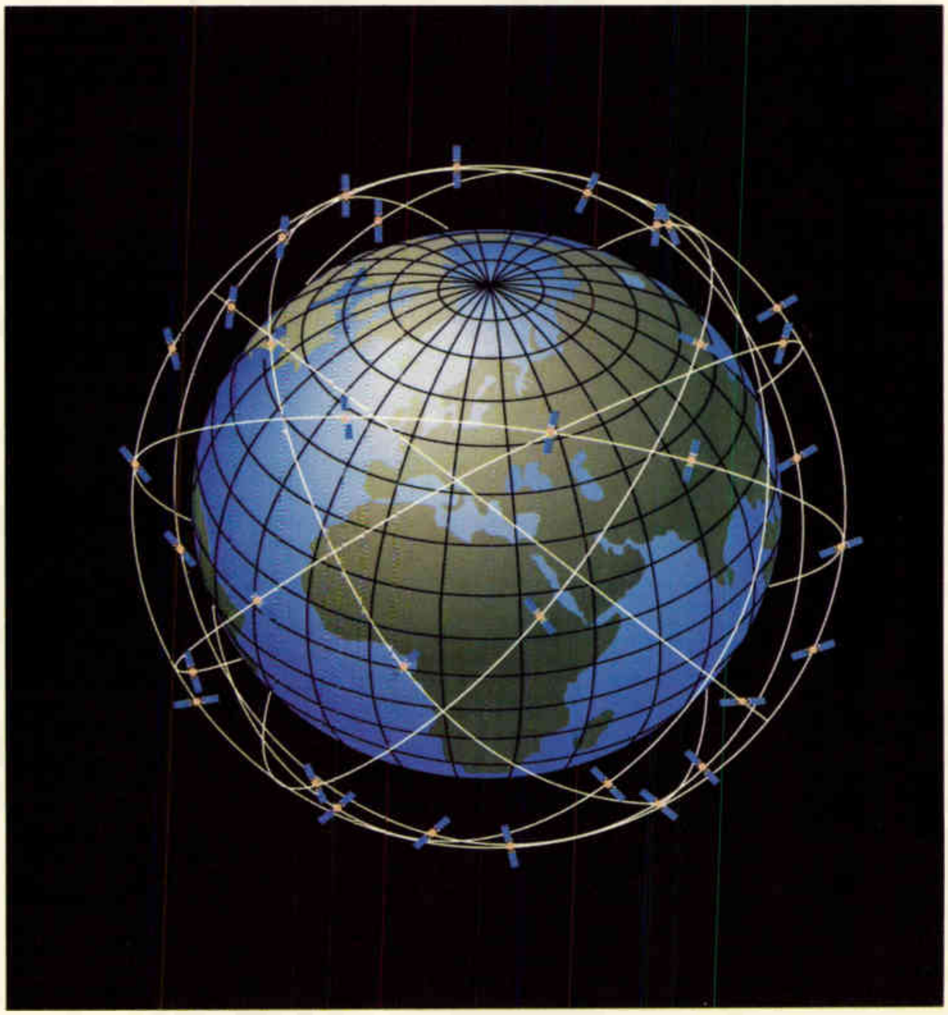
The primary market for these satellite telephone systems is the high-end businessman who travels to areas which aren't

Above, the Boeing Delta II launch vehicle lifts off on Feb. 14 carrying the Global 1 satellite. Happy Valentines ...

Below, the Globalstar 48-satellite low earth orbit (LEO) constellation will bring worldwide wireless communications services to over 98% of the world's population.

served by cellular phone services. But Globalstar is also aiming its efforts towards the opposite end of the market–the three billion people in the world who have never used a telephone! One of the most esoteric applications will be to bring telephone capabilities into third world countries and other areas which aren't supported by landlines. In many cases it's more economical to use satellites than to lay wire or fiber optic cable.

Ironically, the market *least* likely to use Globalstar will be high technology areas which already have existing cellular phone networks, including almost all of the United States. Clearly it's less expensive to use existing cellular networks, and Globalstar handsets will automatically default to local cellular service. The handsets will be compatible with both analog and digital cellular systems. If there is no cellular service available, then the handsets will automatically make contact through the orbiting satellite network. The Globalstar handsets will be built by



It's an irony of the electronic age that three billion people who have never used a phone before may get their "rites of passage" with Globalstar PCS field units.

Globalstar will enable international travelers to make and receive calls or faxes at a unique telephone number through their satellite-based mobile handsets virutally anywhere in the world.

that it not interfere with existing users. Globalstar has promised that it will deactivate the satellite cells close to radio astronomical telescopes when notified of any interference problems.

The user handsets will transmit to the satellites on L-band (1610-1626.5 MHz). The satellite then transmits the user signal to a gateway on C-band (6875-7055 MHz). The return signal from the gateway to satellite is also on C-band (5091-5250 MHz). Finally, the signal is received by the user handset on S-band (2483.5-2500 MHz). But, in effect, the handsets are dual band radios which can only communicate with the gateways via the satellites when outside the range of terrestrial cellular telephone networks.

All of the signals will be encoded using digital CDMA (Code Division Multiple Access) spread spectrum technology which was pioneered by Qualcomm. CDMA can be likened to a large party in which multiple conversations take place without interfering with each other. In comparison, a more conventional FM transmission with a dedicated frequency would be the equivalent of placing each pair of party guests into a separate room.

QUALCOMM, Orbitel Mobile Communications Ltd., and TELITAL S.r.I.

There are many cases where Globalstar won't be usable. If a country refuses to permit access, the handsets will be intelligent enough to realize that they're in unsupported regions. If the antenna is blocked (e.g., inside a building), if you're above 70 degrees in latitude or in a distant ocean region where you're out of range of a gateway, then you won't be able to use Globalstar.

Radio Astronomy Interference

The Globalstar assigned frequencies are close to a frequency allocation designated for radio astronomy purposes. Globalstar's license requires

CDMA offers many advantages besides shared bandwidth, including encryption and clearer signal quality. The satellites and handsets automatically adjust bandwidth and power to whatever levels are required for clear service.

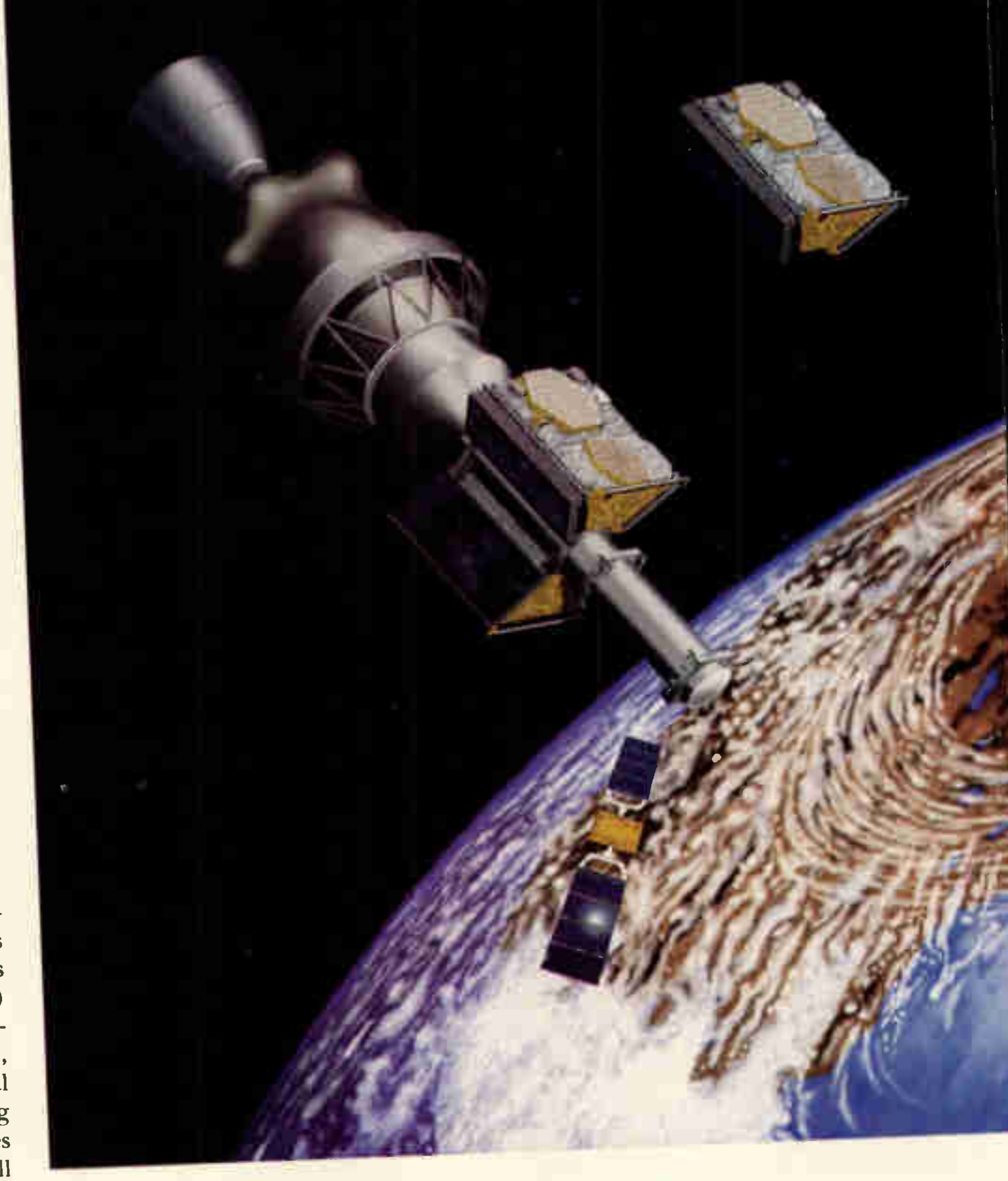
Globalstar Ground Network

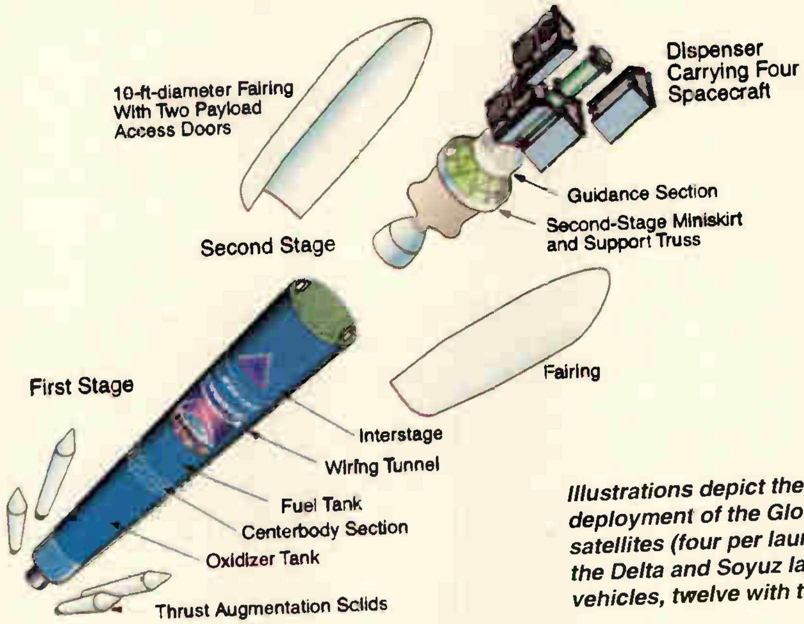
Globalstar operates two SOCCs (Satellite Operations Control Centers) and eight GOCCs (Ground Operations Control Centers). The primary SOCC is located at Globalstar's corporate headquarters in San Jose, California. The backup SOCC is located in El Dorado Hills, California. The SOCCs are responsible for controlling the satellites in orbit. Commands from the SOCCs can also be sent to the satellites via the gateway stations.

The GOCCs are responsible for planning and controlling the satellite utilization and coordinating gateway activities. The GOCCs also monitor the systems performance and will handle day-to-day chores like billing the telecommunications providers. The GOCCs will also be to reconfigure the gateways to optimize satellite usage over certain high-traffic areas (e.g. more populated zones, special events which temporarily increase demand, etc.)

Each telecommunications gateway station will cost between $2 and $5 million, depending on its capabilities. A typical gateway station will have four tracking antennas which will follow the satellites from horizon-to-horizon. The stations will interface the satellites to existing telecommunications networks. In virtually all cases, the gateways will be operated by the local country's telecommunications authority.

One item still to be determined is how international usage will be handled in "delicate" areas. For example, one of the first gateway stations is under construction in South Korea. From its location it will be able to service customers in much of the Far East, including Japan, parts of Eastern Russia, and the entire Korean peninsula. But what if a businessman in North Korea wants to use his Globalstar phone to call somebody? Clearly the North Korean telecommunications authority will want its share of the action since that's where the call's originating. But how North Korea will feel about that particular call being routed through a gateway station located in its adversary's territory is a matter which hasn't been decided.





Illustrations depict the deployment of the Globalstar satellites (four per launch with the Delta and Soyuz launch vehicles, twelve with the Zenit).

Who Will Operate Globalstar?

As a rule, these large satellite constellations are operated and funded by a consortium of aerospace and telecommunications companies. Each partner contributes its expertise, whether it's spacecraft components, handsets, specialized voice processing integrated circuits, communications infrastructure, or launch vehicles, and each gets a portion of the consortium's ownership. In many cases a partner is also the Post and Telegraph in a country in exchange for access to that country's market.

Globalstar was founded by Loral Corporation and QUALCOMM Inc. Other companies with partnership interests in Globalstar are AirTouch Communications–San Francisco, California; Alenia Spazio–Rome, Italy; Alcatel NV–Paris, France; DACOM Corporation–Seoul, Korea; Daimler-Benz Aerospace AG–Munich, Germany; Elsag Bailey–Genoa, Italy; France Telecom–Paris; Hyundai Electronics Industries Co., Ltd–Seoul, South Korea; Space Systems/Loral–Palo Alto, California; and Vodafone Group plc–Newbury, England. These international communications companies have exclusive agreements to wholesale Globalstar services in their assigned countries.

Each of the Globalstar satellites is valued at $13 million. The total space segment (launch vehicles, satellites, insurance, etc.) is valued at $1.4 billion, with a total Globalstar investment of $2.5 billion.

That investment will be repaid 55 cents at a time–the wholesale rate for each minute. Globalstar's partners will not sell directly to end users, preferring to sell its services to the local telecommunications firms in each country. Currently Globalstar's partners have permission to provide service to 115 countries covering much of the world. India is the most populated country not to have granted authority. Globalstar projects a market of three million users by 2002; the system will have a maximum capacity of seven million users.

In its buzzword-compliant, user-friendly, corporately-approved statement, Globalstar claims: "Globalstar's strategy for successful operation is based upon: leveraging the marketing, operating and technical capabilities of its strategic partners; employing a system architecture designed to minimize cost and technological risks; and offering potential users worldwide low-cost, high quality telecommunications services."

The Globalstar Satellite

The satellites are trapezoidal to maximize the available space within different launch vehicle fairings. Globalstar is using three different launch vehicles–the U.S. Delta, Ukrainian Zenit, and Russian Soyuz launchers to minimize costs while maximizing the likelihood of filling their constellation on schedule. Even if a Zenit vehicle with twelve satellites was lost in a launch accident there would still be enough satellites in orbit to permit services to start on schedule. The more reliable Delta launches were purposely scheduled up front to ensure some satellites in orbit for initial testing.

Each satellite weighs 450 kg. The solar arrays generate two kilowatts of power at launch, which gradually degrades to 1.1 kilowatts. The planned lifetime is seven years.

The flat antennas are fixed to the Earth-facing side of the satellite. The phased array design projects a pattern of 16 spot beams on the Earth's service, covering a service area, or "footprint" of several thousand kilometers in diameter. In addition each satellite has four GPS antennas for location determination, two-axis attitude determination, and timing.

The satellites are being built by a multinational consortium led by Space Systems Loral. Final satellite assembly is being performed by Alenia Spazio in Rome, Italy. Aerospatiale Espace and Defense in Paris, France, is responsible for the satellite structures and portions of the thermal control system. Alcatel Espace in Paris, France, is responsible for the payload modules and transponders. Daimler-Benz aerospace in Germany is responsible for the power systems, solar arrays and attitude and orbital control subsystems. Hyundai in Seoul, South Korea, manufacturers the satellite's electronic subsystems.

The large number of companies investing in the project minimizes each individual company's risk, and permits an extremely rapid production schedule–one satellite every 10.3 days. But it does bring its own logistics problems–imagine having several satellite components stuck in customs.

The final assembly plant in Rome, Italy, operates more like a car assembly plant than a satellite factory. Eight specialized teams are located throughout the building and the satellites move from station-to-station on roll-around carts. At one station the wiring harness is installed. At another the communications payload is integrated. Finally the assembled satellite is tested in a thermal vacuum chamber and vibration stand to verify that it can handle the space and launch environments. Ultimately the satellites are shipped to either Cape Canaveral, Florida, or Baikonur, Kazakhstan, for launch. A current launch schedule is presented in Table One.

TABLE 1: Current Globalstar Launch Schedule

Expected Launch Date	Launch Vehicle	Launch Provider	Number of Satellites	Launch Site
*Feb 14, 1998	Delta	Boeing	4	Cape Canaveral, FL
Apr 24, 1998	Delta	Boeing	4	Cape Canaveral, FL
3rd Quarter 98	Zenit	NPOYuzhnoya	12	Baikonur, Kazakhstan
4th Quarter 98	Zenit	NPOYuzhnoya	12	Baikonur, Kazakhstan
4th Quarter 98	Zenit	NPOYuzhnoya	12	Baikonur, Kazakhstan
1st Quarter 99	Soyuz	Starsem	4	Baikonur, Kazakhstan
1st Quarter 99	Soyuz	Starsem	4 (1)	Baikonur, Kazakhstan
2nd Quarter 99	Soyuz	Starsem	4 (1)	Baikonur, Kazakhstan
TOTAL 56			* = Already Launched	

The Globalstar Launchers

A Delta 7420-10 launch vehicle can launch four Globalstars at a time. This is an unusual Delta configuration which has only four solid strap-on motors instead of the usual nine. The only previous Delta with four solids was Delta 109, flying the GEOS-C satellite out of Vandenberg Air Force Base on April 9, 1975. The wide 10 foot fairing is the same composite fairing used for the Iridium launches. On Delta launches the Globalstars are stacked in two "decks" with two satellites on each deck.

The first Globalstar launch took place on February 14, 1998, after several frustrating weather delays. The second Globalstar launch is scheduled for April 24, 1998. Space Systems/Loral has options for an additional eight Delta launches, but they do not have any current plans to use those launch options.

The higher performance Zenit-2 can launch twelve Globalstar satellites at a time. Since this is more than the number of satellites in an orbital plane, a special launch technique will be used. The Zenit will place the satellites into 900 km orbits. At predetermined time, groups of four satellites will be raised to their operational altitude. The remaining satellites will remain in their parking orbit until orbital mechanics moves them into the proper plane to be raised up to their proper orbital slots. It will take up to two months after launch before all 12 of the satellites on a Zenit launch reach their operational locations.

Zenit Globalstar launches are currently scheduled for July 15, September 15, and early December of 1998.

The Zenit launcher has a much wider fairing, so satellites are arranged as three decks with four satellites on each deck.

Globalstar purchased its Soyuz launches through the French Starsem firm which has Soyuz marketing rights. Each Soyuz launch will carry four Globalstar satellites. The Soyuz launches are scheduled for February through April 1999. The Soyuz dispenser mounts three satellites on one deck with an additional satellite on top.

Besides the 48 operational satellites and eight on-orbit spares, an additional eight ground-spare satellites are being built. The spares will be "stored" in a 920 km storage orbit. Orbital mechanics will rotate the storage orbit underneath the operational satellites, permitting spare satellites to enter service fairly quickly. These satellites can be used to replace failed satellites or as required to replenish the constellation.

The future of telecommunications is almost here. By the middle of 1999, Globalstar will be able to offer high quality, 21st century telecommunications to the world. ST


The fully deployed Globalstar satellite.

Zenit Launch Vehicle Marks Lucky 13th Year

By Phillip S Clark

When it was introduced to flight status in 1985 the two-stage Zenit launch vehicle was the first completely new vehicle to be introduced to the Soviet space program since the failed N-1 lunar booster in 1969: it was also the first completely new class of launch vehicle to be successfully flown since the introduction of the R-36-O FOBS launcher in 1966 which would later be adapted as the two-stage Tsyklon launch vehicle.

It was hoped that the Zenit-2 (two-stage version) would act as a replacement for the Soyuz-class launch vehicle, being capable of flying heavy photo-reconnaissance satellites, the Zarya multi-manned space station ferry (which later resurfaced as an early concept for the Freedom emergency-return spacecraft), and the Uragan military spaceplane.

Unfortunately, the introduction of the Zenit-2 coincided with the start of the Soviet Union's decline, and most of the programs planned for the vehicle were cancelled. In addition, the vehicle's launch record was not too good–and there are still recurring problems with the vehicle; as a result the launch rate has been slow.

Having said this, three-stage versions of the Zenit have been proposed for commercial launches to geosynchronous orbit from near-equatorial sites, and such a mission would allow the Zenit-3 to match the payload capability of the four-stage Proton-K when it is flying from the more northerly Baikonur launch site.

The History of Zenit

The basic two-stage version of Zenit (Zenit-2) which has flown bears the designator 11K77, and the original plan by the

Yuzhnoye design bureau in the Ukraine was to use the first stage of Zenit for a whole family of launch vehicles with different payload capabilities.

It was hoped that 11K55 and 11K66 two-stage variants would be developed–with different second stages–for the launches of small satellites. In addition, the 11K37 was planned as a variable configuration launch vehicle, using clusters of two, four or six Zenit first stages (presumably as strap-on boosters), which would give a group of launch vehicles with a payload range of 30-60 tons to low Earth orbit.

Of the planned Zenit variants, only two have flown to date, with the three-stage variant expected to debut during 1998 or early 1999 as part of the Zenit Sea Launch program. The Zenit-1 is a modification of the vehicle's first stage which was used in a cluster of four as the strap-on boosters of the Energiya launch vehicle. The Zenit-2 is the standard vehicle which has been flying since April 1985, and the Zenit-3 is the planned modification which will carry a (Proton class) Block DM third stage for geosynchronous orbit missions.

Work on the Zenit-2 launch vehicle was underway within the Yuzhnoye bureau in December 1974, with the official government resolution for the vehicle's development coming on March 16, 1976. Work on the Zenit-1 was undertaken, starting in February 1977.

The first orbital attempt with a Zenit-2 came in April 1985 when a mock-up Tselina-2 ELINT satellite was launched, but failed to reach orbit: the next launch in June also failed to place its payload into orbit, although some debris from the high-altitude explosion of the vehicle did reach orbit. In October the first orbital launch was successfully completed when Cosmos 1697 was placed into orbit, but the next launch was an in-orbit failure.

The Zenit-2 was finally declared to be operational in December 1987.

Description of the Zenit-2

The first Russian description of the Zenit launch vehicle was in a presentation entitled "Glavcosmos Operational Space Transportation Systems," presented at the second European Aerospace Conference

"Progress in Space Transportation" in May 1989. Numerical details were given for the launch vehicle in this paper and they are summarised in Table 1.

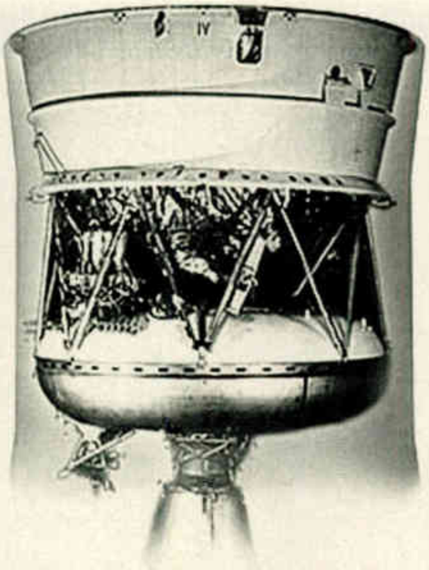
When the data are analyzed the Russian figures for the dry and propellant masses of each stage do not match the figures quoted in the Russian paper. For the first stage the sum of the dry and propellant masses comes to 346,880 kg, while the paper quotes 352,700 kg–a difference of 5,820 kg: in the case of the second stage the calculated total is 88,900 kg and the quoted figure is 89,800 kg–a difference of 900 kg. Finally, the quoted mass of the vehicle without a payload is quoted as 445 tons: adding the dry and propellant masses gives 435,780 kg–a difference of 9,200 kg, while adding the paper's own individual stage masses gives 442,500 kg–a difference of 2,500 kg.

Referring to the second stage figures, the difference between the calculated 88,900 kg and the quoted 89,800 kg could be a result of something as simple as a typing error in the original Glavcosmos document. That would therefore give a calculated launch mass (without payload) of 441,600 kg (352,700 + 88,900 kg); 3,400 kg less than the quoted 445 tons.

It is not easy to reconcile the first stage difference of more than 5,800 kg, and therefore the question of what this represents cannot be answered.

Taking the launch vehicle's total mass, 445 tons is 3,400 kg less than the revised Glavcosmos figure (352,700 + 88,900 kg) and 9,200 kg less than the sum of the component parts. It is possible that 3,400 kg is the mass of the payload shroud.

Depending on the orbital altitude, the payload range of the Zenit-2 is from three tons to 13.74 tons when launched from



Tyuratam. The limit is 13.74 tons to a 51 deg, 200 km orbit: for a flight to a Sun-synchronous 99 deg, 200 km orbit, the payload capability is 11.38 tons. Should the vehicle be flown from an equatorial site then the maximum payload mass to a low Earth orbit increases to 15.7 tons.

TABLE 1

Details of the Zenit-2 Vehicle Released in 1989

Length .... 57 meters
Diameter .... 3.9 meters
Total mass without payload: 445,000 kg (435,780)
First stage: 28,080 kg dry mass, 318,800 kg propellant mass, 352,700 kg total mass, kg (346,880)
Second stage: 8,300 kg dry mass, 80,600 kg propellant mass, 89,800 kg total mass (88,900)

Notes: The data in this table are taken directly from the paper *Glavcosmos Operational Space Transportation Systems*. The figures shown in parentheses are the arithmetical results of the addition rather than the totals quoted in the Russian paper.

The stated launch mass of a Zenit-2 with a payload of 15.7 tons is 461 tons (thus suggesting that the mass of 445 tons includes the payload shroud). From Tyuratam the maximum launch mass would be about 459 tons.

All launches of the Zenit-2 have been from two pads at Tyuratam, but there have been long-delayed plans to introduce the vehicle for launches out of Plesetsk. The Tyuratam pads are designated 45L and 45R: 45R was destroyed during a launch failure in October 1990. The Plesetsk pads were planned to form complex 35, but because of the financial problems within the Russian space program it is unclear whether these pads will be finished or will ever be used for Zenit launches.

The same paper also gave the following accuracy of the Zenit-2 to launches into 200 km circular orbits:

altitude	±3.5 km
orbital period	±2.5 sec (±0.04 min)
orbital inclination	±2 arc-min (±0.03 deg)

In 1989 Glavcosmos issued a promotional film which shows some payload integration shots of the Zenit booster, as well as the booster being rolled out horizontally, raised to the vertical on the pad and launched.

The Zenit launcher's technical complex is designed to conduct the complete working cycle of the assembly, including check-out and test of the rocket stages after arrival at the launch site as well as the integration of the booster with the spacecraft. The technical complex (as described by the Soviets) includes:

- Assembly and test unit
- Technological block to prepare and store compressed gases and to locate thermostatic systems.
- The hangar for the transportation-installation facility and spacecraft prime mover
- Storage of spare parts for the launcher and technological [support] equipment

As with all Soviet launch vehicles, the integration and assembly is performed horizontally and the complete booster is transferred to the launch pad by rail for final testing, propellant loading and launch.

The assembly and test unit in the integration hall (hangar) is equipped with two bridge cranes and has two positions for the assembly, testing and mating of the launch vehicles and spacecraft.

During tests the pressurization of the launcher pneumohydraulic systems, the order and quality of operations of the on-board systems in the flight simulation mode, and the integration of the spacecraft with the booster are fully checked.

The time taken for the integration of a Zenit booster with its payload is said to be 80 hours and the number of specialists required to undertake the work is 60.

Once the booster has been transported to the launch complex the actual raising of the vehicle to the vertical is fully automatic, and all electrical couplings between the booster and the launch pad are completed automatically. In fact the human presence at the launch pad has been minimized almost to the point where no one is actually required.

The launch facilities at Tyuratam were built to allow up to fifteen launches each year, although the Zenit-2 has never approached this launch rate.

Using liquid oxygen and kerosene, the Russians are regularly stressing that the vehicle is "environmentally friendly," although the same comments can be made about the far older Vostok-Soyuz family of launch vehicles which has been operating since 1957.

The Russians have provided data for the down- and cross-range errors in the first stage debris landing zone. Depending upon the trajectory being flown, the impact point will be 860-1,100 km downrange from the launch site, with an error limit in downrange of ±25 km and crossrange being ±15 km.

The impact point for the payload fairing again depends upon the trajectory, but is 860-1,900 km downrange from the launch site with the error limit being ±55 km downrange and ±30 km crossrange.

Depending upon the mass of the payload, the maximum longitudinal overloads should be 4-6g and, transverse, they should be 0.6g. During the stage separations the overloads should be 1.1g with a frequency of 9-12 Hz in the longitudinal direction and 0.4g with a frequency of 2-10 Hz in the transverse direction.

When launching payloads to a high circular orbit the Zenit-2 uses a somewhat inefficient launch profile. Taking a standard launch of a Tselina-2 ELINT payload as an example, the payload is to be launched into a 71 deg, 850 km circular orbit. An efficient launch profile would have the second stage of the Zenit-2 enter an initial transfer orbit with approximate parameters of 71 deg, 150-850 km; coast half way around this orbit; and, when approaching apogee in the southern hemisphere, the second stage engine (or the vernier system if it has sufficient thrust) would reignite to circularize the orbit.

The Zenit-2 does not follow this profile: rather it follows one which was tried and tested by the Meteor variant of the Vostok launch vehicle (8A92M) until it was retired in 1991. For Zenit the second stage is launched directly into an ascent orbit with a northern hemisphere apogee of 850 km (the southern hemisphere perigee is within the Earth's body): after the RD-120 second stage engine has been shut down the vernier engines continue to fire, providing the acceleration and attitude control. When an altitude of 850 km is reached the second stage and attached payload have both the velocity and direction required to maintain a circular 850 km orbit.

Since the launch of the first Zenit-2 payloads into orbit, observers of the former-Soviet space program spotted a tell-tale characteristic of the launches which allowed Zenit missions to be distinguished from other launches using similar orbits (of course, this was in the days when there were no launch vehicles announced for Soviet launches). There were always four small objects tracked in orbit which had apogees which were significantly higher than those of the payload and the second stage, and the presence of these was a recognizable "fingerprint" for a Zenit-2 launch.

Initially the Russians and Ukrainians offered no explanations for these extra four objects when asked about them, but more recent enquiries have allowed them to be identified. When the payload separates from the Zenit second stage, four solid propellant motors fire against the direction of motion in orbit to ensure a clean separation of the rocket stage and payload and also to push the rocket stage into a slightly different orbit. When the ignition of these motors takes place, a cover from each motor is separated by the force of the ignition, entering somewhat higher orbits–and these are the four extra objects seen with each launch.

Two examples of the objects tracked from Zenit-2 launches are shown in Table 2.

TABLE 2

Examples of Objects Tracked from Zenit-2 Launches

International Designator	Object	Incl deg	Period min	Altitude km	AoP deg
1994-023A	Cosmos 2278	71.01	101.97	849-855	66
1994-023B	Second stage	71.01	101.86	843-850	307
1994-023C	Motor cover	71.03	104.98	845-1,142	94
1994-023D	Motor cover	71.04	104.87	846-1,131	71
1994-023E	Motor cover	70.98	105.02	846-1,145	94
1994-023F	Motor cover	70.98	104.99	843-1,145	64
1994-074A	Resurs-01 1	98.05	97.98	661-663	93
1994-074B	Second stage	98.04	97.92	654-664	314
1994-074C	Motor cover	98.31	99.93	646-864	182
1994-074D	Motor cover	97.87	101.23	662-972	150
1994-074E	Motor cover	98.30	101.08	663-957	150
1994-074F	Motor cover	97.82	100.05	647-875	180

Note: Orbital data taken from *Worldwide Satellite Launches 1994*. AoP is the argument of perigee.

Rocket Engines for the Zenit-2

There has been some confusion concerning the designator of the engine used on the first stage of the Zenit launch vehicle. Most Russian and Ukrainian literature refers to the RD-170 as the engine used on both the Zenit-1 strap-on boosters of Energiya and also on the first stage of the Zenit-2 launch vehicle. In 1991 this writer was told by a person from the West who regularly visits the Yuzhnoye bureau in connection with a proposed joint project with the Ukrainians, that the first stage engine for the Zenit-2 was actually designated RD-171 since it was a modification of the Zenit-1 engine. Since then some Russian literature has confirmed this, as has the *Sea Launch User Guide* issued by the Boeing Commercial Space Company in support of the Sea Launch program.

The primary engine for the Zenit-2 second stage is the RD-120: like the RD-170 and RD-171 it was designed by NPO Energomash. The vernier engines for the second stage were developed by NPO Yuzhnoye, the bureau responsible for the overall development and manufacture of the Zenit launch vehicle.

Table 3 provides a summary of the numerical data for the rocket engines used on the

TABLE 3

Summary of Zenit-2 Rocket Engines

Design Bureau	NPO Energomash	NPO Energomash	NPO Yuzhnoye
Designator(s)	RD-171 11D521	RD-120 11D123	RD-8??
Application	First stage	Second stage	Second stage verniers
Development Period	1976-1985	1978-1985	1978-1985
Oxidiser	liquid oxygen	liquid oxygen	liquid oxygen
Fuel	kerosene	kerosene	kerosene
Combustion Chambers	4	1	4
Thrust, kN: vacuum	7,911	834	78
sea level	7,259		
Thrust, tons: vacuum	806.7	85	7.95
sea level	740.3		
Exhaust Velocity, m/s: vacuum	3,350	3,432	3,350
Specific Impulse, sec: vacuum	337	350	342
Chamber Pressure, atm	250	166	78
Burn Time, sec: normal	140-150	200-315	300-1,100
maximum	165		
Engine Mass, kg: empty	10,663	1,125	370
with propellant	1,285		
Base diameter, meters	3.99	1.954	
Height, meters	3.56	3.872	

Zenit-2 vehicle.

It is planned to introduce an improved-performance RD-172 engine for the first stage of Zenit, but it is not known when this will happen. This new engine will have a vacuum thrust of 8,307 kN (847 tons) and a chamber pressure of 255.6 atm.

Planned Payloads for the Zenit-2

There were two proposed manned programs which did not reach flight status. One was a manned spaceplane called Uragan which was intended as a quick reaction orbital fighter, responding to any United States shuttle launches out of the Vandenberg launch site which the Russians might havesuspected of carrying either deployable or fixed military payloads which went beyond what the Russians felt was acceptable in orbit. Following the loss of the United States *Challenger* shuttle orbiter in January 1986 and the subsequent cancellation of the planned Vandenberg launches, the Russians quietly cancelled the Uragan program and transferred the cosmonauts who had been selected to either their own *Buran* shuttle program or to the Soyuz-TM/*Mir* program.

The second proposal for a manned payload atop Zenit-2 involved a large space station ferry craft called Zarya which could carry a crew of five to six people. The Zarya program was authorized in the second half of the 1980s, but work on the vehicle was subsequently halted because of budget cut-backs. Zarya was planned to act in both manned and unmanned modes, so that it could either carry a crew to a space station or it could be a dedicated resupply spacecraft.

The main descent module would have the same general shape as the Soyuz, but would have a base diameter of 3.7 meters (Soyuz is about 2.3 meters): instrumentation, etc, would be modifications of proven Soyuz systems where possible. The launch mass of the craft would be about 13 tons and with a full crew complement it could carry a cargo of 1.5 tons: on unmanned missions the cargo load would be about 3.75 tons. After re-entry the main parachute would deploy to slow down the craft, and as the ground approached, a radio-altimeter would ensure the deployment of landing legs and a retro-rocket firing to cushion the landing. This would (hopefully!) ensure that the landing was always stable and that the spacecraft would not roll over after landing. It was intended that each Zarya spacecraft be capable of flying 10-15 times.

Details of the "Soyuz-derived" rescue vehicle which were proposed for Freedom missions strongly suggest that it would have been a direct descendent of Zarya, if not Zarya itself. The rescue-Zarya would be launched with a mass of 12 tons aboard a Zenit booster, or if carried aboard a space shuttle the mass could be reduced to 10 tons, because less propellant would be required for in-orbit maneuvers. The reduced mass for a Zenit launch was because Zarya was intended to be launched unmanned and mainly empty in order to dock with *Freedom*.

In reality, the overwhelming number of Zenit-2 launches have carried the 3,200 kg Tselina-2 ELINT satellites (all within the Cosmos program), using 71 deg, 850 km circular orbits.

During 1986-1987 there were four launches of 10-11 ton satellites which have never been satisfactorily explained. It has been variously suggested in the West that they might have been test payloads for either the Uragan spaceplane program (before it was cancelled) or a large photoreconnaissance satellite. However,

TABLE 4

Launch Record of the Zenit-2 Launch Vehicle

Launch Date	Payload	Incl deg	Period min	Perigee km	Apogee km	Comments
1985						
Apr 13	Cosmos	*Confirmed launch failure			Tselina-2 ELINT test	
Jun 21	Cosmos	*64.41	89.88	197	340	Tselina-2 ELINT test: only debris reached orbit
Oct 22	Cosmos 1697	70.99	101.97	850	854	Tselina-2 ELINT
Dec 28	Cosmos 1714	*70.99	94.78	163	853	Tselina-2 ELINT:
1986						
Jul 10	Cosmos 1767	64.88	88.52	196	207	Purpose unknown
Oct 22	Cosmos 1786	64.88	113.29	190	2,564	Atmospheric density sphere
1987						
Feb 14	Cosmos 1820	64.83	88.82	180	252	Purpose unknown
Mar 18	Cosmos 1833	71.01	101.94	849	852	Tselina-2 ELINT
May 13	Cosmos 1844	71.01	101.95	849	853	Tselina-2 ELINT
Aug 1	Cosmos 1871	97.03	88.27	179	199	First Zenit Sun-synchronous attempt
Aug 28	Cosmos 1873	64.84	88.82	177	255	Purpose unknown
1988						
May 15	Cosmos 1943	71.01	101.96	849	851	Tselina-2 ELINT
Nov 23	Cosmos 1980	71.00	101.99	849	854	Tselina-2 ELINT
1990						
May 22	Cosmos 2082	71.00	101.97	849	855	Tselina-2 ELINT
Oct 4	Cosmos	* Confirmed launch failure			Tselina-2 ELINT	
1991						
Aug 30	Cosmos		* Confirmed launch failure			Tselina-2 ELINT
1992						
Feb 5	Cosmos		* Confirmed launch failure			Tselina-2 ELINT
Nov 17	Cosmos 2219	71.01	101.97	849	855	Tselina-2 ELINT
Dec 25	Cosmos 2227	71.02	101.96	849	854	Tselina-2 ELINT
1993						
Mar 26	Cosmos 2237	71.02	101.95	849	853	Tselina-2 ELINT
Sep 16	Cosmos 2263	71.00	101.96	849	855	Tselina-2 ELINT
1994						
Apr 23	Cosmos 2278	71.01	101.97	849	855	Tselina-2 ELINT
Aug 26	Cosmos 2290	64.81	89.55	212	293	Photoreconnaissance
Nov 4	Resurs-01 1	98.05	97.98	661	663	Remote sensing
Nov 24	Cosmos 2297	71.00	101.97	849	854	Tselina-2 ELINT
1995						
Oct 31	Cosmos 2322	71.02	101.94	849	852	Tselina-2 ELINT
1996						
Sep 4	Cosmos 2333	71.01	101.94	849	852	Tselina-2 ELINT
1997						
May 20	Cosmos	* Confirmed launch failure		Tselina-2 ELINT		* Launch vehicle failure

these flights remain a complete mystery in reality.

The first actual flight (and, up to February 1998, the only flight) of a photoreconnaissance satellite on a Zenit-2 was the 10.6 tons Cosmos 2291, launched in August 1994. In November that year a Zenit-2 was used to launch the latest Resurs-O1 satellite to a Sun-synchronous orbit.

TABLE 5

Summary of Zenit-2 Launch Vehicle Failures

Launch Date	Satellite	Comments
Apr 13, 1985	Cosmos	No details available
Jun 21, 1985	Cosmos	Second stage vernier exploded 511 seconds after launch: debris reached orbit
Dec 28, 1985	Cosmos 1714	Payload shroud failed to separate, stage vernier exploded
Oct 4, 1990	Cosmos	First stage engine exploded 3-5 seconds after launch: pad 45R destroyed
Aug 30, 1991	Cosmos	Second stage engine failure
Feb 5, 1992	Cosmos	Second stage engine failure
May 20, 1997	Cosmos	First stage engine exploded seconds after launch

Zenit-2 Launch Record

Table 4 presents a complete launch listing for the Zenit-2 vehicle, through to the beginning of 1998. Sometimes Russian or Ukrainian launch statistics also include eight extra "Zenit flights," which represent the two flights of Energiya, each with four Zenit-1 strap-on boosters: these flights are excluded from this listing.

This launch record does leave a lot to be desired from a reliability point-of-view, especially since marketing literature for the vehicle was initially inaccurate (at best; dishonest at worst) in terms of acknowledging launch failures. The flight of June 1985 placed three pieces of short-lived debris into orbit, and initially it was unclear to western observers whether this was a launch failure or an intended sub-orbital mission which had (accidentally?) orbited the debris. Later it became known that there had been a launch in April 1985 and that this also did not reach orbit. As a result some western writers (including this one) speculated that these might have been test flights which were intentionally sub-orbital.

It is now known from reliable Russian sources that the April and June 1985 launches were actually orbital attempts which failed. However, when Yuzhnoye issued their Zenit user's manual, they repeated the western suggestions that these were sub-orbital test flights, presumably in an attempt to hide the fact that three of the first four launches were failures.

The Yuzhnoye manual also claimed that Cosmos 1714 was intended to enter its eccentric orbit as the operational one, although western analysis showed that this was an intended Tselina-2 launch which had failed to enter the planned circular orbit.

The Ukrainian literature claims that Cosmos 1714 was intended to operate in its eccentric 163-853 km orbit in order to equate it with the flight of Cosmos 1786. Without access to internal Russian and Ukrainian documentation it is not possible to disprove this claim: however, the evidence based upon orbital analysis indicates that the claims of a successful mission are not true.

Table 5 provides a summary of the Zenit-2 launch failures. From 28 launches there have been seven which failed to either reach orbit at all or (on one occasion) failed to reach the correct orbit. This gives the Zenit-2 a success rate of only 75 percent–hardly a record which one would expect for a commercial launch vehicle which has flown for more than a decade, even though the launch rate has been low.

Following the successful return to flight in November 1992, the next two Zenit-2 launches involved malfunctions, although the satellite payloads do not appear to have been damaged.

Cosmos 2227 was launched on December 25, 1992, and approximately 24 hours after launch the second stage partially disintegrated in orbit: there were two further disintegrations later on December 26 and a fourth one on December 30, resulting in a total of 219 pieces of debris. The debris events were caused by an overpressurisation of the propellant tank due to evaporating liquid oxygen. The next launch on March 26, 1993, placed Cosmos 2237 into orbit: two days later the Zenit-2 second stage disintegrated in orbit, with 29 pieces of debris being tracked. Again, the satellite does not appear to have been affected and the cause of the disintegration appeared to be the same as with the Cosmos 2227 rocket body disintegration.

Following these debris events the Russian and Ukrainians have started to vent the unused propellants from the Zenit-2 second stages after separation of the payload: this action should prevent any similar debris events from subsequently-launched rocket stages.

TABLE 6

Numerical Data for the Zenit-3SL Rocket Stages

Stage	Zenit Stage 1	Zenit Stage 2	Block DM-SL Stage 3
Length (meters)	32.9	10.4	6.2
Diameter (meters)	3.9	3.9	3.7
Fueled mass (kg)	353,800	90,500	17,200
Fuel mass (kg)	88,200	22,600	4,300
Oxidizer mass (kg)	232,000	58,300	10,300
Dry mass (kg)	33,600*	9,600*	2,600*
Engine thrust (tons):			
vacuum	803.9	85	8.5
sea level	737.4		

Notes These data are taken directly from the *Sea Launch User's Guide*, Table 2-2 and 2-3, with the exception of the figures marked * which are derived by simply subtracting the combined fuel and oxidiser masses from the fuelled masses as appropriate.

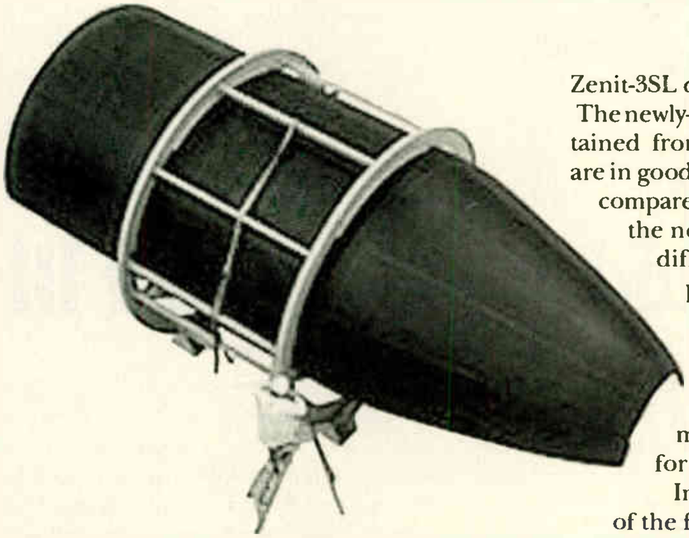
The Zenit-3 Launch Vehicle and the Sea Launch Proposal

The Zenit-3 was first described by the Soviets in 1989 as a future variant of the basic Zenit-2 vehicle. The first launch of a Zenit-3 was then scheduled for about 1993 from the Soviet Union.

The Zenit-3 takes the basic Zenit-2 and adds a third stage which is derived from the Proton-K launch vehicle's Block DM class fourth stage. Like the first two stages of the Zenit-3, the Block DM uses liquid oxygen and kerosene, although some variants have used liquid oxygen and syntin which give a somewhat better performance.

When launched from Tyuratam the Zenit-3 was described as being capable of launching 3,820 kg to geosynchronous transfer orbit or 600 kg to a geosynchronous orbit. A near-equatorial launch would permit 4,500-5,900 kg to enter geosynchronous transfer orbit and 1,900-2,400 kg to geosynchronous drift orbit. The upper limit of the drift orbit capability was a close match for the maximum mass which the far larger four-stage Proton-K could launch to the same orbit from Tyuratam.

The Zenit-based Sea Launch program is a joint venture which involves Boeing Commercial Space Company (United States), NPO Energiya (Russia), NPO Yuzhnoye (Ukraine), Yuzhmash (Ukraine) and Kvaerner A.S. (Norway):



together they make up the Sea Launch Limited Partnership.

The first flight of the Zenit-3SL vehicle is currently expected in late 1998.

Numerical details of the three stages which comprise the Zenit-3SL are given in Table 6. It will be recalled that the numerical data for the first and second stages of the Zenit-2 literally did not add up and that data is combined with the relevant Zenit-3SL data in Table 7.

The newly-derived dry masses obtained from simple subtraction are in good agreement when one compares the original 1989 and the new 1996 data, and the differences can be explained by evolution of the Zenit launch system since the first flights in 1985, possibly combined with modifications especially for the Zenit-3SL variant.

In flight the separation of the first and second stages is accomplished by firing small solid propellant thrusters located at the top of the first stage. The Block DM-SL is capable of restarting seven times in orbit.

Since the Zenit-3SL is planned for launch from a mobile, sea-based mobile platform, the launch site will be varied to some extent. In practical terms there are considerations like the rocket stage impact points, weather, access and command ship transit times which restrict the actual location. Two potential launch sites are under consideration in the Pacific Ocean: one off Long Beach, which would allow access to orbital inclinations greater than 45 deg, and one close to Kiritimati Island, which would permit access to all orbital inclinations.

The maximum performance for a Zenit-3SL mission to geosynchronous transfer orbit is 5,250 kg.

TABLE 7

Comparison of 1989 Zenit-2 Data and 1996 Zenit-3SL Data

	Zenit-2	Zenit-3SL
Stage 1: total mass (tons)	352.7	353.8
propellant mass (tons)	318.8	320.2 (232.0 + 88.2)
derived dry mass (tons)	33.9	33.6
quoted dry mass (tons)	28.08	
Stage 2: total mass (tons)	89.8	90.5
propellant mass (tons)	80.6	80.9 (58.3 + 22.6)
derived dry mass (tons)	9.2	9.6
quoted dry mass (tons)	8.3	

The Block-DM Family Launch Record

It is probable that the Block DM-SL being used for the Sea Launch program will be derived from the commercial Block DM family which has been flying aboard the four-stage Proton-K vehicle. These stages in turn derive from the Block DM variants which have seen long service in the domestic Soviet/CIS space program over the years.

TABLE 8

Flight Record of the Proton-K Block DM Fourth Stages

Variant	Period of Operation	Proton-K Failures	Stage 4 Failures	Stage 4 Successes	Total Flights
USSR/CIS Domestic Fourth Stages					
Block DM	1974-1988	5	1	58	98
Block DM-2	1982-date	3	4	84	91
Block DM-2M	1994-1996	0	0	3	3
Block DM-5	1997	0	0	1	1
	Sub-totals	8	5	146	159
Commercial Fourth Stages					
Block DM1	1996-date	0	0	1	1
Block DM2	1997-date	0	0	2	2
Block DM3	1996-date	0	1	3	4
Block DM4	1997-date	0	0	1	1
	Sub-totals	0	1	7	8
Overall totals		8	6	153	167

These figures are correct through to the end of 1997.

Table 8 provides a summary of the flight records of the various Proton-K Block DM stages which have flown to date. Failures which are due to the basic three-stage Proton-K not reaching orbit and in-orbit fourth stage failures are shown as separate items. For domestic launches, if one excludes failures to reach orbit, the original Block DM had a success rate of 98 percent, while the Block DM-2 has a success rate of 95 percent. Overall, the domestic Block DM has had a success rate of 97 percent (146 successes from 151 orbital missions).

Of course, the commercial modifications of the Block DM have been used less frequently, and thus the failure of the Block DM3 stage on the AsiaSat 3 launch affects the statistics more than it would if there had been more launches. Overall, from the eight commercial launches, the stages have a success rate of 88 percent. Taking all of the domestic and commercial Block DM launches together, the stage has a success rate of 96 percent.

Final Thoughts

The Zenit launch vehicle system has been under-used compared with the plans which were in place when it was introduced in 1985, when the Soviet Union still existed and space budgets almost guaranteed a blank check. In reality, the number of launches has been relatively small: in recent years only averaging one or two annually.

Additionally, the vehicle has continued to experience failures with the first and second stage propulsion systems: of the first four flights, three were failures, and during 1990-1992 there were three consecutive launch failures.

While Zenit will continue to fly in support of the domestic space program, but with a low launch rate, whether it will be successful as a commercial three-stage vehicle with the addition of the reliable Block DM class upper stage remains to be seen.

The Zenit-3SL third stage can be 100 percent reliable, but with unreliable first and second stages demonstrated within the CIS domestic program one cannot be certain that this unreliability will not carry forward to the Sea Launch program. ST

U N D E R   C O N S T R U C T I O N :

The KD2BD 9600 Baud Modem, Part III

By John A. Magliacane, KD2BD
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In the final part of this construction series, we will discuss the alignment, testing, and use of the KD2BD 9600 Baud Modem we have just built.

Modem Construction

The KD2BD 9600 Baud Modem was constructed on a single perforated circuit board measuring 4.5" x 4.5" inches (11.5 x 11.5 cm) using point-to-point wiring between individual component leads. Perforated circuit board construction is a simple, yet effective method of prototyping electronic circuit designs, and takes only slightly greater construction time compared to building a kit from a printed circuit board design.

Integrated circuit placement is shown in Figure 1. This layout is by no means sacred, but is included as a guideline for construction. All dual in-line package (DIP) integrated circuits should be installed in low-profile sockets to ease construction and allow initial circuit testing to be performed without the risk of damaging any of the ICs used in the modem. The two low-power voltage regulator chips and all transistors may be safely wired in without the use of sockets.

TNC Interfacing

The KD2BD 9600 Baud Modem was designed to interface with an MFJ modem 1270B terminal node controller (TNC). The 1270B is a TAPR TNC-2 clone, and as such, uses a standard modem disconnect header arrangement to interface with external modems. Figure 2 shows how connections are made between the KD2BD 9600 Baud Modem and the MFJ-1270B or other TNC-2 clone. Users of TNCs by other manufacturers should consult technical literature pertaining to their specific TNC to determine the proper modem disconnect header connections that need to be made between the TNC and an external modem such as the one described here.

TABLE 1

Integrated circuit power connections

Reference	Number	+12v	+8v	GND
U1, U2, U4, U9	TL084	Pin 4	--	Pin 11
U3, U6	CD4070B	Pin 14	--	Pin 7
U5, U15	CD4013B	Pin 14	--	Pin 7
U7, U16	CD4006B	Pin 14	--	Pin 7
U8	D4046B	--	Pin 16	Pin 8
U10	CD4016B	Pin 14	--	Pin 7
U11	LM3914	Pin 3	--	Pin 2
U14	CD4040B	Pin 16	--	Pin 8

Alignment and Testing

After all circuit components and IC sockets have been wired on the circuit board, alignment and testing of the modem can begin. Before installing any integrated circuits into their sockets, verify that connections made for +Vcc and GND are correct for each chip. Table 2 indicates the DC power connections for each integrated circuit in the modem, and may be used as a reference. This test may be made using an ohmmeter. Also verify that a short does not exist between +Vcc and GND.

If all connections check out correctly, apply 12 volts DC to the modem and verify that the output voltage of each voltage regulator is correct and that the proper +Vcc voltage is being fed to each chip socket using a voltmeter. Table 1 may again be used as a reference. U8 is the only chip that is supplied with +8 volts. All others are supplied with 12. If all is found to be correct, power can be removed, and all chips may be carefully inserted into their proper sockets.

Connect the modem to the host TNC and connect power to the modem. Adjust both R70, the FSK deviation control, and R71, the FSK Center Frequency adjust control, to mid-position. An oscilloscope attached to the FSK Output connection of the modem should display a pseudo-random serial data stream. If a high impedance audio amplifier and speaker or audio signal tracer is placed at this point, a hissing sound should be heard if the modulator is working properly.

Audio loop back testing can be accomplished by connecting the modem's FSK Output to the modem's FSK Input connection. This permits alignment and testing of the demodulator using the modulator section of the modem as a test signal source. With a high impedance voltmeter, measure the DC voltage at U1A pin 1 with respect to ground. Adjust the Slicer Level control, R7, until the voltage seen at U2A pin 2 is the same as what is seen at U1A pin 1. Temporarily remove the audio loop back connection, and connect a frequency counter to pin 3 of U8. Adjust R23 until the counter reads 9600 Hz. Reconnect the audio loop back

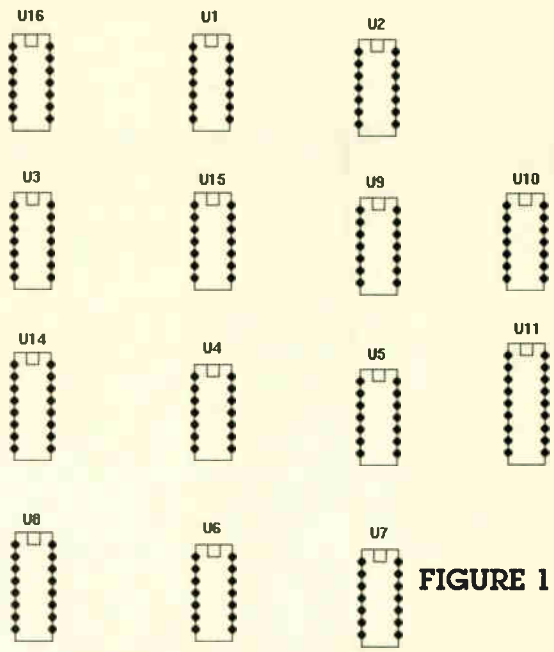


FIGURE 1

Parts placement of DIP ICs used in the KD2BD 9600 Baud Modem.

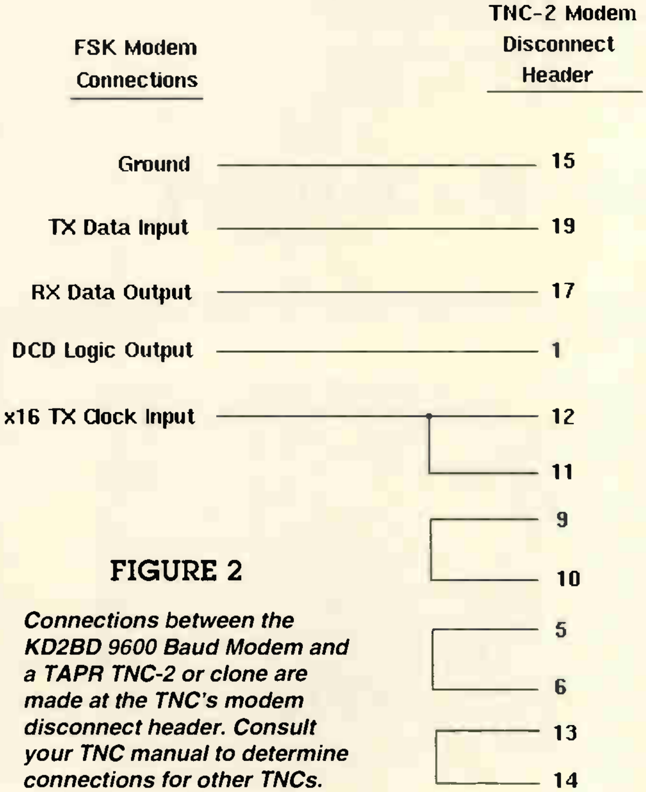


FIGURE 2

Connections between the KD2BD 9600 Baud Modem and a TAPR TNC-2 or clone are made at the TNC's modem disconnect header. Consult your TNC manual to determine connections for other TNCs.

connection. At this point, the Data Carrier Detect (DCD) LED should be lit and the Signal Quality meter should show significant up-scale deflection.

With a dumb terminal or computer running a terminal emulation software package connected to the TNC, set the TNC's full-duplex parameter ON (FULLDUP ON). Proper operation of the modem may be had by trying to establish a connection with the callsign assigned to your TNC. The throughput experienced should be flawless.

Transceiver Interfacing

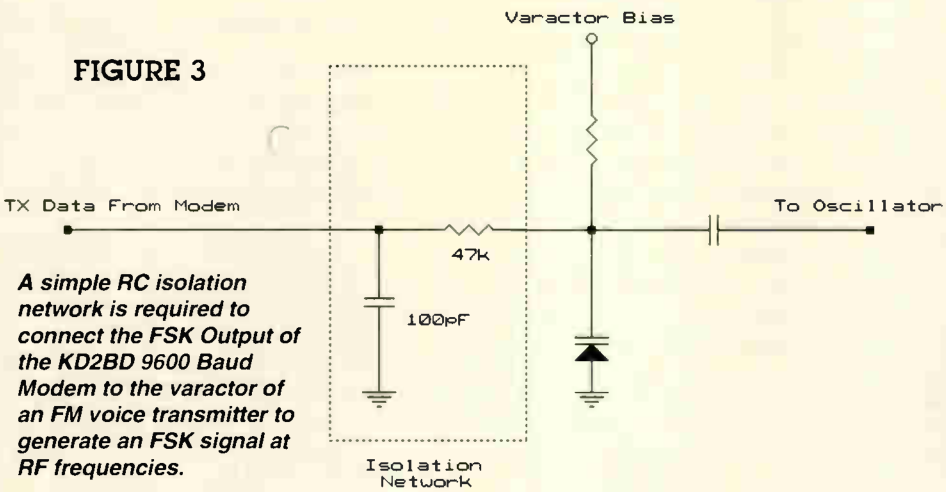
Proper interfacing between any 9600 baud FSK modem and transceiver will vary depending on the transceiver circuit design and the make and model of the transceiver. Mike Curtis, WD6EHR, authored a *9600 Baud Packet Handbook* that describes 9600 baud packet communications, including modem connection points as well as modifications to popular transceivers. Mike's handbook was widely distributed electronically via packet radio BBSs several years ago, and is probably available today via the Internet.

Many Internet sites contain 9600 baud circuit modifications and connection points for 9600 baud modems for many different types of transceivers. The proper transceiver interfacing methods or transceiver circuit modifications are left to the expertise of the reader, but the following general information should be of use regardless of the specifics of the radio transceiver used in conjunction with this modem.

FSK signals are tapped off from the receiver's FM detector prior to any de-emphasis circuits or DC blocking capacitors. The input impedance of the KD2BD 9600 Baud Modem is high, so the modem

(Continued on page 60)

FIGURE 3



A simple RC isolation network is required to connect the FSK Output of the KD2BD 9600 Baud Modem to the varactor of an FM voice transmitter to generate an FSK signal at RF frequencies.

By Lawrence Harris
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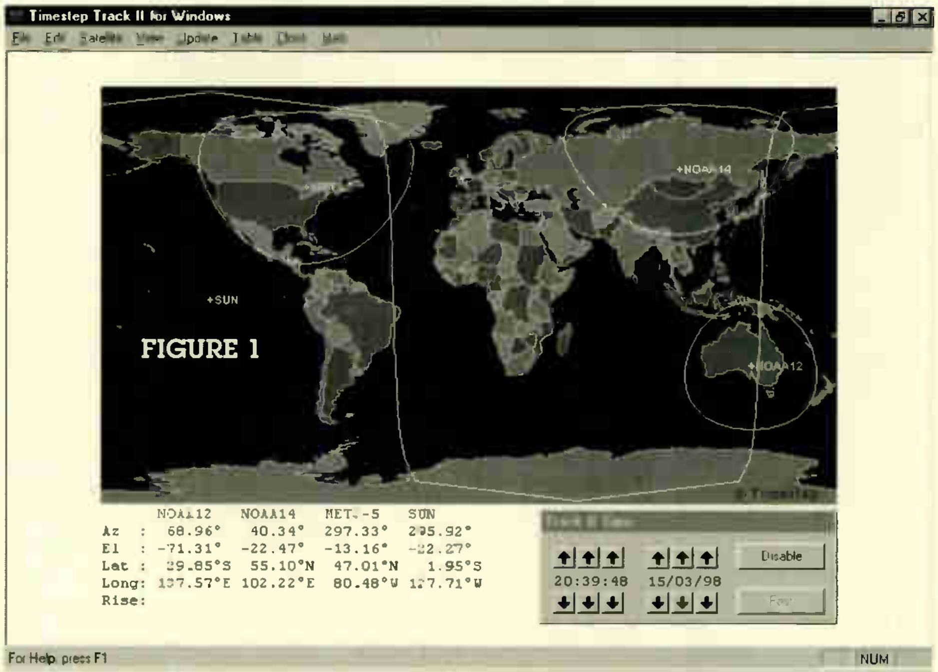
Decoding Weather Satellite Imagery

My own receiving station is a converted garage within the bottom level of our house. When we gave up the car (yes, this can happen), Marion, my wife, suggested that I move my receivers and computers from the downstairs passage-way into the new room–and I needed no persuasion. Re-routing the antenna cables produced a very comfortable "shack" where I now have at least one scanner almost permanently monitoring selected frequencies. Many of my visitors are from the media, and all express amazement that one can actually listen-in to the satellites, and even collect "live" pictures. I find their surprise to be surprising, now that satellite television is fairly commonplace.

For those unfamiliar with the monitoring of satellites in general, and weather satellites in particular, it is important to make a significant distinction at this point. There is a big difference between "monitoring" and "decoding." My monitoring scanner is a 300-channel Radio Shack PR-2004 (known in the UK as a Tandy PR-2004). This can be fed by either a roof-mounted 137 MHz crossed dipole or by a discone (a wideband antenna) that sits in the loft, three levels up.

When I do monitoring, I have this receiver scan a narrow or wideband of selected frequencies, depending on which antenna I have connected. Using the discone and a wideband preamp, I can log several easily identifiable satellites. Tracking software, updated with new Kepler element sets, allows me to monitor many satellites which transmit on frequencies to which I can tune.

For this purpose–monitoring–the scanner is perfect. Many other scanners are equally excellent, so it is not an easy choice for a newcomer to make when considering the purchase of a scanner. When the satellite is heard with this type of scanner, we hear less than half the full signal. General purpose scanners have their circuitry designed and optimized for the reception of utility transmissions, usually of terrestrial origin, and are therefore likely to have an internal intermediate frequency (IF) bandwidth of about 15 kHz. The signal from the satellite contains information occupying some 35 kHz bandwidth, and it can occupy even more when the relative movement of the satellite (Doppler effect) is taken into account.



Meteor 3-5 footprint around mid-March–south-bound during the day

As a result of this, only a small amount of the information content of the signal actually gets through the receiver's electronics. The sound emanating from the speaker may seem quite powerful during a high elevation pass, but it is merely a distorted replica of the original rich melody generated by the onboard electronics and containing such a wealth of information.

Consequently, to actually "decode" the telemetry from weather satellites we must enter a new ball park. Special receivers, designed to minimize interference and to extract the complete image information, are a necessity if a quality picture is to be decoded from the telemetry. It is this subject–the design of weather satellite receivers versus general purpose receivers–which the beginner to weather satellite monitoring finds so daunting–and about which I am asked most often by enquirers.

To produce a quality image you must either construct or purchase a weather satellite receiver. Advertisements for some of these are carried in *Satellite Times*, and *View from Above* will periodically refer to the appropriate manufacturers.

Meteor 3-5 rests

While NOAA's 12 and 14 satellites transmit continuously on 137.500 and 137.620 MHz respectively, the Meteor 3-5 weather satellite, controlled by the Commonwealth of Independent States, operates in a different manner.

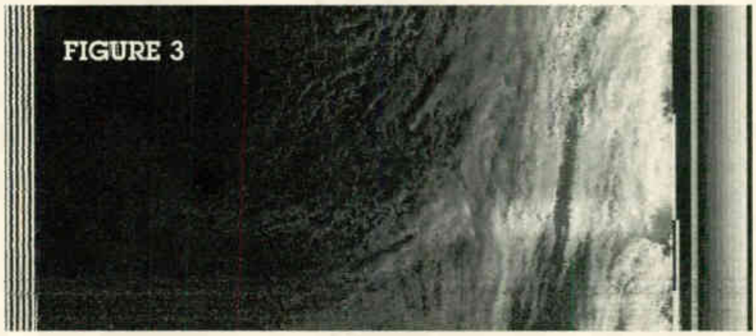
The plane of its orbit slowly rotates with respect to the sun, so there are regular periods when this plane coincides with local twilight–the day/night boundary. At such times, the satellite's power systems receive a reduced amount of solar illumination, and on some of these occasions the satellite controllers switch off the APT transmitters–137.850 MHz goes silent.

When I do monitoring, I have this receiver scan a narrow or wideband of selected frequencies, depending on which antenna I have connected. Using the discone and a wideband preamp, I can log several easily identifiable satellites.

FIGURE 2

Meteor 3-5 1520 UTC Nov 27, 1997

FIGURE 3



Meteor 3-5 1008 UTC on Feb 9, 1998

A message from Mike Kenny of Satellite Engineering, Bureau of Meteorology, in Melbourne, Australia, informed the weather satellite newsgroup on the Internet that Meteor 3-5 would be switched off between February 10 and March 10. This is the current period during which its orbital plane crosses the twilight zone. By mid-March the satellite is passing south-bound during the day, and experiencing increased levels of illumination–see figure 1.

To illustrate the twilight illumination effect I delved into my recent records to identify one of the first and last Meteor images from the November 1997 to February 1998 season.

Figure 2 shows the twilight region on the eastern side of the image as Meteor 3-5 was moving northwards into evening twilight during late November. Figure 3 shows the twilight region on the western side of the image during early February, when Meteor 3-5 was moving northwards into the morning twilight. The images themselves show some jitter, presumably caused by wear-and-tear of the scanning equipment on the satellite.

One small zero for a GOES

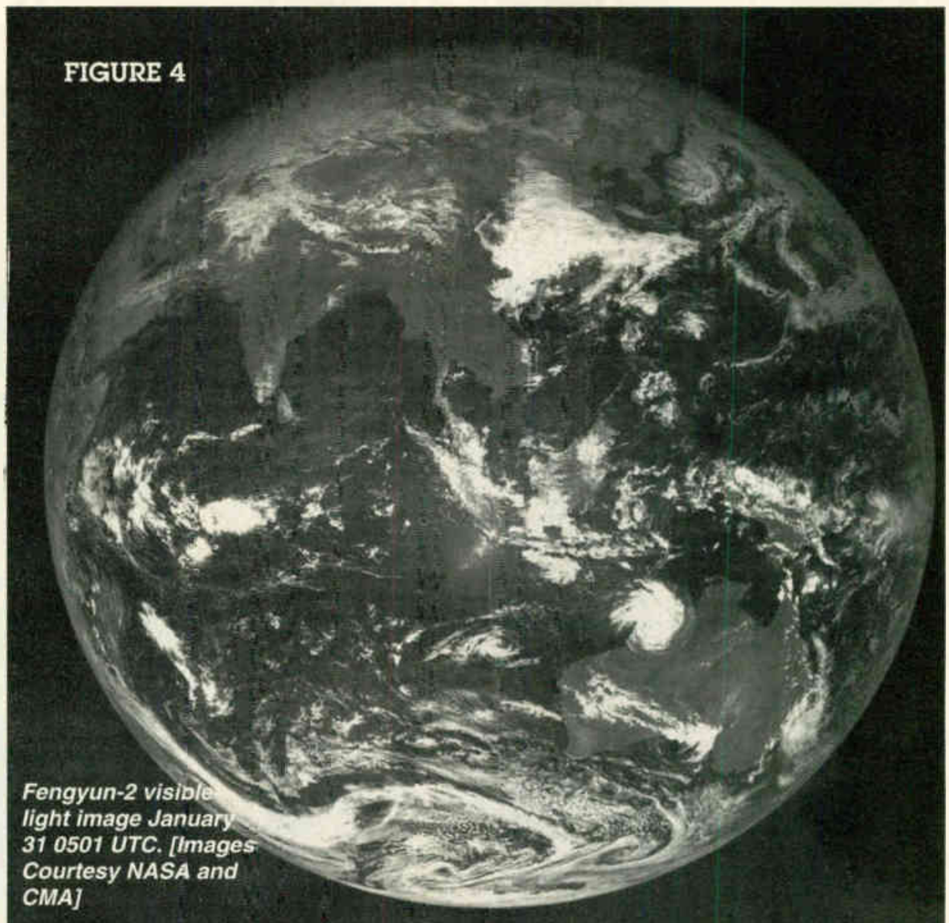
On February 2 at approximately 1500 UTC, the Information Processing Division (IPD) implemented a change in all the WEFAX header annotations to accommodate a two character satellite ID requirement if and when GOES-10 becomes operational. The change will be implemented for the current satellites. GOES-8 is now GOES-08 and GOES-9 is GOES-09. The Binary Coded Header remains the same.

ESA and EUMETSAT fund METOP and EPS

The European Space Agency (ESA) and Europe's weather satellite organization (EUMETSAT) have released an "Authorization To Proceed," to the European industry allowing all planned activities to start on the METOP spacecraft. METOP is the METeorological Operational Polar satellite system, the European contribution to the polar satellite constellation. EPS is the EUMETSAT Polar System, which comprises the space segment, launches and operations related to the METOP satellites.

The instruments on METOP will pro-

FIGURE 4



Fengyun-2 visible light image January 31 0501 UTC. [Images Courtesy NASA and CMA]

Fengyun-2 evidently scans the earth every hour–including those hours when the sun is on the other side of the earth (as seen from Fengyun-2)–resulting in some very dramatic imagery. Figure 5 shows the effects of such scans.

duce high-resolution images, vertical temperature and humidity profiles, and temperatures of the land and ocean surface on a global basis. Also on board the satellites will be instruments for monitoring ozone and wind flow over the oceans. This instrument payload will be of significant value to meteorologists and other scientists, particularly those studying the global climate. The first launch–METOP-1–is planned for 2003 as part of an international joint system in cooperation with the USA.

Regular pictures from Fengyun-2

I recently reported on the work being done by NASA to get images from the Chinese geostationary weather satellite Fengyun-2 on to the web for use by meteorologists and researchers. Patrick L. Coronado of NASA's Goddard Space Flight Center told me that his group was working to achieve this objective. Dr. James C. Dodge is the Program Manager of the Global Data Integration and Validation Science Division, at the Office of Earth Science, NASA Headquarters, and he contacted me to advise of test images available for me to view on a recently setup Internet site.

Access is currently available via a link on Geoff Chester's web page at: **http://climate.gsfc.nasa.gov/~chesters/goesproject.html** from where the option full-disc GMS, FY and GOES is available. The link to FY leads to a selection of Fengyun-2 images, including both visible and infra-red imagery of 4 km resolution.

Jim told me that they had just begun experimental reception of Fengyun-2 imagery and that they expect to begin routine operations around March. The Chinese are not yet calibrating their images, but NOAA is helping them. Jim expects image navigation, which is already reasonable, to improve when the Chinese begin a routine official direct broadcast service. Jim has agreed to inform me as this service becomes fully operational.

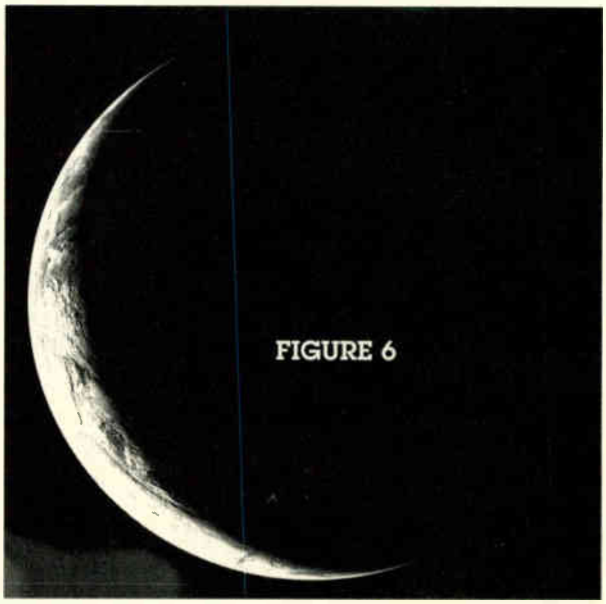


FIGURE 6

Fengyun-2 evidently scans the earth every hour–including those hours when the sun is on the other side of the earth (as seen from Fengyun-2)–resulting in some very dramatic imagery. Figure 5 shows the effects of such scans.

The Peoples' Republic of China founded the National Satellite Meteorological Center (SMC) on July 1, 1971, as a scientific research and operational facility affiliated to the State Meteorological Administration.

To complete this sequence of Fengyun-2 images, I also collected the sunset and sunrise images–see figures 6 and 7–which show the crescent earth as seen at 1402 UTC with the sun near sunset and at 1902 UTC when the sun is rising.

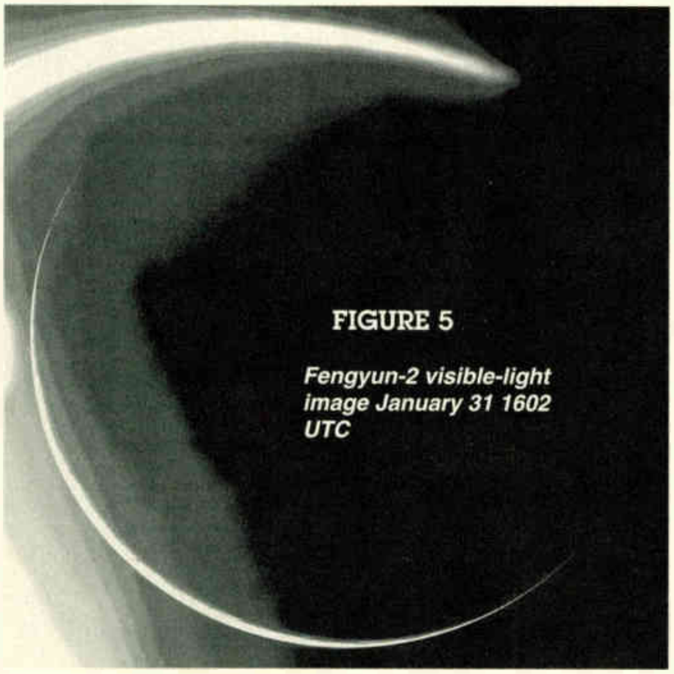


FIGURE 5

Fengyun-2 visible-light image January 31 1602 UTC

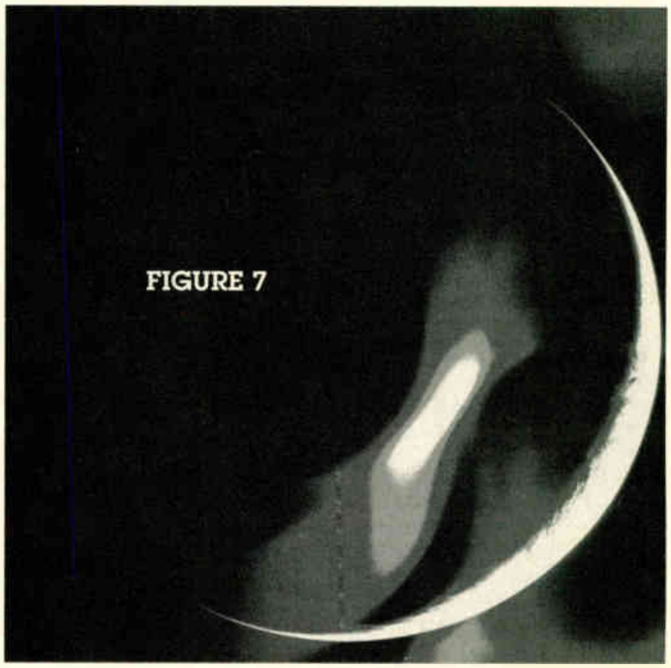
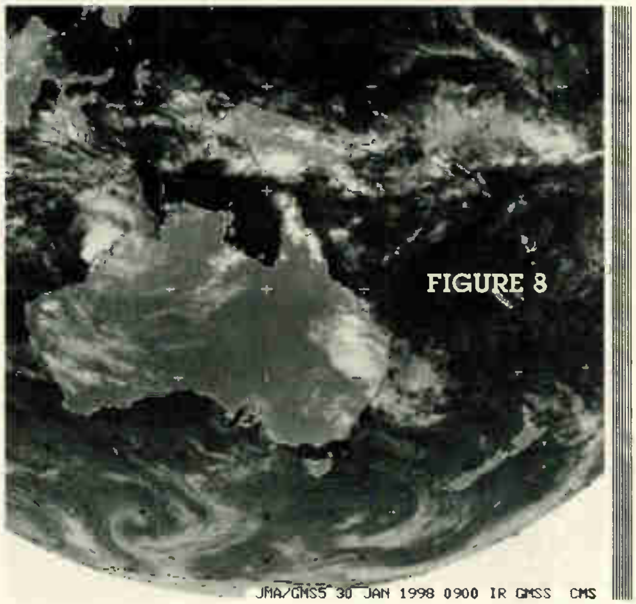


FIGURE 7

Those who have experimented with the use of conventional cassette recorders for recording APT audio output (the subcarrier content) from a weather satellite receiver, will know that the input level (coming from the receiver) has to be set low enough to prevent the recorder's electronics from activating the automatic gain control (AGC).

From the UK, I can collect images directly from Meteosat-6, which also disseminates selected images from GMS-5, GOMS and GOES-8. GMS-5 covers areas not far from the longitude of Fengyun-2, so images at similar times show the weather systems from a different perspective.



GMS-5 (the GMSS infra-red format transmitted by Meteosat-6) on Jan 30 at 0900 UTC Note the active weather system over northwest Australia, seen by both GMS-5 and FY-2.

Correspondence

Mail from distant lands is always welcome, and several correspondents have e-mailed me during their travels abroad. A message from Ben Ramsden in Malaysia told me he had successfully received polar orbiting weather satellite pictures. He purchased a Minidisk recorder/player to record the receiver's audio on location. Being smaller than a traditional "Walkman" and having a built-in rechargeable battery, they are potentially ideal for mobile usage during weather satellite monitoring. Ben's main concern was whether the analog-to-digital (A/D) and D/A conversion would degrade the receiver's audio signal in a way which might be detrimental to picture quality.

Those who have experimented with the use of conventional cassette recorders for recording APT audio output (the subcarrier content) from a weather satellite receiver, will know that the input level (coming from the receiver) has to be set low enough to prevent the recorder's electronics from activating the automatic gain control (AGC). Too high a signal and the recorder filters out a portion of the spectrum with consequent loss of detail.

Because of Malaysia's location, there are very few passes to choose between, and NOAA-12 morning/evening passes are near dawn/dusk, so the visible image is either missing or of low level. Ben says NOAA-14 telemetry is "almost unreceivable" due to a local taxi company on or near 137.620 MHz, but Meteor 3-5 signals are OK if you monitor during daylight hours.

Ben comments that weather satellite monitoring has an uncertain legal position in Malaysia, so he doesn't wish to stand in high places with funny aerials.

Ben suspects that the NOAA-14 image lacks detail in certain areas having similar color. He commented that edges show up very well; northern Malaysia, Thailand, Cambodia, Laos and Vietnam "are very clear," including lakes and river estuaries. Ben expects to be "moving on" soon, so plans to get a few more images before leaving.

Ben Ramsden's NOAA-14 image from January 31 0750 UTC from Pinang, Malaysia

Frequencies

NOAA-14 transmits APT on 137.620 MHz
NOAA-12 transmits APT on 137.500 MHz
NOAAs transmit beacon data on 137.770 or 136.770 MHz
METEOR 3-5 transmits APT on 137.850 MHz when in sunlight (except for scheduled rests)
OKEAN-4 and SICH-1 sometimes transmit APT briefly on 137.400 MHz
GOES-08 and GOES-09 use 1691.0 MHz for WEFAX ST

By John Magliacane, KD2BD
magliaco@email.njin.net

Money Talks, Spectrum Walks

In late January, the Telecommunications Authority in the country of Guatemala auctioned off four frequencies between 430 and 435 MHz for commercial use, despite their use by amateur radio operators in that part of the world. Amateurs in the region have been trying to convince authorities not to auction spectrum that is shared by amateurs to commercial users for over a year, but as is often the case, the money that could be gained through such a frequency auction spoke much louder than reasonable arguments by hams against the selling of spectrum rights to the highest bidder. Mexico also recently lost UHF amateur band spectrum to commercial interests, and this appears to be the disturbing trend.

FIGURE 1

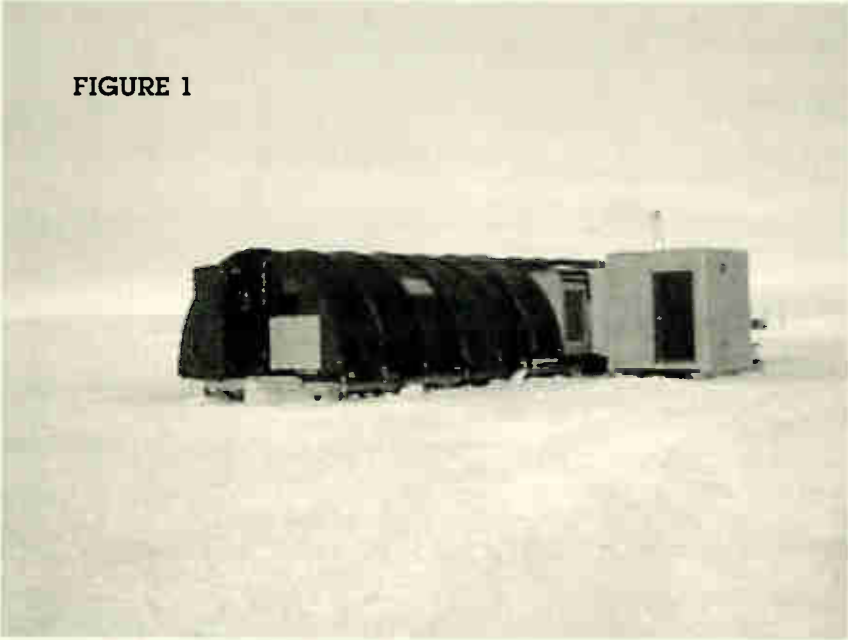


Image of a 10-person Jamesway uploaded to the KITSAT-OSCAR-25 satellite by Andre Phillips, VK0MAP, during his recent stay at the South Pole. A heating unit is visible to the right.

Although the 430 to 435 MHz spectrum loss in Guatemala does not directly effect OSCAR satellite communications, a precedent has now been set, and just as arguments against such an auction by amateur radio operators largely fell on deaf ears, there is no guarantee that frequencies within the 435 to 438 MHz UHF amateur satellite sub-band will not be auctioned off to the highest bidder in the future.

The implications of frequency auction involving spectrum used by OSCAR satellites are staggering. While commercial interests buying rights to UHF spectrum are primarily concerned with short-range communication services, it is well known that even low-power transmissions can be relayed half a world away via a transponder carried on-board a communication satellite in earth orbit. Clearly, something needs to be done to prevent future spectrum grabs that affect worldwide amateur satellite communications if OSCAR satellites are to continue to utilize spectrum that is not exclusively allocated to the amateur radio service.

The situation is not all doom and gloom, however. Frequency allocations used in amateur radio satellite communications did fare well at the World Radio Conference held in Geneva, Switzerland, late last year. WRC97 delegates did agree to upgrade the Earth Exploration Satellite Service from secondary to primary at 1215 to 1300 MHz. This service should have only minimal impact on amateur use of 1240 to 1300 MHz, but more to the point, the presence of these satellites reduces the possibility that other, less-compatible services might later be introduced into this band.

More South Pole Activity on the Pacsats

Andre Phillips, VK0MAP, was active on the KITSAT-OSCAR-25 satellite from the South Pole in late January and early February this year. Andre is a New Zealander who is no stranger to the Antarctic. He has traveled to the South Pole on a number of occasions in the past, and held a keen interest in communicating via the digital OSCAR satellites from the southern polar region of the globe.

During his latest stay, Andre exchanged many messages and several image files with amateurs around the world via the KITSAT-OSCAR-25 satellite. One such message is shown in Table 1. Figure 1 is an image Andre uploaded to KO-25 showing a ten person "Jamesway" accommodation module. Andre reported that such modules have a very basic construction, are surprisingly comfortable with each module having its own heating system, and are only used during the summer. Andre concluded his satellite activities and returned home in mid-February.

SEDSAT-1 Slated for July Launch

The Students for the Exploration and Development of Space Satellites (SEDSAT-1) is a student project whose goals are to design, build, and fly a microsat class satellite. The project is managed and primarily composed of students from the University of Alabama's (Huntsville) (UAH) Students for the Exploration and Development of

Of particular interest to amateur radio operators is the fact that SEDSAT-1 will carry an analog and a digital communications transponder in addition to a high-resolution earth imaging camera. Table 2 lists the tentative frequencies to be used by SEDSAT-1.

TABLE 1

A message sent to John Magliacane, KD2BD from Andre Phillips, VK0MAP via the KITSAT-OSCAR-25 satellite during his stay at the South Pole earlier this year:

To : KD2BD
From: VK0MAP
Time: 025819UTC
Date: 22 Jan 1998

South Pole Station Antarctica

Hello John,

Thanks for the brief mention in *SpaceNews* and it would have been fun to chat direct with Ron when he was down here. Most of your article comments apply to this station as well. The rig here is a Kenwood TS-790A with PacComm Tiny 2. It all works very nicely I must say. The up/downlink antennas are a couple of Lindenblads fashioned from no. 8 fencing wire and they do an excellent job. I get a solid 5+ minutes of connect time per pass. At the Pole UO-22, KO-25 and POSAT all rise to an elevation of 34 degrees, and KO-23 to 12 degrees.

As I write there is a Herc taking off outside. They pass only a few hundred feet from my window and are an impressive sight, especially when occasionally generating condensation trails right from ground level. We get 2-5 Herc flights in per day.

73's
Andre
VK0MAP/VK5AAP/ZL3AW

Andre Phillips
Dept of Astrophysics & Optics
UNSW, Sydney, NSW
Australia, 2052
ph: (61 2) 9385-5003, fax: 9385-6060

WWW:
http://www.phys.unsw.edu.au/astro.html (UNSW Astrophysics)
http://www.phys.unsw.edu.au/~mcba/aasto (AASTO project)
http://www.phys.unsw.edu.au/~mgb/jacara.html (Antarctic astronomy)

Space (SEDS) organization. The project manager is Dennis Wingo, KD4ETA, a physics student at UAH, and a staff member of the UAH Center for Space Plasma and Aeronomic Research and the Consortium for Materials Development in Space.

Of particular interest to amateur radio operators is the fact that SEDSAT-1 will carry an analog and a digital communications transponder in addition to a high-resolution earth imaging camera. Table 2 lists the tentative frequencies to be used by SEDSAT-1.

SEDSAT-1 was originally to be deployed from the space shuttle on mission STS-85 from a cannister attached to a 12-mile (20-km) tether. The tether deployment would have released SEDSAT-1 into an orbital altitude much higher than that of the space shuttle, but problems experienced with tether experiments carried onboard previous space shuttle missions forced NASA to cancel the tether deployment system for SEDSAT-1.

Instead, SEDSAT-1 will be launched on a Delta-II Booster rocket that will place the spacecraft into a 500 km x 1000 km low-earth orbit having an inclination of 31 degrees. This orbit is expected to provide a much longer orbital lifetime than what would have been possible through the space shuttle tether deployment. The lower orbital inclination, however, will limit the communications access to temperate latitudes of the earth.

SEDSAT-1 differs from previous satellites carrying digital transponders in that it will make use of an uplink in the 23-cm

FIGURE 2

Early SEDSAT-1 logo showing deployment through a tether attached to the space shuttle. The satellite will instead be launched on a Delta-II Booster rocket in July.

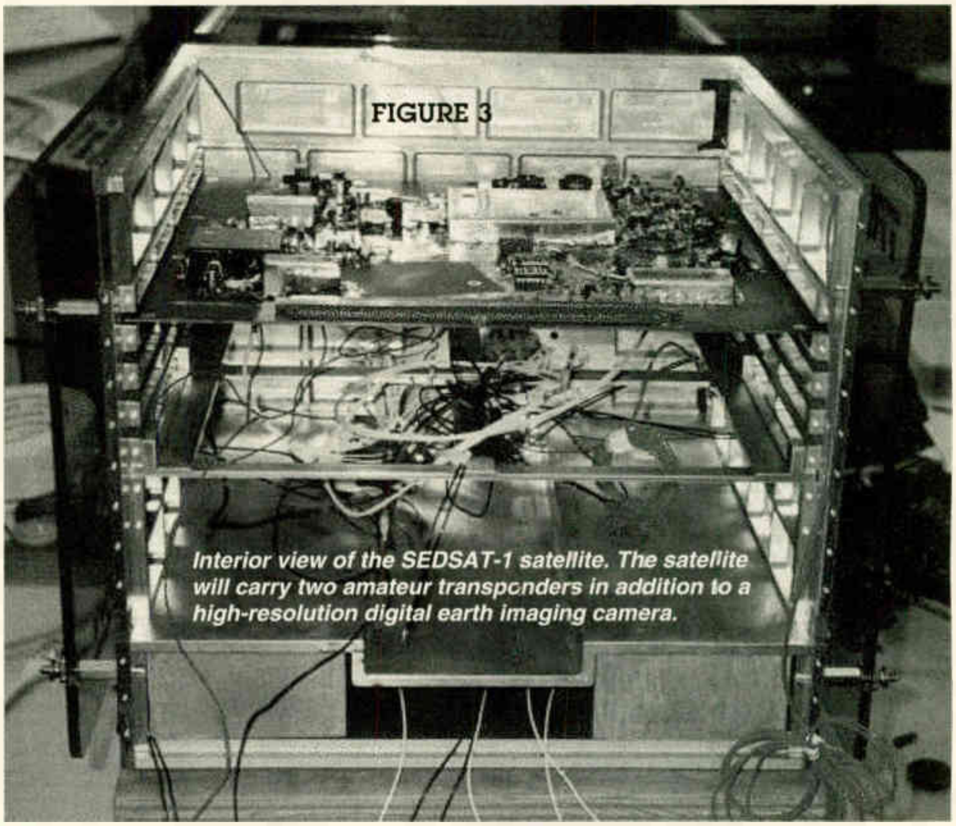


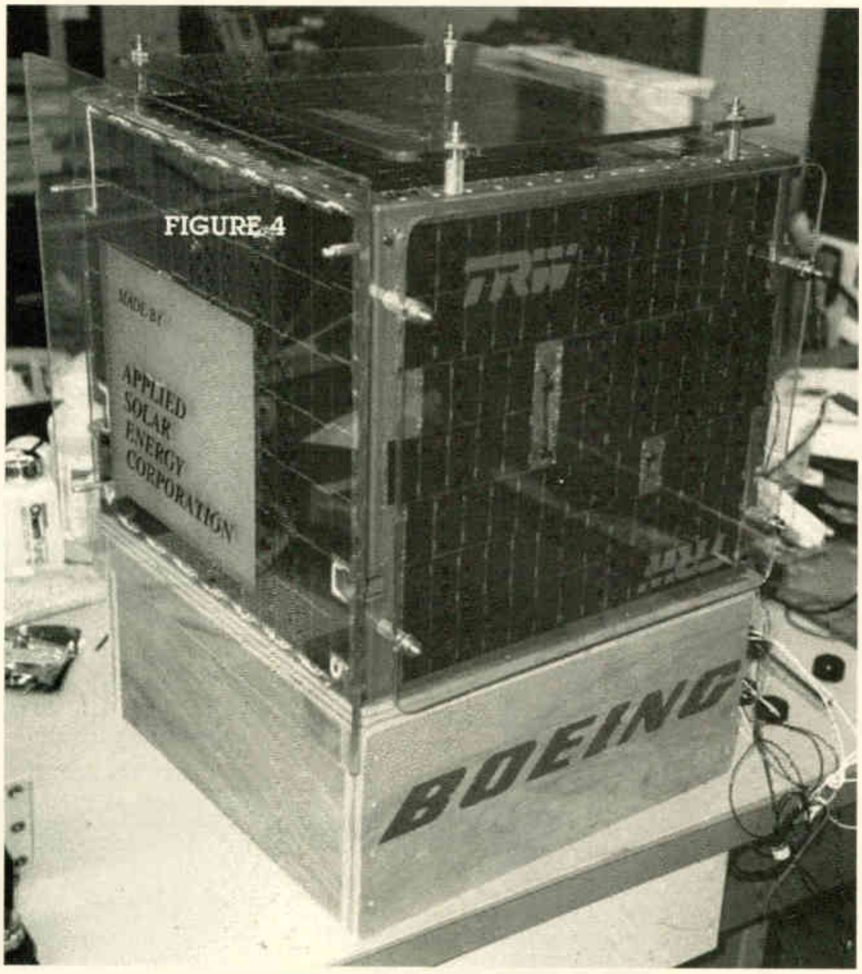
FIGURE 3

Interior view of the SEDSAT-1 satellite. The satellite will carry two amateur transponders in addition to a high-resolution digital earth imaging camera.

Stacy Mills, W4SM, reports that AMSAT-OSCAR-10's signals have improved and are quite strong even at apogee, except for periods of deep signal fading which can be largely corrected by changing the ground station's antenna polarization.

amateur band rather than the 2-meter band. Ten to 25 watts of transmitter power plus a medium gain antenna system capable of tracking the satellite across the sky are recommended for successful communications with the satellite.

During periods of 9600 baud operation, a standard 9600 baud FSK modem, such as the *KD2BD 9600 Baud Modem* described in *Satellite Times*, will permit access to the digital communication transponder carried onboard SEDSAT-1. Higher downlink rates will be used primarily for transmitting digital images captured by SEDSAT-1 earth imaging camera to ground stations wishing to receive them.



Exterior via of the SEDSAT-1 satellite. Solar cells will be mounted on each facet of the spacecraft to power the spacecraft electronics.

AMSAT-OSCAR-10 Doing Better

Stacy Mills, W4SM, reports that AMSAT-OSCAR-10's signals have improved and are quite strong even at apogee, except for periods of deep signal fading which can be largely corrected by changing the ground station's antenna polarization. These findings suggest strongly that AMSAT-OSCAR-10 has switched (glitched) itself to its high-gain antennas. There is probably a component of Z-axis wobble accounting for the signal fading. As illumination improves, the FMing heard earlier in the year seems to have disappeared. The switch to the high-gain antenna would also explain the often poor signals near perigee when the squint angle is particularly bad and the high-gain antennas are pointed away from the earth.

AMSAT-OSCAR-10's apogee has moved and is currently located in the northern hemisphere (ArgP > 180). AO-10's apogee will continue to rise higher to the north for the rest of 1998, peaking at ArgP = 270 in December.

FUJI-OSCAR-20 Memory Glitch

A memory error was detected in the onboard computer system of the FUJI-3 (FO-29) satellite in January. FO-29's spacecraft operating software was reloaded, but the process took longer than expected due to a poor uplink budget efficiency. All previously published operating schedules for FUJI-OSCAR-29 have been canceled because of this problem, and until the situation is fully resolved, the satellite is expected to remain in analog mode (Mode JA) continuously until further notice.

Mir Amateur Radio Status

Miles Mann, WF1F, reports that the *Mir* packet radio Personal Message System (PMS), and the SAFEX-II repeater were turned off recently as a result of difficulties being experienced with the amateur radio hardware on *Mir* plus the crew's very busy work schedule. The operating parameters programmed into the terminal node controller on *Mir* were lost in December last year and need to be correctly reset. Ground stations should avoid using the *Mir* PMS under these conditions until the TNC has been properly reprogrammed.

Look for announcements made in AMSAT News Service bulletins and in weekly *SpaceNews* reports for the latest information on the amateur radio activity taking place from the *Mir* space station.

ST

TABLE 2

SEDSAT-1 Frequencies

Mode A Linear Transponder:
Uplink:145.915 to 145.975 MHz
Downlink:29.350 to 29.410 MHz

Mode L Digital Transponder:
Uplink:1268.250 to 1,268.100 MHz accepting digital FSK data at rates of 9.6, 19.2, 38.4 and 56 kbit/sec.

Downlink:437.850 to 438.000 MHz transmitting digital FSK data at rates of 9.6, 19.2, 38.4 and 56 kbit/sec.

Tentative frequency for use by the SEDSAT-1 satellite slated for launch in July. The RF output of each transponder will be 3 watts average and 15 watts peak.

By Keith Stein
kstein@erols.com

ARIA Performs Last Atlas Tracking Support

The U.S. Air Force Advanced Range Instrumentation Aircraft (ARIA), from the 452nd Flight Test Squadron based at Edwards Air Force Base, California, performed their last tracking support for Lockheed Martin's Atlas launch vehicle on January 29, 1998.

The Air Force successfully launched the Lockheed Martin Atlas 2A rocket carrying a classified military payload from the Cape Canaveral Air Station, Florida, on January 29, 1998. The mission, designated AC-109, carried a secret spacecraft designed and built by the U.S. National Reconnaissance Office (NRO).

The Atlas vehicle left Cape Canaveral and headed straight up the U.S. east coast shoreline in a northeast direction as tracking stations in Bermuda, Virginia (Wallops Island), and New Hampshire monitored downlink telemetry from the booster's S-band system (2203.0 MHz, and 2206.0 MHz).

The vehicle continued climbing into a high inclination orbit and soon headed out-of-range of all tracking stations and was picked up by two ARIA aircraft. The two ARIAs, EC-135 aircraft (converted Boeing 707s), were positioned to monitor the deployment of the NRO satellite about 70 minutes and 16 seconds after launch. Orbital information for NRO or Department of Defense payload is classified, so you won't find any NORAD two-line elements for these types of flights.

In the future, Atlas tracking support will be performed by NASA's Tracking and Data Relay Satellite-1 (TDRS-1), or a tracking station located on Ascension Island in the Atlantic Ocean.

The ARIAs are a personal favorite of mine to monitor in the HF band. If you have an HF receiver with upper side band (USB) you can sometimes catch the ARIA's supporting satellite and missile launches from numerous sites around the world. Here are some of frequencies used by ARIA:

Pacific Missile Range HF Frequencies

Mode is upper side band (USB) and frequency in kHz.

3162 4486 4760 5700 5822 6820 6889 7705
9029 9212 10272 10352 10510 10660
10804 11510 13218 13756 13900 14987 15021
15763 15793 17428 19303 19640 20261 22760

Common callsigns heard in these HF nets include: Abnormal 10, Abnormal 20, ARIA 1, ARIA 2, and ARIA Control.

Update on NASA's Mir VHF Network

NASA's network of *Mir* VHF groundstations (Dryden Flight Research Center-DFRC, Wallops-WPS, and White Sands Complex-WSC) now provide "VHF-1" support to the *Mir* complex (139.208 MHz uplink/143.625 MHz downlink) and "VHF-2" support to the Soyuz spacecraft (130.167 MHz uplink/121.750 MHz downlink).

Mir VHF-1 Support

DFRC has two fully redundant systems (quad Yagi prime and dual Yagi backup). DFRC plans to replace the dual Yagi with a quad Yagi if the level of support justifies the upgrade. WPS installed a quad Yagi as their new prime system in June 1997. The original single Yagi has been retained for backup. The WSC system was installed in June 1997. WSC has a quad Yagi with dual equipment strings. WSC may be upgraded to add a second quad Yagi for backup if there is a requirement for full redundancy.

Soyuz VHF-2 support

All three stations implemented a capability to "only" monitor Soyuz downlink in June 1997. Stations do not have clearance to transmit on VHF-2, unless there is an emergency. DFRC has a quad Yagi prime with a single Yagi as backup. WPS and WSC have a single Yagi with no backup.

Currently WPS and WSC are scheduled to support *Mir* VHF communications for all passes above 5 degrees. WPS and WSC average between 12 to 14 passes daily (6 to 7 per station). DFRC is only scheduled on request from Mission Control Center-Moscow (MCC-M). All three stations support *Mir* passes even during crew sleep periods in case of an emergency. Future plans could see all three sites automated for remote operations to free up staff and resources for other projects.

TABLE ONE

Six Month Pass Summary (As of August 20, 1997)

	DFRC	WPS	WSC
March	35	69	N/A
April	11	45	N/A
May	40	57	N/A
June	41	102	35 (since 6/25/97)
July	63	206	134
August	10	118	84
Site Totals	200	597	253
Grand Total	1,050		

How many *Mir* passes do you monitor per month?

Change on 75 Meter AMSAT Net

After eight years of service as Net Control Station (NCS) of the East Coast 75 meter AMSAT net, Ron Long, W8GUS, is retiring to pursue other activities.

Ron has groomed his successor, Al Tribble, W3STW, well. Al has been serving as Assistant NCS for some time now. As a reminder, this net meets on or about 3.840 MHz each Tuesday evening at 9:00

Orbital Sciences Corporation (OSC) successfully launched their second Taurus launch vehicle on February 10, 1998, carrying the U.S. Navy's Geosat Follow-On (GFO) satellite along with two Orbcomm satellites.

p.m. Eastern time (0200 UTC). It is followed at 9:00 p.m. Central time (0300 UTC) by the Mid-America AMSAT Net, and at 9:00 p.m. Pacific time (0400 UTC) by the West Coast AMSAT Net.

New GEOSAT Follow-on Satellite Launched

Orbital Sciences Corporation (OSC) successfully launched their second Taurus launch vehicle on February 10, 1998, carrying the U.S. Navy's Geosat Follow-On (GFO) satellite along with two Orbcomm satellites. The launch took place at 5:20 a.m. Pacific time (1320 UTC) from Vandenberg Air Force Base (VAFB), California, launch pad 576E.

The 368-kg GFO satellite, built by Ball Aerospace & Technologies Corp. (BATC), will perform precision ocean altimetry by measuring variations in sea surface elevation which result from geotropic ocean currents. GFO has a design life of eight years, operating in a 779 x 790 km orbit inclined 108 degrees to the earth's equator.

The San Diego-based Space and Naval Warfare Systems Command (SPAWAR) Meteorological and Oceanographic Systems Program Office is responsible for the acquisition and launch of GFO. The first commands by NAVSOC, Laguna Peak, California, were successful and initial telemetry was received and being evaluated.

The three payloads started separating from the Taurus third stage about 14 minutes after launch, out-of-range from any ground stations. A playback of telemetry containing spacecraft separation data was to be downlinked to a ground station in McMurdo, Antarctica, about 30 minutes after launch, but "no RF signal was observed" on the 2288.5 MHz S-band downlink. Later, the U.S. military's North American Aerospace Defense Command (NORAD) confirmed separation of all three payloads from the Taurus vehicle. McMurdo's lack of acquisition is being investigated.

Mission Downlink Frequency Assignments

137-138.0 MHz	Orbcomm Telemetry
150.000 MHz	GFO Doppler Beacon
401.1 MHz	Orbcomm Doppler Beacon
450.0 MHz	GFO Doppler Beacon
2207.5 MHz	GFO Telemetry
2269.5 MHz	Taurus Telemetry
2288.5 MHz	Taurus Telemetry
5765.0 MHz	Taurus Tracking Transponder
13495.0 MHz	GFO Radar Altimeter

X-33 Range Operations Under Development

NASA's X-33 Technology Demonstrator remains on schedule for its first flight in March 1999 from Edwards Air Force Base, California. High-mach flights will end at Malmstrom Air Force Base, Montana, and low-mach flights will end at Michael Army Air Field, Utah. NASA's Dryden Flight Research Center at Edwards Air Force Base, California, will provide mission control, telemetry, uplink, and range safety operations. Telemetry downlink and command uplinks are redundant at all landing sites.

The plan is still to have three flights to Michael Army Air Field, Utah, and five flights to Malmstrom AFB. Reentry plasma RF signal attenuation is an issue; thus L-band support is still under investigation. The possibility of remote tracking sites at Michael Army Airfield is also being investigated.

Low-Mach Flights

Engine Cut-off	175 seconds
Downrange	100 miles
Altitude	165,000 ft (31 miles high)
Duration of Flight	14 minutes
Landing Site	Michael Army Air Field, Utah

High-Mach Flights

Engine Cut-off	195 seconds
Downrange	140 miles
Altitude	250,000 ft (47 miles high)
Duration of Flight	24 minutes
Landing Site	Malmstrom Air Force Base, MT

X-33 Test Frequency List
Edwards AFB, California

116.400	Automatic Terminal Information Service
120.700	Tower
121.800	Ground Control
123.325	ARIA Dispatch
141.100	Army Aviation
236.600	Tower
239.800	Metro
267.800	ARIA Dispatch
269.900	Automatic Terminal Information Service
304.000	Command Post
318.100	Tower
339.900	Army Aviation
341.600	Metro
372.200	Pilot-to-Dispatcher
390.100	Ground Control

Michael AAF (Dugway Proving Ground), Utah

36.100	Range Control
126.200	CTAF
134.100	Clover Control
248.200	Fire Sta
301.700	Clover Control

Malmstrom Air Force Base, Montana

121.800	Ground Control
124.500	Tower
239.800	Metro
252.900	Tower
269.900	Automatic Terminal Information Service
271.900	Helicopter Operations
275.800	Ground Control
311.000	Command Post
321.000	Command Post
372.200	Pilot-to-Dispatcher

And Finally ...

As mentioned earlier in the *ST Downlink* column, it was learned in early February that B.J. Arts-WT0N, known as BJ to all of his friends, passed away in his home town of Hibbing, Minnesota. BJ had been very active on the satellites and the VHF bands. He will be missed by all of his friends around the world.

This month's column is dedicated to the memory of our good friend B.J. Arts, WT0N.

NASA's X-33 Technology Demonstrator remains on schedule for its first flight in March 1999 from Edwards Air Force Base, California. High-mach flights will end at Malmstrom Air Force Base, Montana, and low-mach flights will end at Michael Army Air Field, Utah.

Satellite Listening Post Intercepts

All times are in UTC.

AM	Amplitude Modulation
APT	Automatic Picture Transmissions
ARIA	Advanced Range Instrumentation Aircraft
bps	Bytes per second
CPSK/PM	Coherent Phase Shift Keying/Phase Modulation
DoD	Department of Defense
FM	Frequency Modulation
FSK	Frequency Shift Keying
M	MHz
Mil	Military
NASA	National Aeronautics and Space Administration
Navsat	Navigation satellite
NFM	Narrowband FM
NOAA	National Oceanographic and Atmospheric Administration
NRO	National Reconnaissance Office
Ops	Operations
Pax	Passengers
PKT	Packet telemetry
RHCP	Right hand circular polarization
SDPSK	Skewed Differential Phase Shift Keying
UHF	Ultra High Frequency
USB	Upper Sideband

K6820.0 ARIA CONTROL, ARIA 1, ABNORMAL 10 heard preparing to track launch of Delta/Iridium mission number 7 at 1300 using USB mode. (Keith Stein-Woodbridge, VA)

M121.600 NASA 923 (T-38 aircraft, tail number N932NA) heard cleared to Ellington Field, TX, AM mode. (Sandy-Denver, CO)

M121.750 Astronaut Bonnie Dunbar heard aboard space shuttle *Endeavour* talking with Anatoli Solovyov on *Mir* during leak checks before opening the *Mir* hatch, between 2143-2147, NFM mode. (Roger Iveson-Hawes, North Yorkshire, England)

M123.125 NASA 921 (T-38 aircraft, tail number N921NA) on the ground doing some radio checks with NASA Flight Ops. JOSA 708 calling NASA Flight Ops at 1700. They were inbound to Ellington Field, TX, with 4 pax (Chris Parris-Conroe, TX)

M124.200 NASA 8 heard (Beech 200, tail number N8NA) landing at Washington National Airport, 2000, AM mode (Ronald Perron-Glen Burnie, MD)

M125.650 NASA 8 departed Washington National to Baltimore Washington International (BWI) at 1400, AM mode. M119.7 also heard . (Perron-MD)

M126.650 Weather 1, a LJ-35 aircraft, was in contact with Range Weather reporting a heavy cloud layer during launch countdown for Atlas/NRO mission, AM mode. (Al Stern-Satellite Beach, FL)

M136.640 1964-083D (965) Transit 5B5 satellite with a FSK sideband telemetry signal at 1448. This sideband is off the 136.650 MHz center frequency. (Van Horn-Brasstown, NC)

M137.620 1994-089A (23455) NOAA-14, afternoon pass at 1827 of its APT downlink. A coherent transmission was noted on its 137.770 MHz beacon frequency for a brief period of time. (Van Horn-NC)

M137.7075 1995-017A (23545) Orbcomm FM 1/OSC 1 with a continuous, high power SDPSK at 4800-bps signal at 1520 UTC. (Van Horn-NC)

M143.625 Pavel Vinogradov aboard *Mir* (1986-017A/16609) heard talking with Russian mission control between 2143-2147, NFM mode. (Iveson-England)

M145.800 Connected to the Russian *Mir* (1986-017A/16609) space station packet station (callsign R0MIR-1) at 2311, NFM mode. (Robert Bruno, FM5BW-Martinique)

M145.825 Amateur radio satellite DOVE (also known as DO-17/1990-005E/(20440) with a packet downlink at 1547, NFM mode. (Bruno-Martinique)

M149.940 1992-073A (22207) Cosmos 2218 (Russian mil navsat) with usual FSK/FM downlink, but also heard the unmodulated tracking beacon on 399.840 MHz. The 399.840 beacon was slightly weak in signal strength at 1527 UTC (orbit number 26226). (Van Horn-NC)

M149.970 1996-073A (24677) Cosmos 2336 (Russian mil navsat) with usual FSK/FM downlink at 1803 UTC (orbit number 5473). Also heard the coherent unmodulated carrier tracking beacon on M399.920. (Van Horn-NC)

M150.000 1995-002A (23463) Tsikada (Russian civilian navsat) with usual FSK/FM downlink at 1737. Also heard the coherent unmodulated carrier tracking beacon on M400.000. 1994-041A (23179) Nadezhda 4 (Russian civilian navsat) with usual FSK/FM downlink at 1837 UTC with the coherent unmodulated carrier tracking beacon on M400.000. (Van Horn-NC)

M235.400 NASA 920 (T-38 aircraft, tail number N902NA) calling inbound to NASA Maintenance about some minor problems with the aircraft. (Parris-TX)

M255.400 NASA 901 (T-38A aircraft tail number N901NA) heard activating flight plan from Ellington Field, TX, to Navy Pensacola, FL, at about 1440, AM mode. (Parris-TX). NASA 966 (T-38A aircraft) requesting weather for Fresno International. (Sandy-Denver, CO)

M259.700 Voice downlink heard from space shuttle *Endeavour* (mission STS-89) during launch and orbit 2, AM mode at 0255. (Stein-VA)

M263.625 DoD Cape, Tantum 1 Whiskey and King 4 supporting launch of space shuttle mission STS-89 on a UHF military satellite downlink, NFM mode. (Magnus Hammarstedt-Ostersund, Sweden)

M289.600 NASA 801 (C-21/BE-20 aircraft, tail number N801NA) heard landing, AM mode. May be from Dryden Flight Research Center (DFRC), CA, former astronaut Gordon Fullerton was the pilot. (Sandy-CO)

M296.700 NASA 706 (ER-2 aircraft) heard above 60,000 feet at 1826, AM mode. Also heard on M138.900 and M321.300 (Rick-Sacramento, CA)

M468.8250 1995-025A (23581) GOES (9) West time code, CPSK/PM Manchester coding format, 50 kHz bandwidth 100-bps signal, RHCP. Nice and strong on the Grove Scanner beam oriented west at 2015 UTC. This is a continuous downlink signal (Van Horn-NC)

M468.8375 1994-022A (23051) GOES (8) East time code, CPSK/PM Manchester coding format, 50 kHz bandwidth 100-bps signal using RHCP. Much weaker signal off the back of the beam, but same signal signature as 468.825. On the Grove Scanner beam oriented west at 2015 UTC. This is a continuous downlink signal. (Van Horn-NC)

G11.568 Shuttle/Mir docking "live" on NASA Select via Reuters digital transponder on Intelsat-K at 21.5 degrees west. (Iveson-England)

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INTRODUCTION

The Satellite Services Guide (SSG) is designed to keep the satellite listening enthusiasts up to date with the latest information available on a wide variety of hard-to-obtain space and satellite information. Many hours of personal observations and contributor reports have been compiled into this section. Errors are bound to happen, especially since services and elements sets change often, and geostationary satellites constantly change orbital positions. Care has been taken to check the accuracy of the information presented and it does represent the most current information available at press deadline.

How to Use the Satellite Service Guide

The various sections of the SSG include:

1. **Satellite Radio Guide** — This is a listing of audio subcarrier services that can be heard with a standard C-band (3.7 - 4.2 GHz) and in some cases a Ku-band (11.7-12.2 GHz) TVRO satellite system (no additional equipment is required). Services are broken down into various categories and provide the user with the satellite/transponder number and frequencies in megahertz of the various audio channels. These audio subcarriers are broadcasting on active TV channels that are either scrambled or not scrambled. You do not need a subscription for any of the radio services listed. Tuning in to an audio subcarrier will disrupt the TV sound, but not the TV picture. Listings with a 'N' are narrow bandwidth, 'DS' indicates discrete stereo.

2. **Single Channel Per Carrier (SCPC) Services Guide** — A SCPC transmitted signal is transmitted with its own carrier, thus eliminating the need for a video carrier to be present. Dozens of SCPC signals can be transmitted on a single transponder. In addition to a standard TVRO satellite system, an additional receiver is required to receive SCPC signals. Most SCPC signals will be found in the C-band.

3. **Satellite Transponder Guide** — This guide lists video services recently seen from satellites transmitting in C-band located in the U.S. domestic geostationary satellite arc. A standard TVRO satellite system is required to view these services. White boxes indicated video services in the clear or non-video services. Gray shaded boxes indicated video services that are scrambled using the VideoCipher 2+ encryption system and are only available via subscription. Black boxes are video services that are scrambled using various other types of encryption schemes and are not available in the U.S. Transponders that are encrypted have the type of encryption in use listed between the brackets (i.e. - [Leitch]). O/V indicates that wild feeds, network feeds and other random video events have been monitored on that transponder. (none) means that no activity of any kind has been observed on the transponder indicated.

4. **Ku-band Satellite Transponder Services Guide** — This section of the SSG performs the same service as the C-band Satellite Transponder Guide listed above, but covers signals found in the Ku-band from 11.7 to 12. 2 GHz.

5. **Amateur and Weather Satellite Two Line Orbital Element Sets** — This section of the guide presents the current (as of press deadline) two line orbital element sets for all of the active amateur and weather satellites. These element sets are be used by computerized orbital tracking programs to track the various satellites listed.

6. **Geostationary Satellite Locator Guide** — This guide shows the space catalog object number, International payload designator, common name, location in degrees east/west and type of satellite/frequency bands of downlinks for all active geostationary satellites in geostationary orbit at publication deadline.

7. **Amateur Satellite Frequency Guide** — This guide lists the various amateur radio satellites (hamsats) and their frequency bandplans. Most of the communications you will hear on these satellites will utilize narrow bandwidth modes of operation (i.e- upper and lower sideband, packet, RTTY, morse code). *Satellite Times* would like to thank the officers and staff of AMSAT for this use of this chart in the magazine.

8. **Satellite Launch Schedules** — This section presents the launch schedules and proposed operating frequencies of satellites that will be launched during the cover date of this issue of the magazine.

Satellite Radio Guide

By Robert Smathers and Larry Van Horn

AUDIO SUBCARRIERS

An audio sub-carrier requires the presence of a video carrier to exist. If you take away the video carrier, the audio sub-carrier disappears as well. Most TVRO satellite receivers can tune in audio subcarriers and they can be found in the range from 5.0 to 9.0 MHz in the video carrier.

Audio frequencies in MHz, All satellites/transponders are C-band unless otherwise indicated. DS=Discrete Stereo, N=Narrowband, W=Wideband

Classical Music

SuperAudio—Classical Collections	G5, 21	6.30/6.48 (DS)
WFMT-FM (98.7) Chicago, IL—Fine Arts	G5, 7	6.30/6.48 (DS)
WQXR-FM (96.3) New York, NY	S4, 14	6.20/6.80 (DS)

Satellite Computer Services

Planet Connect, Planet Systems, Inc 19.2 kbps svc,	G4, 6	7.398
Skylink, Planet Systems, Inc	G4, 6	7.264
Superguide	G5, 7	5.48

Contemporary Music

DWRR-FM (101.9) from the Philippines	G4,24 (Ku)	6.80
SuperAudio—*Light and Lively Rock*	G5, 21	5.96, 6.12 (DS)
WPHZ-FM (96.9) Bremen (South Bend market), IN	G4, 15	6.48, 7.30 (DS)

Country Music

SuperAudio—*American Country Favorites*	G5, 21	5.04/7.74 (DS)
WOKI-FM (100.3) Oak Ridge-Knoxville, TN., ID-*The Hit Kicker*	G6, 7	6.20
WSM-AM (650) Nashville, TN	C4, 24	7.38, 7.56

Easy Listening Music

Easy Listening Music (English)	T5, 14	6.80
Easy Listening Music (French)	T5, 14	6.20
IAM Radio-easy listening music	G4, 6	7.69
SuperAudio—*Soft Sounds*	G5, 21	5.58/5.76 (DS)
FCC mandated safe-harbor program audio-easy listening music	G3R, 9	6.80
	G5,2	6.80
United Video—easy listening music	C4, 8	5.895 (N)

Foreign Language Programming

Antenna Radio (Greek)	S4, 14	7.80
Apna Sangeet Radio India	GE1, 16	7.38
Arab Network of America radio network	GE2, 22	5.80
DZMM-AM (630), from the Philippines	G4, 24 (Ku)	6.20
La Cadena CNN Radio Noticias (CNN Radio News in Span.)	G5,17	7.56
KAZN-AM (1300) Pasadena, CA—Asian Radio	GE1, 22 (Ku)	6.20
Radio Maria (Italian)—religious programming	G7, 10	5.80
Radio Maria	G7, 10	8.03
Radio Tropical	GE1, 4	7.60
SRC AM Network	E2, 1	7.38
SRC FM Network	E2, 1	5.41/5.58 (DS)
Unidentified station-foreign language	GE-1,22 (Ku)	5.80
WCRP-FM (88.1) Guyama, PR (Spanish)—religious	G4, 6	6.53
XEWA-AM (540) San Luis Potosi, Mexico (Spanish)	M2, 8	7.38
XEW-AM (900) Mexico City, DF Mexico (Spanish), ID-*La Voz de la America Latina*—contemporary music	M2, 14	7.38

Jazz Music

KLON-FM (88.1) Long Beach, CA., ID-*Jazz-88*	G5, 2	5.58/5.76 (DS)
Superaudio—*New Age of Jazz*	G5, 21	7.38/7.56 (DS)
WLVE-FM (93.9) Miami Beach, FL., ID-*Smooth-Jazz-Love-94*	S4, 12	6.20/6.80
(Present as audio for Hero Teleport slate)		

News and Information Programming

Broadcast News	E2, 1	5.78
Business Radio Network	C4, 10	8.06 (N)
Cable Radio Network	G5, 2	7.24 (N)
	C1, 21	7.30
CNN Headline News	G5, 22	7.58
CNN Radio News	GE3, 9	5.62
	G5, 5	7.58
	G5, 22	6.30
USA Radio Network—news, talk and information	GE3, 13	5.01 (ch 1), 5.20 (ch 2)
Virginia News Svc/WBVS-AM (670) Clairemont, VA	G5,11	5.94
WCBS-AM (880) New York, NY—news	G7, 19	7.38
WCCO-AM (830) Minneapolis, MN	G6, 15	6.20

Religious Programming

Ambassasor Inspirational Radio	GE3, 15	5.96, 6.48
Brother Staire Radio	G5, 6	6.48
KHCB-FM (105.7) Houston, TX	C1, 10	7.28
Salem Radio Network	GE3,17	5.01
Trinity Broadcasting radio service	G5, 3	5.58/5.78 (DS)
WHME-FM (103.1) South Bend, IN, ID-*Harvest FM*	G4, 15	5.58/5.78
WHVN-AM (1240) Charlotte, NC	G1R, 17	7.92
WROL-AM (950) Boston, MA (occasional Spanish)	GE3, 3	6.20
Z-music—Christian rock	G1R, 6	7.38/7.56

Rock Music

SuperAudio—*Classic Hits*-oldies	G5, 21	8.10/8.30 (DS)
SuperAudio—*Prime Demo*-mellow rock	G5, 21	5.22/5.40 (DS)
WCNJ-FM (89.3) Hazlet, NJ/Skylark Radio network—Oldies	GE1, 6	5.80

Shortwave Broadcasters via Satellite

C-SPAN Audio 1: Various shortwave broadcasters	C3, 7	5.20
C-SPAN Audio 2: British Broadcasting Corp. (BBC)	C3, 7	5.41
Deutsche Welle	GE1, 22	7.38, 7.56, 7.74, 7.92
Radio Dubai United Arab Emirates (Arabic)	G7, 10	7.48
RAI Satelradio Italy (Italian)	G7, 14	7.38
WEWN-Worldwide Catholic Radio, Vandiver, AL	G1R, 11	5.40 (English), 5.58 (Spanish)
WHRI Americas–World Harvest Radio, South Bend, IN	G4, 15	7.46
WHRI Europe, Africa, Middle East–World Harvest R., South Bend, IN	G4, 15	7.55
KWHR Asia–World Harvest Radio, South Bend, IN	G4, 15	7.64
KWHR South Pacific–World Harvest Radio, South Bend, IN	G4, 15	7.73
World Radio Network: WRN1 North America	G5, 6	6.80
World Radio Network: WRN2 North America	G5, 6	6.20 (Multi-lingual)

Sports

Prime Sports Radio—sports talk and information	GE3, 24	5.80

Speciality Formats

Aries In Touch Reading Service	C4,10	7.87
California State Legislature audio	S4, 24	6.80
Colorado Talking Book Network	C1,3	5.60
SuperAudio—Big Bands (Sun 0200-0600 UTC)	G5, 21	5.58/5.76 (DS)
Weather Channel—background music	C3, 13	7.78
Wisdom Radio Network	GE1, 12	7.10
Yesterday USA—nostalgia radio	G5, 7	6.80
	G1R, 24	7.38

Talk Programming

American Freedom radio network	GE1, 7	5.80
Amerinet Broadcasting	G1R, 17	5.58
For the People radio network	C1, 6	7.50
Friday Night Live (Friday 9 p.m.ET)	SBS6, 13B (Ku-band)	6.20
Omega Radio Network	GE1, 6	7.56
Orbit 7 Radio Network	C1, 14	7.48
Radio America Network	C1, 2	5.58
Republic Radio International	G7, 14	7.70
Talk America Radio Network #1—talk programs	GE3, 9	6.80
Talk America Radio Network #2—talk programs	GE3, 9	5.41
Truth Radio	GE1, 7	7.56
TVRO.NET (featuring Keith Lamonica)	S4, 16	5.80
United Broadcasting Network	C1, 2	7.50
WOKIE Network—tech talk	SBS6, 13B (Ku)	6.20 (network is active when Megabingo is present)
WWTN-FM (99.7) Manchester, TN—news and talk	G5, 18	7.38, 7.56

Variety Programming

CBM-AM (940) Montreal, PQ Canada—variety/fine arts	E2, 1	6.12
KBVA-FM (106.5) Bella Vista, AR., ID-*Variety 106.5*	G4, 6	5.58/5.76 (DS)
KSL-AM (1160) Salt Lake City, UT—news/talk/country (*Road Gang*-overnight)/BYU Sports	C1, 6	5.58
West Virginia Public Radio	GE1, 12	7.78
WUSF-FM (89.7) Tampa-St. Petersburg, FL (Public Radio), ID-*Concert 90*	C4, 10	8.26 (N)
WWRL-AM (1600) New York, NY–American Urban Radio Network	GE3, 9	6.30/6.48 (DS)

Satellite Radio Guide/SCPC Services Guide

FM SQUARED (FM²) AUDIO SERVICES

Another type of satellite audio carrier is known as FM Squared. FM Squared signalsdo not require a video carrier to exist. These signals are similar to audio subcarriers as we know it except that they are normally located below the 5.00 MHz audio subcarrier frequency that a normal satellite receivers can tune to. The new Universal SC-50 can tune these frequencies and was used to update this section.

GE-3 Transponder 13 (C-band)
Ambassador Inspirational Radio
1.410, 4.470 and 4.650 MHz
Blank audio carriers
1.050 and 3.570 MHz
Focus on the Family
1.230 MHz
Information Radio Network
3.390 MHz
International Broadcasting Network (IBN)
4.830 MHz
USA Radio Network
5.010 (ch 1) and 5.200 MHz (ch 2)
Various Religious Programs (no common ministry)
.330 and 3.750 MHz
VCY/America (channel 1)
.510 MHz
VCY/America (channel 2)
.780 MHz

GE-3 Transponder 17 (C-band)
Blank audio carriers
1.770 and 3.570 MHz
Data Transmission
.800 MHz
Focus on the Family
1.050 and 1.400 MHz
In-Touch—religious
4.470 MHz
Salem Satellite Network
4.650, 4.840 and 5.010 MHz
SRN News
.330 MHz
KDMM-AM (1150) Highland Park, TX–Indian, Vietnamese and Chinese multi-ethnic format
1.280 MHz

Galaxy 4 Transponder 3 (Ku-band)
Blank Audio Carriers
1.000, 2.060, 3.250, 3.620, 4.200 and 4.450 MHz
Data transmissions
2.950, 3.070 and 3.190 MHz
AP Network News
3.530 MHz
In-Store audio network ads (various companies)
.710, .810, .910, 1.150, 1.260, 3.440, 3.700, 3.800, 3.880 and 3.970 MHz
Muzak Services
.150, .270, .390, .510, 1.360, 1.480, 1.600, 1.720, 1.840, 1.960, 2.190, 2.310, 2.440, 2.560, 2.680, 2.800, 3.340, 4.080, 4.200 and 4.340 MHz

Galaxy 4 Transponder 4 (Ku-band)
Blank Audio Carriers
.960 and 1.350 MHz
Data Transmissions
.255, .300, .350, .470, .575, .650, .710, .740, .765, .845, .890, .930, 1.120, and 1.225 MHz

Galaxy 4 Transponder 16 (Ku-band)
Blank audio carriers
2.280 MHz
Data transmissions
.645, 2.140, 2.350, 2.730, 3.205, 3.245, 3.265, 3.475, 3.735 and 3.970 MHz
In-Store audio networks
.150, .270, .390, .755, .870, .990, 1.110, 1.230, 1.350, 1.470, 1.590, 1.710, 1.965 and 2.070 MHz

Anik E1 Transponder 6 (Ku-band)
Nova Network FM Squared Services

FM CUBED (FM³) AUDIO SERVICES

This audio is digital in nature and home dish owners have not been able to receive it by normal decoding methods yet. The only satellite that FM Cubed transmissions have been discovered on so far is Galaxy 4, transponder 4. WEFAX transmissions and Accu-Weather (for subscribing stations) are transmitted on this transponder.

Single Channel Per Carrier (SCPC) Services Guide

By Robert Smathers

The frequency in the first column is the 1st IF or LNB frequency and the second column frequency (in parentheses) is the 2nd IF for the SCPC listing. Both frequencies are in MHz.

GE-2 Transponder-Horizontal 12 (C-band)

1204.90 (75.1)	*Radio Marti*—U.S. Information Agency Spanish language radio service to Cuba

GE-2 Transponder-Vertical 13 (C-band)

1178.70 (81.3)	NASA space shuttle audio

GE-3 Transponder-Horizontal 13 (C-band)

1207.90 (52.1)	Wisconsin Voice of Christian Youth (VCY) America Radio Network—religious programming
1204.45 (55.55)	KJAV-FM (104.9) Alamo, Tex—Spanish language religious programming/ *Nuevo Radio Christiana Network*
1204.25 (55.75)	Wisconsin Voice of Christian Youth (VCY) America Radio Network—religious programming
1204.00 (56.0)	SRN (Salem Radio Network) News
1201.50 (58.5)	Wisconsin Voice of Christian Youth (VCY) America Radio Network—religious programming
1201.30 (58.7)	Wisconsin Voice of Christian Youth (VCY) America Radio Network—religious programming

Galaxy 4 Transponder 1-Horizontal (C-band)

1443.80 (56.2)	Voice of Free China (International Shortwave Broacaster) Taipei, Taiwan
1443.60 (56.4)	KBLA-AM (1580) Santa Monica, CA—*Radio Korea*
1443.40 (56.6)	Voice of Free China (International Shortwave Broadcaster) Taipei, Taiwan
1438.30 (61.7)	WWRV-AM (1330) New York, NY—Spanish religious programming and music, ID - *Radio Vision Christiana de Internacional*
1436.50 (63.5)	West Virginia Metro News—network news feeds

Galaxy 4 Transponder 3-Horizontal (C-band)

1405.00 (55.0)	Illinois News Network—network news feeds/Chicago Blackhawks NHL radio network
1404.80 (55.2)	KOA-AM (850)/KTLK-AM (760) Denver, Colo—news and talk radio/University of Colorado sports
1404.60 (55.4)	WGN-AM (720) Chicago, IL—news and talk radio/Northwestern University sports
1404.40 (55.6)	Illinois News Network—network news feeds/Chicago Bulls NBA radio network
1404.20 (55.8)	Tribune Radio Networks/Wisconsin Radio Network
1402.70 (57.3)	WLAC-AM (1510) Nashville, TN—news and talk/*Road Gang* trucker program (overnight) Tennessee sports
1402.00 (58.0)	Occasional Audio
1401.80 (58.2)	Michigan News Network—network news feeds/Central Michigan sports
1401.50 (58.5)	Occasional audio/Agrinet—Agriculture news/USA Radio Network—network feeds
1399.60 (60.4)	Talk America Radio Network 1—talk radio
1399.20 (60.8)	Talk America Radio Network 2—talk radio
1399.00 (61.0)	Sports Byline USA/Sports Byline Weekend/ *On Computers* radio show
1398.80 (61.2)	United Broadcasting radio network—talk radio

(Continued on Page 38)

Single Channel Per Carrier (SCPC) Services Guide

By Robert Smathers

(Continued from Page 37)

1398.50 (61.5)	Occasional audio
1398.30 (61.7)	WJZK-FM (104.1) La Grange, GA—smooth jazz format
1398.00 (62.0)	Occasional audio
1397.80 (62.2)	Occasional audio/Colorado Avalanche NHL radio network
1397.50 (62.5)	Minnesota Talking Book Radio Network-reading service for the blind
1397.30 (62.7)	Clemson sports
1397.10 (62.9)	WTMJ-AM (620) Milwaukee, WI - talk radio/Wisconsin Radio Network—network news feeds/University of Wisconsin sports
1396.90 (63.1)	Occasional audio/KRLD-AM (1080) Dallas, TX—news/talk (occasional)
1396.70 (63.3)	Radio America/American Entertainment Network
1396.40 (63.4)	Georgia Network News (GNN)—network news feeds
1396.20 (63.8)	WCNN-AM (680) Atlanta, GA—all sports talk radio/Georgia Tech sports
1396.00 (64.0)	WHO-AM (1040) Des Moines, IA—talk radio/Iowa News Network—network news feeds/Iowa sports
1395.80 (64.2)	WTMJ-AM (620) Milwaukee, WI - talk radio/Wisconsin Radio Network—network news feeds/University of Wisconsin sports
1395.60 (64.4)	WGST-AM/FM (640/105.7) Atlanta, GA ID *Planet Radio*—news and talk radio
1395.40 (64.6)	Michigan News Network—network news feeds
1395.00 (65.0)	Occasional audio
1394.70 (65.3)	WJR-AM (760) Detroit, MI—news and talk radio/Michigan News Network—network news feeds
1394.50 (65.5)	XEPRS-AM (1090) Tijuana, Mexico—Spanish language programming
1394.30 (65.7)	Michigan News Network/Michigan State sports
1384.40 (75.6)	KOA-AM (850)/KTLK-AM (760) Denver, CO—news and talk radio/University of Colorado sports
1384.20 (75.8)	WSB-AM (750) Atlanta, GA—news and talk radio/Georgia sports/Atlanta Hawks NBA radio network
1383.70 (76.3)	Motor Racing Network (occasional audio) NASCAR racing
1383.40 (76.6)	Occasional audio
1383.10 (76.9)	KIRO-AM (710) Seattle, WA—news and talk radio
1382.90 (77.1)	Michigan News Network—network news feeds/Detroit Pistons NBA radio network
1382.60 (77.4)	Soldiers Radio Satellite (SRS) network—U.S. Army information and entertainment radio
1382.00 (78.0)	Tennessee Radio Network—network news feeds/Morehead State College sports
1381.80 (78.2)	WHO-AM (1040) Des Moines, IA - news and talk radio/Iowa News Network—network news feeds/Iowa sports
1381.60 (78.4)	KEX-AM (1190) Portland, OR—news and talk radio/Portland Trailblazers NBA radio network
1381.40 (78.6)	Occasional audio
1381.20 (78.8)	KJR-AM (950) Seattle, WA - sports talk radio/Washington State sports
1377.10 (82.9)	In-Touch—reading service for the blind
1376.00 (84.0)	Kansas Audio Reader Network—reading service for the blind
1375.40 (84.6)	USA Radio Network/Agrinet Agriculture news service

Galaxy 4 Transponder 4-Vertical (C-band)

1376.00 (64.0)	Data Transmissions

Galaxy 4 Transponder 6-Vertical (C-band)

1346.90 (53.1)	WCRP-FM (88.1) Guayama, PR—Spanish language religious programming

Anik E2 Transponder 1-Horizontal (C-band)

1446.00 (54.0)	Canadian Broadcasting Corporation (CBC) Radio—North (Quebec) service

Anik E2 Transponder 7-Horizontal (C-band)

1326.00 (54.0)	Canadian Broadcasting Corporation (CBC) Radio—North (Eastern Arctic) service

Anik E2 Transponder 13-Horizontal (C-band)

1206.00 (54.0)	Canadian Broadcasting Corporation (CBC) Radio—North (MacKenzie) service
1205.00 (54.5)	Canadian Broadcasting Corporation (CBS) Radio—Occasional feeds/events

Anik E2 Transponder 17-Horizontal (C-band)

1126.00 (54.0)	Canadian Broadcasting Corporation (CBC) Radio—North (Western Arctic) service
1125.50 (54.5)	Canadian Broadcasting Corporation (CBC) Radio—North (Newfoundland and Labrador) service

Anik E2 Transponder 23-Horizontal (C-band)

1006.00 (54.0)	Societe Radio-Canada (SRC) Radio–AM Network
1005.50 (54.5)	Canadian Broadcasting Corporation (CBC) Radio-North (Yukon) service

Anik E1 Transponder 21-Horizontal (C-band)

1036.70 (63.3)	In-store music
1037.00 (63.0)	In-store music
1037.50 (62.5)	In-store music

SBS5 Transponder 2-Horizontal (Ku-band)

1013.60 (80.4)	Wal-Mart in-store network (English)
1013.20 (80.8)	Wal-Mart in-store network (English)
1012.80 (81.2)	Sam's Wholesale Club in-store network (English)
1004.00 (90.0)	Wal-Mart in-store network (English)
1003.60 (90.4)	Wal-Mart in-store network (English and Spanish ads)
1003.20 (90.8)	Sam's Wholesale Club in-store network (English)
1002.80 (91.2)	Wal-Mart In-Store Network (English)

SBS5 Transponder 12-Vertical (Ku-band)

1095.00 (91.0)	Russian-American Radio Network

RCA C5 Transponder 3-Vertical (C-band)

1404.80 (55.2)	RFD Radio Service
1404.60 (55.4)	Wyoming News Network—network news feeds/Wyoming sports
1400.60 (59.4)	Learfield Communications/Indiana sports
1400.40 (59.6)	Learfield Communications/Missouri Net
1400.20 (59.8)	Occasional audio/Data transmissions
1400.00 (60.0)	Learfield Communications/Purdue sports
1396.60 (63.4)	Kansas Information Network/Kansas Agnet—network news feeds
1396.20 (63.8)	Missouri Network
1396.00 (64.0)	Occasional audio/Red River Farm Network
1395.70 (64.3)	Missouri Net/WIBW-AM (580) Topeka, KS—country music/Wichita State sports
1386.40 (73.6)	Learfield Communications
1386.20 (73.8)	Radio Iowa/Iowa sports
1386.00 (74.0)	United broadcasting Network—talk radio
1384.60 (75.4)	Capitol Radio Network/North Carolina State sports
1384.00 (76.0)	Occasional audio/ABC Direction Network—network news feeds
1383.80 (76.2)	Occasional audio/Iowa sports
1383.40 (76.6)	Capitol Radio Network
1382.90 (77.1)	Missourinet/Missouri sports
1382.50 (77.5)	Virginia News Network—network news feeds
1382.10 (77.9)	Learfield Communications/Missourinet

Ku-band Satellite Transponder Services Guide

By Robert Smathers

H = Horizontal polarization, V = Vertical polarization, Occ video = Occasional Video, [ ] = Type of encryption or video compression

SBS 6 (SBS6) 74° West

1	11717-H	Data transmissions/FamilyNet [digicipher]
2	11749.5-V	FOX SNG feeds/Occ video
3	11774-H	MSNBC feeds/Occ video
4	11798.5-V	Occ video
5	11823-H	Occ video
6	11847.5-V	Unknown user [digital video]
7	11872-H	Occ video
8	11896.5-V	Occ video
9	11921-H	Occ video
10	11945.5-V	Occ video/CONUS Communications (occ)/CONUS [digital video] (upper half)
11	11963-H	CONUS Communications (half transponders)
12	11994.5-V	CONUS Communications (half-transponders)
13	12019-H	CONUS Communications (half transponders)
14	12043.5-V	Occ video
15	12075-H	Occ video
16	12092.5-V	Occ video
17	12110-H	Unknown user [digital video]
18	12141.5-V	Occ video/CNN Newsbeam (occ)
19	12174-H	CNN Newsbeam (occ)

SBS 4 (SBS4) 77° West (Inclined orbit)

Transponders 2-10 on this satellite are used for NBC feeds.

1	11725-H	Data transmissions

Satcom K2 (K2) 82° West

1	11729-H	Data transmissions
15	12142-H	GE Americom K2 ID slate

Spacenet 3R (S3R) 83° West

19	11740-H	Unknown user [digital video]
22	11980-H	NY Network (occ)/SUNY (occ)
23	12060-H	Oregon Educational Network (occ)

GE-2 (GE2) 85° West

Primestar direct-to-home programming uses trasponders 1-24 (11.7-12.2 GHz FSS band). These transmissions are encrypted and compressed using the Digicipher system.

GE-3 (GE3) 87° West

1	11720-H	Data transmissions
2	11740-V	Data Transmissions
3	11760-H	Occ video
4	11780-V	Occ video
5	11800-H	Unknown User [digital video]/ Data transmissions
6	11820-V	Data Transmissions
9	11880-H	CNN Newsource [LEITCH]
10	11900-V	National Technology University (NTU) [Spectrumsaver]
11	11920-H	Data transmissions
13	11960-H	Occ video
14	11980-V	CNN Newsource (secondary feeds) (occ)
18	12060-V	PBS leased digital services (High Definition TV testing)
19	12080-H	PBS leased analog services (occ) /The Business Channel (occ)
20	12100-V	PBS adult learning service (ALS)
21	12120-H	PBS leased analog services (occ)
22	12140-V	PBS leased digital services/ Indiana Higher Education [Spectrumsaver]
23	12160-H	PBS stations/regionals 1, 2 and 3 [Digicipher 2 SCPC]
24	12180-H	PBS six-channel affiliate feeds [Digicipher 2] [4DTV]

Telstar 4 (T4) 89°West

1	11730-V	Loral Skynet services [digital]
2	11743-H	Loral Skynet services [digital]
3	11790-V	Loral Skynet services [digital]
4	11803-H	Loral Skynet services [digital]
5	11850-V	Loral Skynet services [digital]
6	11863-H	Georgia Public TV [4DTV]
7	11910-V	Data transmissions/Unknown user [digital video]
8	11923-H	Data transmissions
9	11971-V	Occ video (half-transponders common)
10	11984-H	Occ video (half-transponders common)
11	12033-V	South Carolina Educational TV [4DTV]
12	12046-H	Occ video (half-transponders common)
13	12095-V	Occ video (half-transponders common)
14	12108-H	Louisiana Public TV [Digicipher]/LeHigh University [Spetrumsaver]
15	12157-V	DMX for Business [digital data]/ Muslim TV Ahmadiyya (Powervu)
16	12170-H	Unknown User [digital video]

Galaxy 7 (K7) 91° West

TCI Headend in the Sky [digicipher] uses transponders 1, 4, 6-7, 9-10, 12-13, 15, 19, and 21-22. Using a 4DTV receiver, an unidentified digital audio service (40 channels: 820-859) has been observed on this satellite.

2	11750-H	Data transmissions/Unknown User [digital video]
5	11810-H	Data transmissions
8	11870-H	Data transmissions
11	11930-H	Wescott Communications? [Spectrumsaver]
14	11990-H	Occ video (half transponders common)
16	12020-V	Occ video
17	12050-H	Westcott Communications [Spectrumsaver] (lower half transponder)
17	12050-H	Westcott Communications ASTN [B-MAC]/National Weather Networks (upper half transponder occasional)
18	12050-V	Westcott Communications [Spectrumsaver]
20	12110-H	Data transmissions
23	12170-H	Data transmissions
24	12170-V	Data transmissions/Unknown User [digital video]

Galaxy 3R (G3R) 95° West

Ku-band (11.7-12.2 GHz) side of this satellite is used entirely for the Galaxy Latin American direct-to-home system.

Telstar 5 (T5) 97° West

1	11728.5-V	Data transmissions
2	11735.0-H	Data transmissions
3	11789.5-V	Occ video (half transponders common)
4	11796.0-H	Data transmissions
5	11836.0-V	Unknown User [digital video]
7	11867.0-V	Unknown User [digital video]
8	11873.5-H	Unknown User [digital video]
9	11898.0-V	Occ video
10	11904.5-H	Unknown User [digital video]
11	11929.0-V	Occ video
12	11935.5-H	Occ video
13	11960.0-V	Occ video
15	11991.0-V	Unknown User [digital video]
16	11997.5-H	Unknown User [digital video]
17	12022.0-V	Occ video
18	12028.5-H	Occ video
19	12053.0-V	Occ video
20	12059.5-H	Occ video
21	12084.0-V	Unknown User [digital video]
23	12115.0-V	Unknown User [digital video]
24	12121.5-V	Occ video
25	12148.0-V	Occ video
26	12152.5-H	T.C.I. [Digicipher]
27	12177.0-V	Asian TV Network/Business TV [MPEG2/DVB]

Galaxy 4 (K4) 99° West

1	11720-H	Data transmissions
2	11750-V	Data transmissions
3	11750-H	FM² services/Muzak/Data transmissions
4	11780-H	FM²/FM³ services/Planet Connect computer service (19.2 kbps)/Other data transmissions
5	11810-V	Data transmissions
6	11810-H	Unknown user [digital video]
7	11840-H	Unknown user [digital video]
8	11870-V	Data transmissions
9	11870-H	Data transmissions
10	11900-H	CNN Airport Network [Powervu]/Data transmissions
11	11930-V	Occ video (half-transponders common)/The Asian Network (TAN) (occ)
12	11930-H	Occ video
13	11960-H	CCTV-4 (China)
14	11990-V	Data transmissions
15	11990-H	Fordstar [Digicipher 2]
16	12020-H	FM² services
17	12050-V	CBS Newsnet and affiliate feeds (half-transponders)–mixture of digital SNG and analog feeds
18	12050-H	Honk Kong TVB Jade Channel (Chinese) [videocrypt]
19	12080-H	DirectPC [digital]
20	12110-V	Data transmissions
21	12110-H	Bob Jones University home education (occ)/Occ video
22	12140-H	Data transmissions
23	12170-V	CBS Newsnet and affiliate feeds (half-transponders)–mixture of digital SNG and analog feeds
24	12170-H	The Filipino Channel [Oak]

Spacenet 4 (S4) 101° West

Transponders 19 (11740-H), 21 (11900-H), and 23 (12060-H) have failed on this satellite.

20	11820-H	Data transmissions
22	11980-H	Data transmissions
24	12140-H	E.M.G. courses [Digital video] (upper half)

DBS-1 101.2° W/DBS-2 & DBS-3 100.8° W

These satellites provide direct-to-home entertainment and operate in the 12.2-12.7 GHz BSS range.

GE-1 (GE1) 103° West

1	11720-H	Qualcomm data [digital]
2	11740-V	Data transmissions
3	11760-H	NBC Eastern Time Zone programming
4	11780-V	Data transmissions
6	11820-V	Empire Sports [Wegener digital]/Kentucky Educational TV (KET) [Digicipher]
7	11840-H	NBC Pacific Time Zone programming
8	11860-V	Qualcomm data [digital]
9	11880-H	NBC Mountain Time Zone programming
10	11900-V	Qualcomm data [digital]
12	11940-V	Microspace Velocity [digital]/ Serbian TV/TV Polonia
13	11960-H	NSN data transmissions [digital]
14	11980-V	Qualcomm data [digital]
15	12000-H	NBC Contract Channel
16	12020-V	DirectPC [digital]
17	12040-H	NBC Contract Channel
18	12060-V	Starnet [Digicipher]
19	12080-H	NBC Newschannel [Wegener digital]
20	12100-V	Vyvx TV Commmercials distribution [Digicipher]/Occ video
21	12120-H	NBC/MSNBC/CNBC/NBC NewsChannel SNG feeds [Wegner digital]
22	12140-V	Chinese Communications Channel (CCC) [Oak]
23	12160-H	NBC Newschannel SNG/NBC Contract Channel –mixture of Wegener digital SNG and analog feeds
24	12180-H	Fed Ex TV [BMAC]/Occ video

GSTAR-4 (GST4) 105° West

1	11730-H	Data transmissions
2	11791-H	Data transmissions
3	11852-H	Occ video
4	11913-H	Data transmissions
5	11974-H	Occ video/Court TV Backhauls (occ video)
6	12035-H	CBS NewsNet SNG feeds
7	12096-H	CNN Newsbeam/Occ video
8	12157-H	CNN Newsbeam (occ vdieo)/ CNN Newsource International
9	11744-V	Data transmissions
10	11805-V	Data transmissions
11	11866-V	ABSAT (ABC) SNG feeds
12	11927-V	Data transmissions
13	11988-V	CNN Newsbeam/occ video
14	12049-V	Data transmissions/Unknown user [digital video]
15	12110-V	CNN Newsbeam/occ video
16	12171-V	Data transmissions/Unknown users [digital video]

Anik E2 (A1) 107.3° West

Expressvu DBS service uses transponders 1, 2, 11, 13-14, 22-26, and 31-32. Star Choice DBS service uses transponders 9-10, 16 and 27-29.

3	11778-V	CanCom [digital video]
4	11804-V	Shaw [digital video]
5	11839-V	Canadian Parliamentary Access Channel, Youth TV E&W, Vision TV, CHSC Shopping [digital video]
6	11865-V	Moviepix!; The Movie Network [digital video]
7	11900-V	Rogers Network [digital video]
8	11926-V	Rogers Network [digital video]
12	12048-V	Saskatchewan CommunicaNetwork [digital]
15	12144-V	Telesat Canada stationkeeping (GLACS)
17	11730-H	Bravo Canada, MuchMusic Canada [digital video]
18	11756-H	Discovery Channel Canada/Life Network/The Sports Network/ CBC Newsworld [digital]
19	11791-H	Showcase E&W [digital video]
20	11817-H	Superchannel, Moviemax, Family Channel [digital video]
21	11852-H	TV Ontario, TFO (French), Ontario Legislature [digicipher]
30	12122-H	Telesat Canada stationkeeping (GLACS)

Solidaridad 1 SD1 109.2° West

No video has been seen on any Solidaridad 1 Ku-band transponder.

Anik E1 (A2) 111° West

Note: Due to the loss of the south solar panel on March 26, 1996, Anik E1 Ku-band transponders 7-8, 11-16, 21-26, and 29-32 are off indefinitely according to Telesat officials.

1	11717-V	Data transmissions
2	11743-V	Data transmissions
3	11778-V	Data transmissions
4	11804-V	Data transmissions
5	11839-V	DirectPC [digital]
6	11865-V	NovaNet FM² Services
9	11961-V	Occ video
10	11987-V	Occ video
17	11730-H	Woman's Television Network E&W [digital video]
18	11756-H	Data transmissions
19	11791-H	Data transmissions
20	11817-H	New Country Network, Access Network of Alberta, Knowledge Network [digital video]
28	12061-H	RDI feeds

Solidaridad 2 (SD2) 112.9° West

Sky TV direct-to-home service uses transponders 1-4, 6-10, 14-16 on Solidaridad 2.

Anik C3 (C3) 114.9° W (Inclined Orbit)

This satellite rarely has any Ku-band video transmissions.

7	11900-V	Occ video

Morelos 2 (M2) 116.8° West

No video has been seen on any Morelos 2 Ku-band transponder.

Anik C1 (C1) 118.6° West

32	12183-H	Occ video

EchoStar 1/2 & Tempo 1 119°West

These direct-to-home satellites operate in the 12.2-12.7 GHz BSS band.

SBS 5 (SBS5) 123° West

1	11725-H	Unknown User [digital video]
2	11780-H	SCPC services/Data transmissions
3	11823-H	Data transmissions
5	11921-H	Data transmissions
6	11970-H	Data transmissions
7	12019-H	Data transmissions
8	12068-H	Data transmissions/Unknown User [digital video]
9	12117-H	Data transmissions/Unknown User [digital video]
10	12186-H	Occ video
11	11748-V	Data transmissions
12	11898-V	WMNB Russian-American TV (inverted video)
13	11994-V	Data transmissions
14	12141-V	Data Transmissions/USC TV [digital]/CSU-Chico [digital]

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	Galaxy 6 (G6) 74°	Spacenet 3R (S3R) 83°	GE-2 (GE2) 85°	GE-3 (GE3) 87°	Telstar 4 (T4) 89°	Galaxy 7 (G7) 91°	Galaxy 3R (G3R) 95°	Telstar 5 (T5) 97°	Galaxy 4 (G4) 99°	Spacenet 4 (S4) 101°	GE-1 (GE1) 103°
1	Tokyo BS New York feeds	(none)	o/v	Associated Press TV [MPEG/DVB]	Natl Jewish TV/o/v	Sega Channel Interactive [digital]	TVN Theatre 1 [V2+]	Telequest DBS [Digicipher]	SCPC services	Data Transmissions	o/v
2	o/v	(none)	o/v	American Independent Network (AIN) [CLI Spectrumsaver]	Data Transmissions	CBS West [occ VC1]	TVN Theatre 2 [V2+]	Telequest DBS [Digicipher]	Buena Vista TV distribution	STARZ! 2 [V2+]	Data Transmissions
3	Gospel Music Television	(none)	o/v	WSBK-UPN Boston [V2+]	XXXplore TV (adult) [V2+]	Action PPV [V2+]	TVN Theatre 3 [V2+]	Telequest DBS [Digicipher]	SCPC services	Data Transmissions	PBS Alaska/Caribbean channel [4DTV]
4	Horse Racing [digital video]	(none)	La Cadena de Milagro	Nebraska Educational TV (NETV) [4DTV]	Shop at Home	fX East [V2+]	TVN Theatre 4 [V2+]	Telequest DBS [Digicipher]	Data Transmissions	Encore- Westerns [V2+]	FOX Sports Ohio/FOX Sports Cincinnati [V2+]
5	CNN feeds (o/v)	(none)	NASA Contract Channel	Univision [V2+]	FOX feeds	fX East/West [Wegner]	TVN Theatre 5 [V2+]	Telequest DBS [Digicipher]	4 Media Company feeds	Data Transmissions	Hero Teleport (GEMS/HTV) [4DTV]
6	NHK (TV Japan) feeds	(none)	Kuwait TV	(none)	Oui TV (adult) [V2+]	Game Show Network [V2+]	TVN Theatre 6/TVN Promo [V2+]	Telequest DBS [Digicipher]	Shepherd's Chapel Network (Rel)	KNBC-NBC Los Angeles (PT24W) [V2+]	WNBC-NBC New York (PT24E) [V2+]
7	Video Catalog Channel (VCC)	(none)	Data Transmissions	Data Transmissions	Adam and Eve/Spice (adult)/Hot Spice [Digicipher]	The Golf Channel [V2+]	Guthy-Renker TV (infomercials)/TVN Theatre 7 [V2+]	o/v	o/v	3BTV	Cornerstone TV (Rel
8	Horse Racing [digital video]	(none)	Data Transmissions	(none)	ABC feeds East [LEITCH]	o/v	Pandamerica Home Shopping/TVN Theatre 8 [V2+]	ABC NewsOne Channel	Telemundo/Telenoticias [PowerVu]	KOMO- ABC Seattle (PT24W) [V2+]	Fox Sports Chica [V2+]
9	MuchMusic U.S. [V2+]	(none)	NASA TV	WPIX-Ind New York [V2+]	o/v	CBS Eye on People Network [PowerVu]	TVN Theatre 9-adulTVision (adult) [V2+]	FOX Feeds	WB Oom TV/Network	Data Transmissions	Fox Sports South [V2+]
10	Horse Racing [digital video]	(none)	Data Transmissions	(none)	FOX News Edge	United Arab Emirates TV Dubai	Horse Racing [digital video]/o/v	FOX Feeds	o/v	FOXNet (PT24E/W) [V2+]	WKRN-ABC Nashville, TN (PT24E) [V2+]
11	o/v	(none)	o/v	CNN/SI	Xxxcite (adult) [V2+]	Encore [V2+]	o/v	Exxxtasy (adult) [V2+]	o/v	STARZ! East [V2+]	Univision [digital video]
12	TV Asia [PowerVu]/Horse Racing [digital video]	(none)	Data Transmissions	Data Transmissions	Horse Racing [digital video]/ACN	Romance Classics [V2+]	RAI TV/Infomericals	Exotica (adult) [V2+]	o/v	Hero Teleport Contract Channel	Wisdom Network
13	RTPi (Portugal)	DayStar TV Network	Data Transmissions	SCPC/FM2 services	FOX feeds West	Ovation/CSN/Kaleidoscope/Bloomberg/-Box [Digicipher]	Horse Racing [digital video]/o/v	FOX feeds East	o/v	Data Transmissions	Fox Sports South Sports Alternate (occ)/o/v
14	Horse Racing [digital video]	(none)	USIA Worldnet TV/VOA radio [PowerVu]	CNN feeds	ABC feeds	Independent Film Channel [V2+]	X!/XXXplore Promo (adult)	True Blue (adult) [V2+]	o/v	WWOR-UPN New York [V2+]	Fox Sports New England [V2+]
15	Midwest Sports Channel [V2+]	(none)	Unknown User [digital video]	KTLA-Ind Los Angeles [V2+]	The X! Channel (adult) [V2+]	Your Choice TV [Digicipher]	o/v	Paramount Syndication/o/v	World Harvest TV (Rel)	Data Transmissions	Fox Sports Alternate/o/v
16	Horse Racing [digital video]	(none)	Data Transmissions	CNN International/CNN fN [V2+]	Eurotica (adult) [V2+]	Access Television/The Recovery Network [Digicipher]	HBO 2 East [V2+]	UPN Network/o/v	CBS West [occ VC1]	NPS Promo Channel	Fox Sports Bay Ar [V2+]
17	o/v	(none)	Data Transmissions	FM2 services	FOX feeds	(none)	Cinemax 2 East [V2+]	o/v	CBS feeds [occ VC1]/WB Network (occ)	(none)	Fox Sports Alternates (occ)
18	EWTN International/Alabama Cable Network [Powervu]	(none)	o/v	(none)	PBS National Schedule	Teleport Minnesota/CBS feeds/o/v	Inforamerica TV (Informercials)	o/v	CBS feeds/ Eyemark syndicated feeds	STARZ! West [V2+]	Fox Sports New York [V2+]
19	University Network-Dr. Gene Scott (Rel)	HTS Alternate	Data Transmissions	Fox Sports Detroit [V2+]	Horse Racing [digital]/X! Promo (adult)	CBS East [occ VC1]	HBO 3 [V2+]	America's Collectibles Network	CBS East [occ VC1]	(none)	America's Voice TV
20	o/v	(none)	o/v	Gem Shopping Channel	(none)	FOX News Channel	HBO 2 West [V2+]	o/v	CBS East [occ VC1]	(none)	AFRTS [Powervu]
21	o/v	(none)	(none)	Fox Sports World [V2+]	ABC feeds West [LEITCH]	BET on Jazz	Superstar Programming Promo/o/v	ABC West Hot Backup [LEITCH]	CBS feeds/o/v	Data Transmissions	Univision feeds (oc
22	Horse Racing [digital video]	(none)	Arab Network of America (ANA)	(none)	ABC feeds East [LEITCH]	(none)	Horse Racing [digital video]	ABC East Hot Backup [LEITCH]	o/v	Data Transmissions	Deutsche Welle TV
23	Worship TV/Praise TV (Rel) [MPEG2/DVB]	Home Team Sports (HTS)	NHK Secondary Feeds	(none)	o/v	fX Movies [V2+]	3 Angels Broadcasting	o/v	SCOLA [Wegener]/LDS TV (occ)/B&W Network	Data Transmissions	Outlaw Music Channel (o/v)
24	Horse Racing [digital video]/o/v	(none)	o/v	America One	o/v	Intl Channel/Encore Themed Channels [4DTV]	Horse Racing [digital video]/o/v	o/v	CBS Newspath	KPIX-CBS San Francisco (PT24W) [V2+]	WSEE-CBS Erie, PA (PT24E) [V2+]

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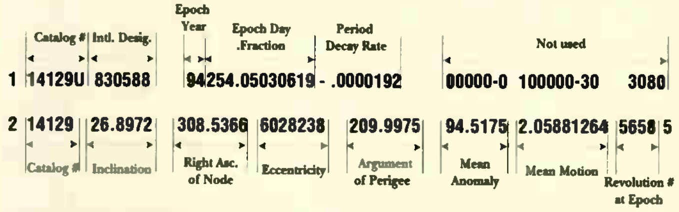
Anik E2 (A1) 107.3°	Solidaridad 1 (SD1) 109.2°	Telesat E1 (A2) 111°	Solidaridad 2 (SD2) 112.9°	Morelos 2 (M2) 116.8°	Galaxy 9 (G9) 123°	Galaxy 5 (G5) 125°	Satcom C3 (F3) 131°	Galaxy 1R (G1) 133°	Satcom C4 (F4) 135°	Satcom C1 (F1) 137°	
CBC-H English Eastern	Data Transmissions	Data Transmissions	Data Transmissions	Data Transmissions	o/v	Disney East [V2+]	Family Channel-E/W/ FIT TV/IFE [PowerVu]	Comedy Central West [V2+]	American Movie Classics (AMC) [V2+]	Various Fox Sports Nets [V2+]	1
o/v	Data Transmissions	(Inactive)	Data Transmissions	Unknown User [digital video]	o/v	Playboy (adult) [V2+]	The Learning Channel [V2+]	Univision/Galavision [PowerVu]	Request TV PPV [Digicipher]	KMGH-ABC Denver [V2+]	2
Unknown user [digital]	SCPC services	Data Transmissions	Data Transmissions	Data Transmissions	NHK TV	Trinity Broadcasting (Rel)	Viewer's Choice PPV [digital video]	Encore Themed Services [4DTV]	Nickelodeon East [V2+]	KRMA-PBS Denver [V2+]	3
Cancom [PowerVu]	Data Transmissions	Data Transmissions	Data Transmissions	Data Transmissions	General Communication [digital video]	Sci-Fi [V2+]	Lifetime West [V2+]	TV Food/Outdoor Life Networks [Digicipher]	Lifetime East [V2+]	Data Transmission	4
CBC feeds	(none)	Data Transmissions	o/v	Data Transmissions	Showtime/TMC/SDC-(W) [4DTV]/VH-1(W)[Powervu]	CNN [V2+]	Odyssey (Rel)	Classic Arts Showcase	Product Information Network	KDVR-Fox Denver [V2+]	5
o/v	Data Transmissions	(Inactive)	Data Transmissions	Unknown User [digital video]	o/v	WTBS-Ind Atlanta [V2+]	Court TV/NW Cable News [4DTV]	Z-Music	Madison Square Garden [V2+]	KCNC-CBS Denver [V2+]	6
CBC-M feeds	Unknown User [digital video]	Data Transmissions	o/v	Data Transmissions	TVN Digital Theaters 1-8 [4DTV]	WGN-Ind Chicago [V2+]	C-SPAN 1	Disney West [V2+]	Bravo [V2+]	SSN FOX Sports West [V2+]	7
o/v	Data Transmissions	(Inactive)	Data Transmissions	XHGC canal 5	General Communication [digital video]	HBO West [V2+]	QVC-2 Fashion Channel	Cartoon Network [V2+]	Prevue Channel	NBC-East	8
CBC-B English Atlantic	Multivision DBS [Digicipher]	(Inactive)	(none)	Unknown User [digital video]	TVN Digital Theaters 9-16 [4DTV]	ESPN [V2+]	Music Choice [4DTV]	ESPN2 Blackout [V2+]/SAH	QVC Network	FOX Sports Net Base 1	9
Cancom [PowerVu]	Mexican Government Channel	(Inactive)	(none)	XEIPN canal 11	TVN Digital Theaters 17-24 [4DTV]	MOR Music	America's Store	MSNBC [V2+]	Home Shopping Network (HSN)	SSN FOX Sports SW [V2+]	10
CBC-A French [Powervu]	Multivision DBS [Digicipher]	(Inactive)	Unknown User [digital video]	Unknown User [digital video]	TVN Digital Theaters 25-32 [4DTV]	Family Channel East [V2+]	Fox Sports Net Base [V2+]	Eternal Word TV Network (Rel)	SpeedVision	o/v	11
Cancom [PowerVu]	(none)	o/v	(none)	(none)	General Communication [digital video]	Discovery West [V2+]	History Channel [V2+]	Valuevision	(none)	Data Transmissions	12
CBC-C English Pacific	o/v	(Inactive)	(none)	Unknown User [digital video]	TVN Digital Theaters 33-35/GRTV [4DTV]	CNBC [V2+]	The Weather Channel [V2+]	Encore Themed Services [4DTV]	Travel Channel [V2+]	Fox Sports Midwest [V2+]	13
Cancom [PowerVu]	Data Transmissions	o/v	Data Transmissions	XEW canal 2	Sundance Channel [V2+]	ESPN2 [V2+]	New England Sports Network [V2+]	ESPN Alternate [V2+]/SAH	California Channel [PowerVu]	KUSA-NBC Denver [V2+]	14
o/v	Multivision DBS [Digicipher]	(Inactive)	Data Transmissions	Unknown user [digital video]	Showtime West [V2+]	HBO East [V2+]	(none)	CNNSI/CNN fn/CNN Intl/T.C.M./CNN Spanish [4DTV]	Animal Planet [V2+]	SC Florida [V2+]	15
lobal TV [PowerVu]	Data Transmission	(Inactive)	Data Transmissions	XEIMT Canal 22	General Communication [digital video]	Cinemax West [V2+]	M2: Music Television	Turner Classic Movies [V2+]	Request TV 1 [V2+]	FOX Sports Arizona/Americas [Digicipher]	16
CBC-D feeds	o/v	(Inactive)	(none)	Unknown User [digital video]	Nickelodeon West [V2+]	TNT [V2+]	Movie Channel East [V2+]	The New Inspirational Network (Rel)	MTV East [V2+]	SSN FOX Sports (alternates) [V2+]	17
Data Transmissions/Unknown user [digital video]	o/v	(Inactive)	(none)	(none)	The Movie Channel West [V2+]	TNN [V2+]	TVLand	HBO/Cinemax [4DTV]	Viewer's Choice [Digicipher]	FOX Sports Rocky Mountain [V2+]	18
Telesat [PowerVu]	Data Transmissions	TV Northern Canada [PowerVu]/Data Transmissions	Data Transmissions	(none)	MTV West [V2+]	USA East [V2+]	Showtime/TMC/SDC (East) [4DTV]	Cinemax East [V2+]	C-SPAN 2 [analog]/CSPAN 3 [digital]	FOXNet [V2+]	19
(Inactive)	(none)	(Inactive)	(none)	Data Transmissions	General Communication [digital video]	BET [V2+]	Jones Computer/GAC/PIN [4DTV]	Home and Garden Network [V2+]	Showtime East 2 [V2+]	Unknown User [digital video]	20
Telesat [PowerVu]	(none)	SCPC services/Data Transmissions	(none)	Mexican Cable [Digicipher]	ESPNews [V2+]	Knowledge TV	Comedy Central East [V2+]	USA West [V2+]	Discovery East [V2+]	FOX Sports West 2 [V2+]	21
(none)	(none)	(Inactive)	(none)	XHIMT canal 7	o/v	CNN/HN [V2+]	Animal Planet/Discovery Channel Services [Digicipher]	Nostalgia-Good TV Channel [V2+]	FLIX [V2+]	SSN FOX Sports NW [V2+] (occ	22
CBC-E English	(none)	(Inactive)	Data Transmissions	Mexican Cable [Digicipher]	(none)	A&E [V2+]	E! Entertainment TV (East) [V2+]/E! (West) [PowerVu]	HBO/Cinemax [4DTV]	VH-1 [V2+]	KWGN-Ind Denver [V2+]	23
CTV [PowerVu]	Unknown User [digital video]	(Inactive)	(none)	XHDF canal 13	General Communication [digital video]	Showtime (East) [V2+]	Digital Music Express Radio (DMX) [digital audio]	Outdoor Channel	CMT [V2+]	SSN Sunshine Network [V2+]	24

Unscrambled/non-video ☐ Subscription ☐ Not available in U.S. ■ o/v = occasional video

Amateur and Weather Satellite Two-Line Orbital Element Sets

Below is an example of the format for the elements sets presented in this section of the Satellite Service Guide. The spacecraft is named in the first line of each entry. Illustration below shows meaning of data in the next two lines.

OSCAR 10
1 14129U 83058B 94254.05030619 -.00000192 00000-0 10000-3 0 3080
2 14129 26.8972 308.5366 6028238 209.9975 94.5175 2.05881264 56585



Notice that there is no decimal point printed for eccentricity. The decimal point goes in front of the number. For example, the number shown above for eccentricity would be entered into your computer tracking program as .6028238.

AMATEUR RADIO SATELLITES

OSCAR 10 (AMSAT OSCAR 10, AO-10)
1 14129U 83058B 98048.20806134 -.00000330 00000-0 10000-3 0 5351
2 14129 26.6440 101.7026 6009121 193.6281 137.5312 2.05883084 82434
OSCAR 11 (UoSAT 2, UoSAT 11, UOSAT OSCAR-11, UO-11)
1 14781U 84021B 98049.98351771 +.00000263 +00000-0 +52050-4 0 00658
2 14781 097.8653 026.7631 0010905 299.9667 060.0456 14.69669171747503
Russian Mir Space Station
1 16609U 86017A 98049.14164222 .00002917 00000-0 38442-4 0 2588
2 16609 51.6606 288.3347 0005365 32.7496 327.3752 15.62205459685437
OSCAR 16 (PACSAT, AMSAT OSCAR-16, AO-16)
1 20439U 90005D 98050.17338202 +.00000052 +00000-0 +36660-4 0 01501
2 20439 098.5214 134.7813 0011004 198.9329 161.1447 14.30041118421535
OSCAR 17 (DOVE, DOVE OSCAR-17, DO-17)
1 20440U 90005E 98050.20449628 +.00000082 +00000-0 +48451-4 0 01438
2 20440 098.5258 135.8542 0010751 198.4635 161.6161 14.30185686421570
OSCAR 18 (WEBERSAT, WEBERSAT OSCAR-18, WO-18)
1 20441U 90005F 98050.20816924 +.00000029 +00000-0 +28002-4 0 01370
2 20441 098.5253 135.7269 0011704 198.8960 161.1791 14.30150279421579
OSCAR 19 (LUSAT, LUSAT OSCAR-19, LO-19)
1 20442U 90005G 98050.15528096 +.00000032 +00000-0 +28871-4 0 01485
2 20442 098.5274 136.4874 0011728 198.1957 161.8810 14.30269442421592
OSCAR 20 (JAS 1B, FUJI 2, FUJI OSCAR 20, FO-20)
1 20480U 90013C 98050.18438002 +.00000010 +00000-0 +92600-4 0 00471
2 20480 099.0752 330.6474 0540408 178.2799 182.0329 12.83241548376389
RS-12/13 (Radio Sputnik 12/13, Cosmos 2123)
1 21089U 91007A 98050.21242035 +.00000010 +00000-0 -53362-5 0 00502
2 21089 082.9225 095.4635 0029127 332.6956 027.2665 13.74091969353083
OSCAR 22 (UoSAT-F, UoSAT-5, UOSAT OSCAR 22, UO-22)
1 21575U 91050B 98050.20674501 .00000090 00000-0 44219-4 0 8365
2 21575 98.2683 106.5739 0006739 229.2280 130.8322 14.37116214345965
OSCAR 23 (KITSAT-A, KITSAT-1, KITSAT OSCAR-23, KO-23)
1 22077U 92052B 98049.91154488 -.00000037 00000-0 10000-3 0 7258
2 22077 66.0804 348.6564 0004966 338.1133 21.9671 12.86306827259484
OSCAR 27 (EYESAT-A, EYESAT-1, AMSAT OSCAR-27, AO-27
1 22825U 93061C 98050.16830364 +.00000078 +00000-0 +48917-4 0 06288
2 22825 098.5191 123.5670 0007709 237.6624 122.3811 14.27757633229311
OSCAR 26 (ITAMSAT, ITAMSAT OSCAR-26, IO-26)
1 22826U 93061D 98050.18773904 +.00000021 +00000-0 +26009-4 0 06249
2 22826 098.5203 123.8976 0008477 237.8371 122.2007 14.27867989229336
OSCAR 25 (KITSAT-B, KITSAT-2, KITSAT OSCAR-25, KO-25)
1 22828U 93061F 98050.16237395 +.00000021 +00000-0 +25480-4 0 06116
2 22828 098.5168 123.9742 0009094 222.1087 137.9364 14.28215924197461
OSCAR 28 (POSAT, POSAT OSCAR-28, PO-28)
1 22829U 93061G 98050.18599968 +.00000014 +00000-0 +22744-4 0 06275
2 22829 098.5173 124.1141 0009250 220.8446 139.2027 14.28202739229380
RS-15 (Radio Sputnik 15)
1 23439U 94085A 98050.17360212 -.00000039 +00000-0 +10000-3 0 02946
2 23439 064.8178 113.4664 0145903 084.1783 277.5750 11.27529083129783
OSCAR 29 (FUJI 3, FUJI OSCAR-29, FO-29)
1 24278U 96046B 98050.04908713 -.00000023 +00000-0 +15705-4 0 01723
2 24278 098.5154 062.2745 0350618 266.3526 089.7461 13.52638121074497
RS-16 (Radio Sputnik 16)
1 24744U 97010A 98045.29613905 .00006020 00000-0 18680-3 0 1502
2 24744 97.2616 310.8858 0006220 321.5817 38.4975 15.33744015 53168

WEATHER/IMAGING SATELLITES
Geostationary Satellites
GOES 2 (Standby spacecraft-US 136.860 MHz on continuously, high power)
1 10061U 77048A 98048.03062537 .00000051 00000-0 10000-3 0 9393
2 10061 13.0967 30.3225 0006930 188.4058 123.4233 1.00255656 20553
GOES 3 (Standby spacecraft-US 137.190 MHz on continuously, high power)
1 10953U 78062A 98047.98362051 -.00000096 00000-0 00000+0 0 9011
2 10953 12.1290 33.4381 0004370 219.1041 140.9194 1.00279796 25173
GOES 7 (Standby spacecraft-US)
1 17561U 87022A 98047.57036481 -.00000144 00000-0 10000-3 0 4642
2 17561 4.2355 65.4783 0002103 256.2248 291.6883 1.00282227 23410
GOES 8 (Operational East-US)
1 23051U 94022A 98048.30565853 -.00000252 00000-0 10000-3 0 346
2 23051 0.2609 274.1760 0004298 10.2869 256.9333 1.00257869 21480
GOES 9 (Operational West-US)
1 23581U 95025A 98048.75705521 .00000084 00000-0 00000+0 0 7989
2 23581 0.1160 97.0943 0003264 232.5884 314.9463 1.00268430 10047
GOES 10 (Standby spacecraft-US post launch testing continues)
1 24786U 97019A 98028.34013576 -.00000082 00000-0 00000+0 0 1654
2 24786 0.0827 69.9528 0008201 236.0143 197.1122 1.00262241 2817
ELEKTRO (Operational Russian spacecraft)
1 23327U 94069A 98041.82529514 -.00000121 00000-0 00000+0 0 4767
2 23327 1.2715 88.8218 0002019 178.9265 246.2882 1.00272653 12056
Feng Yun 2B (Operational Chinese spacecraft)
1 24834U 97029A 98047.41256944 -.00000339 00000-0 00000+0 0 1235
2 24834 0.7216 254.6242 0001074 13.8455 130.9488 1.00277954 2518
Meteosat 5 (Operational ESA spacecraft moving to 65 deg East, aka MOP-2)
1 21140U 91015B 98045.63869792 .00000061 00000-0 00000+0 0 4227
2 21140 1.7670 78.1453 0001386 162.5682 141.0504 1.00422838 27694
Meteosat 6 (Operational ESA spacecraft)
1 22912U 93073B 98039.11568866 -.00000027 00000-0 00000+0 0 9931
2 22912 0.2721 317.4415 0000788 356.5756 225.4462 1.00272770 13886
Meteosat 7 (Operational ESA spacecraft)
1 24932U 97049B 98046.70357060 -.00000091 00000-0 00000+0 0 1031
2 24932 1.4845 290.3929 0003807 359.8161 98.5345 1.00273582 1686
GMS 4 (Standby Japanese spacecraft, aka Himawari 4)
1 20217U 89070A 98047.36201852 -.00000372 00000-0 10000-3 0 7143
2 20217 3.0095 71.7843 0001329 169.9478 154.9160 1.00254714 31521
GMS 5 Operational Japanese spacecraft, aka Himawari 5)
1 23522U 95011B 98026.48738160 -.00000284 00000-0 10000-3 0 5841
2 23522 0.4230 4.9362 0001135 304.3474 131.6016 1.00264097 10350

Near Polar/Polar Orbiting Imaging Spacecraft
NOAA 12 (Operational morning US spacecraft 137.500 MHz APT)
1 21263U 91032A 98049.01090968 .00000049 00000-0 40733-4 0 7039
2 21263 98.5325 60.6607 0012219 302.9993 57.0011 14.22790675351313
NOAA 14 (Operational afternoon US spacecraft 137.620 MHz APT)
1 23455U 94089A 98049.03859475 .00000096 00000-0 77714-4 0 3618
2 23455 99.0255 6.2935 0009646 326.5808 33.4753 14.11739530161639
Meteor 2-21(Russian spacecraft, off at last report)
1 22782U 93055A 98045.88785862 .00000035 00000-0 17858-4 0 6247
2 22782 82.5488 225.5107 0023490 75.0407 285.3352 13.83091628225133
Meteor 3-5 (Operational Russia spacecraft 137.850 MHz APT)
1 21655U 91056A 98047.55692564 .00000051 00000-0 10000-3 0 430
2 21655 82.5524 250.0729 0013764 83.7394 276.5264 13.16859313312870
DMSP B5D2-7 (DoD meteorological polar orbiter: downlink encrypted)
1 23233U 94057A 98049.05476225 .00000128 00000-0 91857-4 0 5541
2 23233 98.7456 107.1766 0011683 245.4879 114.5077 14.12886158179084
DMSP B5D2-8 (DoD meteorological polar orbiter: downlink encrypted)
1 23533U 95015A 98049.06026587 .00000056 00000-0 53878-4 0 3035
2 23533 98.8517 55.0815 0007772 118.1248 242.0712 14.12837177149887
DMSP B5D2-9 (DoD meteorological polar orbiter: downlink encrypted)
1 24753U 97012A 98049.03075049 .00000093 00000-0 73436-4 0 3531
2 24753 98.8979 97.3300 0009889 73.3466 286.8792 14.13037794 45109

EARTH RESOURCES IMAGING SATELLITES
OKEAN 1-7 (Russian Okean 4 137.400 MHz)
1 23317U 94066A 98048.54533205 .00000059 00000-0 55345-5 0 3059
2 23317 82.5409 217.4572 0024297 255.2869 104.5648 14.74195084180454
SICH-1 (Russian Oceanographic spacecraft 137.400 MHz)
1 23657U 95046A 98045.40501771 .00000181 00000-0 24361-4 0 2328
2 23657 82.5330 1.5837 0026218 237.2610 122.6074 14.73649235132259

Amateur Satellite Frequency Guide

The Radio Amateur Satellite Corp.

AMSAT OSCAR 10 (AO-10)
Uplink 435.030-435.180 MHz (CW/LSB)/Downlink 145.975-145.825 MHz (CW/USB)/Beacon: 145.810 MHz (Steady unmodulated carrier)

OSCAR 11 (UoSAT 11/UO-11)
Downlink 145.825 MHz FM, 1200 Baud PSK/Beacon 2401.500 MHz. The operating schedule: ASCII status (210 seconds), ASCII bulletin (60 seconds), BINARY SEU (30 seconds), ASCII TLM (90 seconds), ASCII WOD (120 seconds), ASCII bulletin (60 seconds), and BINARY ENG (30 seconds).

AMSAT OSCAR 16/PACSAT (AO-16)
Uplinks 145.900, 145.920, 145.940 and 145.960 MHz FM, 1200 bps Manchester FSK/Downlinks 437.0513 and 437.025 (secondary) MHz SSB, 1200 bps RC-BPSK and 1200 baud PSK/Beacon 2401.1428 MHz

DOVE (DO-17)
Downlink 145.825 MHz FM, 1200 baud AFSK/Beacon 2401.220 MHz. DOVE is presently sending 1200 baud AX.25 (standard packet) ASCII telemetry about every minute on two meters. On S-band it transmits PSK flags continuously and also the same data that is sent on 2 meters.

WEBERSAT (WO-18)
Downlink 437.104 MHz SSB, 1200 baud PSK AX.25

LUSAT (LU-19)
Uplink 1200 bps Manchester FSK: 145.840, 145.860, 145.880 and 145.900/Downlinks 437.125 and 437.150 (secondary) MHz SSB, 1200 bps RC-BPSK

Fuji OSCAR 20 (FO-20)
JA mode: Uplink 145.900-146.000 MHz (CW/LSB)/Downlink 435.800-435.900 MHz (CW/USB). FO-20 in mode JA continuously.

OSCAR 22 (UO-22)
Uplink 145.900 or 145.975 MHz FM/Downlink 435.120 MHz FM 9600 baud FSK

KITSAT 23 (KO-23)
Uplink 145.850 and 145.900 MHz FM/Downlink 435.175 MHz FM 9600 baud FSK

KITSAT (KO-25)
Uplink 145.980 MHz FM/Downlink 436.5 MHz FM, 9600 baud FSK

ITAMSAT (IO-26)
Uplink 145.875, 145.900, 145.925 and 145.950 MHz FM/Downlink 435.822 MHz SSB, 1200 baud PSK

OSCAR 27 (AO-27)
Uplink 145.85 MHz FM/Downlink 436.792 MHz FM

Fuji OSCAR 29 (FO-29)
Voice/CW Mode JA: Uplink 145.900-146.000 MHz (CW/LSB)/Downlink 435.800-435.900 MHz (CW/USB). Digital Mode JD: Uplink 145.850, 145.870 and 145.910 MHz FM/Downlink 435.910 MHz FM 9600 baud BPSK

Radio Sputnik 10 (RS-10)
Uplink 145.865-145.905 MHz (CW/SSB)/Downlink 29.360-29.400 MHz (CW/SSB) Not operational at this time.

Radio Sputnik 12 (RS-12)
Uplink 145.910-145.950 MHz (CW/SSB)/Downlink 29.410-29.450 MHz. Operational, now in mode A.

Radio Sputnik 15 (RS-15)
Uplink 145.858-145.898 MHz (CW/SSB)/Downlink 29.354-29.394 MHz (CW/SSB)

Radio Sputnik 16 (RS-16)
Uplink 145.915-145.948 MHz/Downlink 29.415-29.448 MHz, HF Beacons 29.408 and 29.451 MHz, UHF Beacon 1 435.504 MHz, UHF Beacon 2 435.548 MHz

Radio Sputnik 17/Sputnik 40 (RS-17)
Downlink 145.820 MHz

MIR Space Station
Uplink: 437.850 MHz/Downlink: 145.800 MHz
From March 1, 1998 the SAFEX MIR 70-cm repeater will be operational. Uplink 435.750 MHz FM/Downlink 437.950 MHz FM, subaudible tone 141.3 Hz

Geostationary Satellite Locator Guide

By Larry Van Horn

This guide shows the orbital locations of 260 active geostationary/synchronous satellites at publication deadline. Synchronous satellite location information is supplied to *Satellite Times* by NASA's Goddard Space Flight Center-Orbital Information Group (Mr. Adam Johnson). We are particularly grateful to the following individuals for providing payload information and analysis: Earth News: Philip Chien; Molniya Space Consultancy: Mr. Phillip Clark; Baylin Publications: Dr. Frank Baylin; JSC NASA: Dr. Nicholas Johnson; University of New Brunswick: Mr. Richard B. Langley; Havard-Smithsonian Center for Astrophysics: Jonathan McDowell; U.S. Space Command/Public Affairs; Naval Space Command/Public Affairs; NASA NSSDC/WDC-A, Goddard Space Flight Center; and the *Satellite Times* staff.

d indicates that satellite is drifting (moving into a new orbital slot or at end of life). *i* indicates an orbital inclination greater than 2 degrees. *#* indicates that the satellite has started into an inclined orbit.

Radio Frequency Band Key

VHF	136-138 MHz
P band	225-1,000 MHz
L band	1.4-1.8 GHz
S band	1.8-2.7 GHz
C band	3.4-7.1 GHz
X band	7.25-8.4 GHz
Ku-band	10.7-15.4 GHz
Ku band	10.7-15.4 GHz
K band	15.4 -27.5 GHz
Ka band	27.5-50 GHz
Millimeter	> 50 GHz

Satellite Service Key

AOR	Atlantic Ocean Region
APR	Asia/Pacific Ocean Region
BSS	Broadcast Satellite Service
DARS	Digital Audio Radio Service
FSS	Fixed Satellite Service
Gov	Government
Intl	International
IOR	Indian Ocean Region
MSS	Mobile Satellite Service
MET	Meteorological Satellite Serv.
Mil	Military
POR	Pacific Ocean Region

OBJ NO.	INT-OESIG/COMMOM NAME	LONG (OEG)	TYPE SATELLITE
22912	1993-073B Meteosat 6/MOP 3 (ESA)	0.0E#	MET (P/L/S) Operational Metsat
23730	1995-067A Telecom 2C (France)	2.9E	FSS-Gov/Mil (S/C/X/Ku)
23712	1995-060A USA 115/Milstar 2 (US)	4.0E/i	FSS-Milcomsat (P/S/K)
25049	1997-071A Sirius 2 (Sweden)	5.2E	BSS (Ku)
20193	1989-067A Sirius/Marcopolo 1/BSB R1	5.8E	BSS (Ku)
22921	1993-076A USA 98/NATO 4B (NATO)	5.9E/i	FSS-Milcomsat (P/S/X)
25134	1998-002A Skynet 4D (UK)	6.0E	FSS-Milcomsat (P/S/X/Ka)
22028	1992-041B Eutelsat 2F4 (EUTE)	6.9E	FSS (S/Ku)
21056	1991-003B Eutelsat 2F2 (EUTE)	9.9E	FSS (S/Ku)
19596	1988-095A Raduga 22 (CIS)	11.0E/i	FSS-Gov/Mil (X/C)
22557	1993-013A Raduga 29 (CIS)	11.3E/i	FSS-Gov/Mil (X/C)
22269	1992-088A Cosmos 2224 (CIS)	11.9E#	FSS-Mil Early Warning (X)
24665	1996-067A Eutelsat 2F7/Hot Bird 2 (EUTE)	12.0E	BSS (Ku)
24208	1996-044A Italsat 2 (Italy)	13.1E#	FSS/MSS (L/S/K/Ka)
20777	1990-079B Eutelsat 2F1 (EUTE)	13.3E	FSS (S/Ku)
23537	1995-016B Eutelsat 2F6/Hot Bird 1 (EUTE)	13.6E	BSS (Ku)
21055	1991-003A Italsat 1 (Italy)	14.4E#	FSS/MSS (S/K/Ka)
24931	1997-049A Hot Bird 3 (EUTE)	15.9E	BSS (Ku)
21803	1991-083A Eutelsat 2F3 (EUTE)	15.9E	FSS (S/Ku)
19688	1988-109B Astra 1A (Lux)	19.1E	BSS (Ku)
21139	1991-015A Astra 1B (Lux)	19.1E	BSS (Ku)
23686	1995-055A Astra 1E (Lux)	19.1E	BSS (Ku)
25071	1997-076A Astra 1G (Lux)	19.1E	BSS (Ku)
23331	1994-070A Astra 1D (Lux)	19.2E	BSS (Ku)
23842	1996-021A Astra 1F (Lux)	19.2E	BSS (Ku)
22653	1993-031A Astra 1C (Lux)	19.4E	BSS (Ku)
19331	1988-063B Eutelsat 1F5/ECS 5 (EUTE)	21.4E/i	FSS (VHF/Ku)
22175	1992-066A DFS 3 (Germany)	23.5E	BSS (S/Ku/K)
25153	1998-006B Inmarsat 3 F5 (INMA)	25.0E	Intl MSS on-orbit spare (L/C)
18351	1987-078B Eutelsat 1F4/ECS 4 (EUTE)	25.3E/i	FSS (VHF/Ku)
20659	1990-054A Gorizont 20 (CIS)	25.7E/i	FSS (C/Ku)
23948	1996-040A Arabsat 2A (Arabsat)	25.9E	BSS/FSS (C/Ku)
20706	1990-063B DFS 2/Kopernikus (Germany)	28.6E	BSS (S/Ku/K)
24652	1996-062A Arabsat 2B (Arabsat)	30.8E	BSS/FSS (C/Ku)
23200	1994-049B Turksat 1B (Turkey)	31.2E	FSS (Ku)
15629	1985-025A Intelsat 510 (ITSO)	32.9E/i	Intl FSS IOR (C/Ku)
20263	1989-081A Gorizont 19 (CIS)	33.7E/i	FSS (C/Ku)
21821	1991-087A Raduga 28 (CIS)	35.0E/i	FSS-Gov/Mil (X/C)
22963	1993-002A Gals 1 (CIS)	35.9E	BSS (Ku)
23717	1995-063A Gals 2 (CIS)	36.0E	BSS (Ku)
20929	1990-095A USA 65/DSP F15 (US)	37.4E#	FSS-Mil Early Warning IOR (S/X)
23775	1996-005A Gorizont 31 (CIS)	39.6E#	FSS (C/Ku) Statsionar 12
23949	1996-040B Turksat 1C (Turkey)	42.0E	FSS (Ku)
22981	1994-008A Raduga 1-3 (CIS)	48.7E#	FSS-Gov/Mil (X/C) Statsionar 24
23880	1996-034A Gorizont 32 (CIS)	52.9E#	FSS (C/Ku) Statsionar 5
19687	1988-109A Skynet 4B (UK)	53.1E/i	FSS-Milcomsat (P/S/X/Ka)
21894	1992-010B Arabsat 1C	55E	BSS/FSS (S/C)
25045	1997-070A Kupon 1 (CIS)	55.0E	FSS (Ku)
20203	1989-069B USA 44/DSCS 3A2 (US)	57.0E/i	FSS-Milcomsat IOR (P/S/X)
23305	1994-064A Intelsat 703 (ITSO)	56.9E	Intl FSS IOR (C/Ku)
20667	1990-056A Intelsat 604 (ITSO)	60.0E	Intl FSS IOR (C/Ku)
22913	1993-074A USA 97/DSCS 3B10 (US)	60.0E/i	FSS-Milcomsat IOR (P/S/X)
20315	1989-087A Intelsat 602 (ITSO)	62.0E	Intl FSS IOR (C/Ku)
23839	1996-020A Inmarsat 3F1 (INMA)	63.8E#	Intl MSS IOR (L/C)
25110	1997-083A Intelsat 804 (ITSO)	64.0E	Intl FSS IOR (C/Ku)
24742	1997-009A Intelsat 801 (ITSO)	64.2E	Intl FSS IOR (C/Ku)
21814	1991-084B Inmarsat 2F3 (INMA)	65.0E#	Intl MSS IOR (L/C)
23461	1995-001A Intelsat 704 (ITSO)	65.9E	Intl FSS IOR (C/Ku)
23636	1995-040A PanAmSat 4/PAS 4 (US)	68.5E	FSS/BSS IOR (C/Ku)
23448	1994-087A Raduga 32 (CIS)	70.0E#	FSS-Gov/Mil (X/C) Statsionar 20
13595	1982-097A Intelsat 505 (ITSO)	71.0E/i	Intl FSS/MSS APR (L/C/Ku)
22787	1993-056A USA 95/UFO 2 (US)	71.1E/i	FSS-Milcomsat IOR (P/S)
10669	1978-016A Ops 6391/FltSatCom F1 (US)	72.7E/i	FSS-Milcomsat IOR (P/S)
23589	1995-027A USA 111/UFO 5 (US)	72.8E/i	FSS-Milcomsat IOR (P/S/K)
08882	1976-053A Marisat 2 (US)	73.0E/i	MSS IOR (P/L/C)
22027	1992-041A Insat 2A (India)	73.9E#	FSS/MET (S/C)
23327	1994-069A Elektro 1 (CIS)	76.1E#	MET (L)
25010	1997-062A Apstar 2R (PRC)	76.4E	FSS (C/Ku)
23680	1995-054A Luch 1-1 (CIS)	77.1E#	FSS-SDRN2 (Ku)
23314	1994-065B Thaicom 2 (Thailand)	78.3E	FSS (C/Ku)
24768	1997-016A Thaicom 3 (Thailand)	78.5E	FSS/BSS (C/Ku)
23653	1995-045A Cosmos 2319 (CIS)	79.6E#	FSS-Data Relay (C)
21759	1991-074A Gorizont 24 (CIS)	79.6E/i	FSS (C/Ku) Statsionar 13
24435	1996-058A Express 2 (CIS)	79.9E	Intl FSS (C/Ku)
18922	1988-014A Zhongxing 1/DFH2-A1/PRC 22 (PRC)	81.5E/i	FSS (C)
20643	1990-051A Insat 1D (India)	82.8E	BSS/FSS/MET (S/C)
22836	1993-062A Raduga 30 (CIS)	83.8E#	FSS-Gov/Mil (X/C) Statsionar 3
19548	1988-091B TDRS F3 (US)	85.7E/i	FSS-Gov (C/S/Ku)
22880	1993-069A Gorizont 28 (CIS)	90.1E#	FSS (C/Ku) Statsionar 6
23765	1995-003A Measat 1 (Malaysia)	91.4E	FSS (C/Ku)
22724	1993-048B Insat 2B (India)	93.3E	BSS/FSS/MET (S/C)
23731	1995-067B Insat 2C (India)	93.4E	BSS/FSS/MET (S/C/Ku)
22245	1992-082A Gorizont 27 (CIS)	96.7E/i	FSS (C/Ku) Statsionar 14
25050	1997-071B Indostar 1 (Indonesia)	96.7E	BSS/DARS (L/S)
20473	1990-011A Zhongxing 3/DFH2-A3/PRC 26 (PRC)	97.8E#	FSS (C)
22210	1992-074A Ekran 20 (CIS)	98.4E/i	BSS (P) Statsionar-T
23723	1995-064A AsiaSat 2 (AC)	100.5E	BSS (C/Ku)
21922	1992-017A Gorizont 25 (CIS)	102.5E/i	FSS (C/Ku) Statsionar 21
24834	1997-029A Fengyun 2B (PRC)	104.8E#	MET (L)
20558	1990-030A Asiasat 1 (AC)	105.5E	BSS (C)
20570	1990-034A Palapa B2R (Indonesia)	107.7E	FSS (C)
23176	1994-040B BS 3N (Japan)	108.8E	BSS (Ku)
20771	1990-077A BS 3A/Yuri 3A (Japan)	108.8E	BSS (S/Ku)
21668	1991-060A BS 3B/Yuri 3B (Japan)	108.9E	BSS (S/Ku)
24769	1997-016B BSAT 1A (Japan)	109.0E	BSS (Ku)
19710	1988-111A Zhongxing 2/DFH2-A2/PRC 25 (PRC)	110.4E/i	FSS (C)
23864	1996-030A Palapa C2 (Indonesia)	112.9E	FSS (C/Ku)
23768	1996-003A Koreasat 2/Mugunghwa 2 (Korea)	114.9E	BSS/FSS (Ku)
14985	1984-049A Zhongxing 5/Chinasat 5/Spacenet 1 (PRC)	115.3E#	FSS (C/Ku)
23639	1995-041A Koreasat 1/Mugunghwa 1 (Korea)	115.9E	BSS/FSS (Ku)
21964	1992-027A Palapa B4 (Indonesia)	117.8E	FSS (C)
22931	1993-078B Thaicom 1 (Thailand)	120.0E	FSS (C/Ku)
20217	1989-070A GMS 4/Himawari 4 (Japan)	120.1E/i	MET (P/L/S)
23108	1994-030A Gorizont 30/Rimsat 2 (CIS)	122.2E#	FSS (C/Ku)
24798	1997-021A Zhongxing 8/DFH3-2 (PRC)	124.9E	FSS (C)
21132	1991-014A Raduga 27 (CIS)	127.5E/i	FSS-Gov/Mil (X/C)
23649	1995-043A JCSAT 3 (Japan)	127.9E	FSS/BSS (C/Ku)
23651	1995-044A N-Star 1 (Japan)	131.8E	FSS (S/C/Ku/K)
23943	1996-039A Apstar 1A (PRC)	134.0E	BSS (C)
23781	1996-007A N-Star 2 (Japan)	135.9E	FSS (S/C/Ku/K)
23185	1994-043A Apstar 1 (PRC)	138.0E	BSS (C)
23522	1995-011B GMS 5/Himawari 5 (Japan)	138.2E#	MET (P/L/S)
25067	1997-075A JCSAT 5 (Japan)	139.3E/d	FSS (Ku)
20953	1990-102A Gorizont 22 (CIS)	139.8E/i	FSS (C/Ku) Statsionar 7
17706	1987-029A Agila 1/Palapa B2P (Philippines)	140.5E#/d	FSS (C)
24880	1997-036A Superbird C (Japan)	143.9E	FSS (Ku/K)
20923	1990-094A Gorizont 21 (CIS)	144.8E/i	FSS (C/Ku) Statsionar 16
20066	1989-046A USA 39/DSP F14 (US)	145.4E/i	FSS-Mil Early Warning POR (S/X)

Geostationary Satellite Locator Guide

OBJ NO.	INT-DESIG/COMMOM NAME	LONG (DEG)	TYPE SATELLITE
24737	1997-008A USA 130/DSP F18 (US)	165.0E	FSS-Mil Early Warning POR (S/X)
24901	1997-042A Agila 2/Mabuhay 1 (Philippines)	145.8E	FSS (C/Ku)
24653	1996-063B Measat 2 (Malaysia)	147.9E	FSS (C/Ku)
24732	1997-007A JCSAT 4 (Japan)	150.0E	FSS (Ku)
23779	1996-006A Palapa C1 (Indonesia)	150.4E	FSS (C/Ku)
18350	1987-078A Optus A3/Aussat K3 (Australia)	151.9E#	FSS (Ku)
20402	1990-001B JCSAT 2 (Japan)	154.0E	FSS (Ku)
23227	1994-055A Optus B3 (Australia)	155.9E	BSS/MSS (L/Ku)
12994	1981-119A Intelsat 503 (ITSO)	156.8E/i/d	Intl FSS APR (C/Ku)
22253	1992-084A Superbird A (Japan)	157.9E	FSS (Ku/K)
22087	1992-054A Optus B1 (Australia)	159.9E	BSS/MSS (L/Ku)
22907	1993-072A Gorizont 29/Rimsat 1 (CIS)	160.8E#	FSS (C/Ku)
21893	1992-010A Superbird B (Japan)	162.0E	FSS (Ku/K)
16275	1985-109C Optus A2/Aussat 2 (Australia)	163.9E/i	FSS (Ku)
23175	1994-040A PanAmSat 2/PAS 2 (US)	169.0E	Intl FSS POR (C/Ku)
12046	1980-087A OPS 6394/FltSatCom F4 (US)	171.5E/i	FSS-Milcomsat POR (P/S/X)
24846	1997-031A Intelsat 802 (ITSO)	174.1E	Intl FSS POR (C/Ku)
22719	1993-046A USA 93/DSCS 3B9 (US)	175.0E/i	FSS-Milcomsat WPAC (P/S/X)
23124	1994-034A Intelsat 702 (ITSO)	177.0E	Intl FSS POR (C/Ku)
24674	1996-070A Inmarsat 3F3 (INMA)	177.9E#	Intl MSS POR (L/C)
20918	1990-093A Inmarsat 2F1 (INMA)	178.9E#	Intl MSS POR (L/C)
16117	1985-092C USA 12/DSCS 3B5 (US)	180.0E/i	FSS-Milcomsat WPAC (P/S/X)
22871	1993-066A Intelsat 701 (ITSO)	180.0E	Intl FSS POR (C/Ku)
23467	1995-003A USA 108/UFO 4 (US)	177.6W/i	FSS-Milcomsat POR (P/S/K)
19121	1988-040A Intelsat 513 (ITSO)	177.0W#	Intl FSS POR (C/Ku)
21639	1991-054B TDRS F5 (US)	174.3W	Intl FSS-Gov (C/S/Ku)
23613	1995-035B TDRS F7 (US)	171.3W#	FSS-Gov (C/S/Ku)
20499	1990-016A Raduga 25 (CIS)	170.0W/i	FSS-Gov/Mil (X/C)
21392	1991-037A Aurora II/Satcom C5 (US)	138.8W	FSS (C)
20945	1990-100A Satcom C1 (US)	137.3W	FSS (C)
23581	1995-025A GOES 9 (US)	135.0W	MET (P/L/S)
21873	1992-006A USA 78/DSCS 3B14 (US)	135.0W/i	FSS-Milcomsat EPAC (P/S/X)
22096	1992-057A Satcom C4 (US)	134.9W	FSS (C)
23016	1994-013A Galaxy 1R (US)	132.9W	FSS (C)
22117	1992-060B Satcom C3 (US)	130.9W	FSS (C)
13637	1982-106B DSCS 3A1 (US)	129.9W/i	FSS-Milcomsat EPAC (P/S/X)
21906	1992-013A Galaxy 5 (US)	125.0W	FSS (C)
23877	1996-033A Galaxy 9 (US)	122.9W	FSS (C)
19484	1988-081B SBS 5 (US)	122.8W	FSS (Ku)
22988	1994-009A USA 99/Milstar 1 (US)	120.0W	FSS-Milcomsat (P/S/K)
15826	1985-048D Telestar 303/3D (US)	119.9W/i	FSS (C)
23754	1995-073A EchoStar 1 (US)	118.8W	BSS (Ku)
24313	1996-055A Echostar 2 (US)	118.5W	BSS (Ku)
24748	1997-011A Tempo 2 (US)	118.4W	BSS (Ku)
16274	1985-109B Morelos 2 (Mexico)	116.7W	FSS (C/Ku)
23313	1994-065A Solidardad 2 (Mexico)	113.0W	FSSMSS (L/C/Ku)
21726	1991-067A Anik E1 (Canada)	111.0W	FSS (C/Ku)
22911	1993-073A Solidaridad 1 (Mexico)	109.1W	FSS/MSS (L/C/Ku)
21222	1991-026A Anik E2 (Canada)	107.2W	FSS (C/Ku)
23846	1996-022A MSAT M1 (Canada)	106.4W	MSS (L/X)
24786	1997-019A GOES 10 (US)	105.8W	MET (P/L/S) In-orbit spare
03029	1967-111A ATS 3 (US)	105.4W/i	Experimental communications (VHF/C)
08747	1976-023B LES 9 (US)	105.2W/i	Experimental Milcomsat (P/Ka)
15677	1985-035A Gstar 1 (US)	104.9W#	FSS (Ku)
20946	1990-100B Gstar 4 (US)	104.9W	FSS (Ku)
19483	1988-081A Gstar 3 (US)	104.6W/i	FSS/MSS (L/Ku)
23696	1995-057A USA 114/UFO 6 (US)	104.5W/i	FSS-Milcomsat CONUS (P/S/K)
24315	1996-054A GE 1 (US)	103.0W	FSS (C/Ku)
23435	1994-084A USA 107/DSP F17 (US)	103.2W#	FSS-Mil Early Warning AOR-W (S/X)
22930	1993-078A DBS 1 (US)	101.1W	BSS (Ku)
21227	1991-028A Spacenet 4 (US)	101.0W	FSS (C/Ku)
23553	1995-019A AMSC 1 (US)	100.9W	MSS (L/X)
23598	1995-029A DBS 3 (US)	100.8W	BSS (Ku)
23192	1994-047A DBS 2 (US)	100.7W	BSS (Ku)
22796	1993-058B ACTS (US)	99.9W	Experimental communications (S/C/K)
17181	1986-096A USA 20/FltSatCom F7 (US)	99.1W/i	FSS-Milcomsat CONUS (P/S/X/K)
22694	1993-039A Galaxy 4 (US)	98.9W	FSS (C/Ku)
17561	1987-022A GOES 7 (US)	98.3W/i	MET (P/L/S)
24812	1997-026A Telstar 5 (US)	97.0W	FSS (C/Ku)

OBJ NO.	INT-DESIG/COMMOM NAME	LONG (DEG)	TYPE SATELLITE
08746	1976-023A LES 8 (US)	95.4W/i	Experimental Milcomsat (P/Ka)
23741	1995-069A Galaxy 3R (US)	94.9W	FSS (C/Ku)
16650	1986-026B SBTS A2 (Brazil)	91.9W#	FSS (C)
22205	1992-072A Galaxy 7 (US)	91.0W	FSS (C/Ku)
23670	1995-049A Telstar 402R (US)	88.9W	FSS (C/Ku)
24936	1997-050A GE 3 (US)	87.2W	FSS (C/Ku)
24713	1997-002A GE 2 (US)	84.8W	FSS (C/Ku)
18951	1988-018A Spacenet 3R (US)	82.9W	FSS (L/C/Ku)
16276	1985-109D Satcom K2 (US)	80.9W#	FSS (Ku)
25086	1997-078A Galaxy 8i (US)	79.1W/d	BSS (Ku)
15561	1985-015B SBTS 1 (Brazil)	79.0W/i	FSS (C)
15235	1984-093B SBS 4 (US)	76.9W/i	FSS (Ku)
12309	1981-018A Comstar D4 (US)	75.8W/i	FSS (C)
23051	1994-022A GOES 8 (US)	75.2W#	MET (P/L/S)
20873	1990-091B Galaxy 6 (US)	73.8W	FSS (C)
20872	1990-091A SBS 6 (US)	73.7W	FSS (Ku)
24714	1997-002B Nahuel 1A (Argentina)	71.7W	FSS (Ku)
23199	1994-049A Brazilsat B1 (Brazil)	70.0W	FSS (C/X)
25152	1998-006A Brasilsat B3 (Brazil)	65.0W	FSS (C/X)
23536	1995-016A Brasilsat B2 (Brazil)	65.1W	FSS (C/X)
25004	1997-059A Echostar 3 (US)	61.4W	BSS (Ku)
24916	1997-046A PanAmSat 5/PAS 5 (US)	58.0W	BSS (C/Ku)
16101	1985-087A Intelsat 512 (ITSO)	55.5W/i	Intl FSS AOR (C/Ku)
21149	1991-018A Inmarsat 2F2 (INMA)	54.8W/i	Intl MSS AOR-W (L/C)
24819	1997-027A Inmarsat 3F4 (INMA)	54.5W	Intl MSS AOR-W (L/C)
23571	1995-023A Intelsat 706 (ITSO)	53.0W	Intl FSS AOR (C/Ku)
23628	1995-038A USA 113/DSCS 3B4 (US)	52.5W/i	FSS-Milcomsat WLANT (P/S/X)
23915	1996-035A Intelsat 709 (ITSO)	49.9W	Intl FSS AOR (C/Ku)
13969	1983-026B TDRS 1 (US)	49.4W/i	FSS-Gov (S/C/Ku)
22314	1993-003B TDRS F6 (US)	46.9W	Intl FSS-Gov (S/C/Ku)
19217	1988-051C PanAmSat 1/PAS 1 (US)	44.8W	FSS AOR (C/Ku)
24891	1997-040A PanAmSat 6/PAS 6 (US)	43.4W	FSS AOR (C/Ku)
23764	1996-002A PanAmSat 3R/PAS 3R (US)	43.1W	BSS (Ku)
16116	1985-092B USA 11/DSCS 3B7 (US)	42.5W/i	FSS-Milcomsat ATL (P/S/X)
19883	1989-021B TDRS F4 (US)	40.9W#	FSS-Gov (C/S/Ku)
12089	1980-098A Intelsat 502 (ITSO)	40.5W/i	Intl FSS AOR (C/Ku)
23413	1994-079A Orion 1 (US)	37.5W	Intl FSS (Ku)
21765	1991-075A Intelsat 601 (ITSO)	34.5W	Intl FSS AOR (C/Ku)
20401	1990-001A Skynet 4A (UK)	34.0W/i	FSS-Milcomsat (P/S/X/Ka)
14077	1983-047A Intelsat 506 (ITSO)	31.4/i	Intl FSS/MSS AOR (L/C/Ku)
22116	1992-060A Hispasat 1A (Spain)	30.1W	BSS/FSS (S/Ku)
22723	1993-048A Hispasat 1B (Spain)	30.1W	BSS/FSS (S/Ku)
21653	1991-055A Intelsat 605 (ITSO)	27.5W	Intl FSS AOR (C/Ku)
15386	1984-114B Marecs B2	26.1W/i	MSS AOR (L)
20523	1990-021A Intelsat 603 (ITSO)	24.5W	Intl FSS AOR (C/Ku)
19772	1989-006A Intelsat 515 (ITSO)	23.7W#/d	Intl FSS AOR (C/Ku)
23967	1996-042A USA 127/UFO 7 (US)	23.7W/i	FSS-Milcomsat AOR (P/S/K)
20253	1989-077A USA 46/FltSatCom F8 (US)	22.8W/i	FSS-Milcomsat AOR (P/S/X/K)
21989	1992-032A Intelsat K (ITSO)	21.5W	Intl FSS AOR (Ku)
24957	1997-053A Intelsat 803 (ITSO)	21.4W	Intl FSS AOR (C/Ku)
15391	1984-115A NATO 3D (NATO)	18.3W/i	FSS-Milcomsat (P/S/X)
23528	1995-013A Intelsat 705 (ITSO)	17.9W	Intl FSS AOR (C/Ku)
21047	1991-001A NATO 4A (NATO)	17.7W/i	FSS-Milcomsat (P/S/X)
21940	1992-021B Inmarsat 2F4 (INMA)	16.9W/i	Intl MSS AOR-E (L/C)
23426	1994-082A Luch 1 (CIS)	15.9W#	FSS-Gov CSDRN (Ku)
24307	1996-053A Inmarsat 3F2 (INMA)	15.4W#	Intl MSS AOR-E (L/C)
23132	1994-035A USA 104/UFO 3 (US)	14.4W/i	FSS-Milcomsat AOR (P/S)
23319	1994-067A Express 1 (CIS)	14.0W	Intl FSS (C/Ku) Statsionar 4
23267	1994-060A Cosmos 2291 (CIS)	13.4W#	FSS-Data Relay (C)
22009	1992-037A USA 82/DSCS 3B12 (US)	12.0W	FSS-Milcomsat ELANT (P/S/X)
22041	1992-043A Gorizont 26 (CIS)	11.4W/i	FSS (C/Ku) Statsionar 11
24932	1997-049B Meteosat 7/MOP 4 (ESA)	10.2W#	MET (P/L/S) In-orbit spare
21140	1991-015B Meteosat 5/MOP 2 (ESA)	9.2W#/d	MET (P/L/S) Relocating to 65E
21805	1991-080B USA 75/DSP F16 (US)	8.9W#	FSS-Mil Early Warning AOR-E (S/X)
21813	1991-084A Telecom 2A (France)	8.0W	FSS-Gov/Mil (S/C/X/Ku)
21939	1992-021A Telecom 2B (France)	5.0W	FSS-Gov/Mil (S/C/X/Ku)
24209	1996-044B Telecom 2D (France)	5.0W	FSS-Gov/Mil (S/C/X/Ku)
23865	1996-030B Amos 1 (Israel)	3.9W	FSS (Ku)
20776	1990-079A Skynet 4C (UK)	1.1W#	FSS-Milcomsat (P/S/X/Ka)
23816	1996-015A Intelsat 707 (ITSO)	1.0W	Intl FSS AOR (C/Ku)
24808	1997-025A Thor 2A	0.6W	BSS (Ku)
20762	1990-074A Thor 1/Marcopolo 2/BSB R2	0.6W	BSS (Ku)
20168	1989-062A TV Sat 2 (Germany)	0.5W	BSS (Ku)

Satellite Launch Schedules

By Keith Stein

All launch dates presented here are unofficial target dates and are subject to frequent changes. In other words, don't plan your vacation around a launch date seen here.

Chinese Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
April 1998	Long March 2C	Taiyuan	Iridium (2 satellites)
April 1998	Long March 3B	Xichang	Chinastar-1
May 1998	Long March 3B	Xichang	Sinosat-1

Chinastar 1	Downlink Frequency Assignments
C-band	18 transponders/3.7-4.2 GHz at 87.5° East
C-band TLM	3700.5 and 4199.5 MHz
Ku-band	20 transponders/12.25-12.75 GHz at 87.5° East
Ku-band TLM	12250.5 and 12759.5 MHz
	Satellite also known as Zhongwei 1

Iridium	Downlink Frequency Assignments
L-band	1616-1626.500 MHz (FDMA/TDMA)
Ka-band	19.4-19.6 GHz (satellite to gateway/earth terminals)
	23.18-23.38 GHz (inter-satellite links)
	29.1-29.3 GHz (gateway/earth terminals to satellites)

Sinosat 1	Downlink Frequency Assignments
C-band	24 transponders/3.635-4.200 GHz at 110.5° East
Ku-band	14 transponders/12.25-12.75 GHz at 110.5° East

European Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
April 1998	Ariane 44L (V108)	Guiana	Insat 2E/ Nilesat 1

Ariane 4	Downlink Frequency Assignments
S-band	2203.0, 2206.0 and 2218.0 MHz

Insat 2E	Downlink Frequency Assignments
C-band	17 transponders in the C-band and extended C-band

Nilesat 1	Downlink Frequency Assignments
Ku-band	12 transponders/11.7-12.1 GHz

Russian Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
April 1998	Proton	Baikonur	Iridium Mission 8 (7 satellites)
April 1998	Proton	Baikonur	Echostar-4
April 1998	Zenit 2	Plesetsk	Resurs O2-N1, Fasat-Bravo, TMSat 1, TechSat 1B, Safir 2, and LLMS
May 1998	Proton	Baikonur	Astra 2A
May 1998	Soyuz	Baikonur	Progress M-40 (238)

Astra 2A	Downlink Frequency Assignment
Ku-band	28 transponder/11.7-12.5 GHz at 28.2° East

Echostar-4	Downlink Frequency Assignments
Ku-Band	16 transponders at 240 watts each/12.2-12.7 GHz at 119° West

Fasat-Bravo	Downlink Frequency Assignment
UHF band	400-401 MHz

Iridium	Downlink Frequency Assignments
L-band	1616-1626.500 MHz (FDMA/TDMA)
Ka-band	19.4-19.6 GHz (satellite to gateway/earth terminals)
	23.18-23.38 GHz (inter-satellite links)
	29.1-29.3 GHz (gateway/earth terminals to satellites)

Progress	Downlink Frequency Assignments
VHF band	166.0 MHz

Proton	Downlink Frequency Assignments
VHF band	132.400, 136.750 and 192.000 MHz
UHF band	232.0 and 240.0 MHz
L-band	915-930.0 MHz
S-band	2800-2810.0 MHz

Safir-2	Downlink Frequency Assignments
UHF band	400-401 MHz

Techsat-1B	Downlink Frequency Assignment
Ku-band	11-12.2 GHz (remote sensing camera)

TMSat-1	Uplink/Downlink Frequency Assignments
VHF uplink	145.925 and 145.975 MHz (9600 baud FSK)
UHF downlink	436.925 MHz (38.4k baud FSK)

Space Transportation System (STS-NASA)

Space Shuttles are launched from the Kennedy Space Center, Florida.

Mission Number	Launch Date/ Orbiter	Inclination Altitude	Mission Duration	Mission/Cargo Bay/Payloads
STS-90	April 1998 Columbia*	39.0/150	16 days	Neurolab
STS-91	May 1998 Discovery**	51.6/190	10 days	S/MM-9***

*STS-90 Crew Assignment: CDR: Richard A Searfoss, PLT: Scott D Altman, MS: Kathryn Hire, MS: Richard M Linnehan, MS: Dafydd R Williams (Canada), PS: Jay C Buckey, PS: James A Pawelczyk.

**STS-91 Crew Assignment: CDR: Charles Precourt, PLT: Dominic Pudwill Gorie, MS: Wendy Lawrence, MS: Franklin Chang-Diaz, MS: Janet Kavandi, MS: Andrew Thomas (D).

***S/MM-9 Crew Assignment: CDR: Talgat Musabayev, FE: Nikolai Budarin, U.S. Astronaut: Andrew Thomas (D).

STS	Downlink Frequency Assignments
UHF Voice	243.0, 259.7, 279.0 and 296.8 MHz (All AM mode)
UHF Boosters	240.0 and 242.0 MHz (recovery beacons)
S-band TLM	2217.5, 2250.0 and 2287.5 MHz.
C-band TRK	5400-5900.000 MHz

Mir	Downlink Frequency Assignments
VHF Voice	143.625 MHz (Daily Operations)
VHF Voice	145.985 MHz (Amateur Radio)
UHF Voice	437.925, 437.950 and 437.975 MHz (Amateur Radio)

Satellite Launch Schedules

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United States Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
April 1998	Athena 2	VAFB	Ikonos-1
April 1998	Pegasus XL	WFF	Orbcomm-2 (8 satellites)
April 1998	Delta II	VAFB	Iridium Mission 9 (5 satellites)
April 1998	Delta II	CCAS	Globalstar-2 (4 satellites)
May 1998	Pegasus XL	WFF	Orbcomm-3 (8 satellites)
May 1998	Titan IV	CCAS	DoD Mission B-25/ Milstar-3
May 1998	Atlas		CCAS Eutelsat W1
May 1998	Titan II	VAFB	NOAA-K
May 1998	Delta II	CCAS	Thor III
May 1998	Delta II	VAFB	Iridium Mission 10 (5 satellites)

Atlas	Downlink Frequency Assignments
S-band TLM	2202.5, 2206.5, 2210.5, 2211.0 and 2215.5 MHz
C-band TRK	5765.0 MHz

Delta II	Downlink Frequency Assignments
S-band TLM	2244.500, 2241.500 and 2252.500 MHz
C-band TRK	5765.000 MHz

Eutelsat W1	Downlink Frequency Assignments
Ku-band	18 transponders/10.95-11.7 GHz at 10.0° East 6 transponders/12.5-12.75 GHz at 10.0° East

Globalstar	Downlink Frequency Assignments
L-band	1610.0-1626.5 MHz
C-band	6875.0-7075.0 MHz

Iridium	Downlink Frequency Assignments
L-band	1616-1626.500 MHz (FDMA/TDMA)
Ka-band	19.4-19.6 GHz (satellite to gateway/earth terminals) 23.18-23.38 GHz (inter-satellite links) 29.1-29.3 GHz (gateway/earth terminals to satellites)

L-1011 A/C	Downlink Frequency Assignments
L-band	1480.5 and 1727.5 MHz
S-band	2250.5 MHz
C-band	4583.5 and 5765.0 MHz

Milstar 3	Downlink Frequency Assignments
UHF band	Four AFSATCOM transponders
S-band	SGLS downlink for telemetry and tracking
SHF	20 GHz downlink
EHF	60 GHz satellite crosslink

NOAA-K	Downlink Frequency Assignments
VHF-band	137.350, 137.500, 137.620 and 137.770 MHz
L-band	1544.500, 1698.000, 1702.500 and 1707.000 MHz
S-band	2247.500 MHz

Orbcomm-2/3	Downlink Frequency Assignments
VHF-band	137.000-138.000 MHz
UHF-band	400.100 MHz

Pegasus XL	Downlink Frequency Assignments
S-band TLM	2269.500 and 2288.500 MHz
C-band TRK	5765.000 MHz

Thor III	Downlink Frequency Assignments
Ku-band	15 transponders at 40 watts each/11.1-11.4 Ghz at 0.8° West

Titan IV	Downlink Frequency Assignments
S-band	2217.5, 2255.5, 2272.5 and 2287.5 MHz

List of Abbreviations and Acronyms

A/C	Aircraft
Astra-2A	Geostationary direct broadcast satellite for Societe Europeenne des Satellites (SES) of Betzdorf, Luxembourg.
C-band	3700 to 6500 MHz
CCAS	Cape Canaveral Air Station, Florida
CDR	Commander
Chinastar-1	Geostationary communications satellite owned by the China Orient Telecomm Company (China Orient). Prime Contractor is Lockheed Martin.
DoD	Department of Defense (United States)
Echostar-4	A direct-to-home TV geostationary satellite working through 45 cm dishes.Satellite owned by Echostar and built by Lockheed Martin.
Eutelsat W1	European commercial geostationary telecommunications satellite owned by Eutelsat.
Fasat-Bravo	A 50-kg microsatellite built by Surrey Satellite Technology Ltd. (SSTL) of Guildford, Great Britain for the Chilean Air Forces (FACH).
GHz	Gigahertz
Globalstar	Globalstar is a low-earth-orbiting (LEO) satellite-based digital telecommunications system that will offer wireless telephone and other telecommunications services worldwide beginning in late 1998 or early 1999. Owned by Globalstar and satellites built by Space Systems/Loral.
Ikonos-1	Earth resources satellite owned by Space Imaging EOSAT.
Insat-2E	Geostationary communications satellite owned by the Indian Space Research Organization (ISRO)
Iridium	The Iridium system is a planned commercial communications network comprised of 66 low earth orbiting satellites. The system will use L-band to provide global communications services through portable handsets. Satellites owned by Iridium and built by Lockheed Martin.
K-band	10.90 to 17.15 GHz
L-band	500 to 1549 MHz
LLMS	A 40-kg Little LEO Messaging System payload for SAIT-Systems SA of Brussels, Belgium.
Loralsat-1	Geostationary communications satellite built and owned by Space Systems/ Loral.
MHz	Megahertz
Milstar	DoD military geostationary communications satellite. A telephone switchboard in space to route all military message traffic and conversations around the world. Built by Lockheed Martin for the U.S. Air Force.
MS	Mission Specialist
Neurolab	Investigates the effects of weightlessness on neurological processes using both human and animal specimens.
Nilesat-1	Communications satellite owned by the Egyptian Radion and TV Union. The satellite was built by Matra Marconi (Eurostar bus).
NOAA-K	Polar orbiting U.S. weather satellite operated by the National Oceanic and Atmospheric Administration (NOAA).
Orbcomm	Orbcomm will provide low-cost alpha numeric data communications and position determination for emergency assistance, data acquisition and messaging services using pocket portable and mobile subscriber terminals.
PLT	Pilot
Progress	An unmanned cargo ship for crew aboard Mir space station.
Resurs 02	Earth imaging satellite built by VNII Elektromekhaniki (VNIIEM) of Moscow, Russia for NPO Planeta of Dogoprudni, Russia.
Safir 2	A 60-kg satellite provided by OHB-Systems GmbH of Bremen, Germany for messaging satellite for its subsidiary OHB Teledata.
S-band	2000 to 2300 MHz
SGLS	Space Ground Link Subsystem
Sinosat-1	Voice and data geostationary communications satellite owned by SinoSatellite Corporations in Beijing, China and built by Aerospatiale.
S/MM-9	Last shuttle mission to the Russian Space Station Mir to support design and assembly of the International Space Station (ISS).
TechSat	A 52-kg satellite built by Technion University in Haifa, Israel.
Thor	Geostationary communications datellite owned by Telenor in Norway and built by Hughes.
TLM	Telemetry
TMSat 1	A 50-kg microsatellite for Thai MicroSatellite Co (TMSat) of Thailand.
TRK	Tracking
UHF	Ultra High Frequency (300 MHz to 3 GHz)
VAFB	Vandenberg Air Force Base, Calif.
VHF	Very High Frequency (30 to 300 MHz)
X-band	8000 to 10999 MHz
XL	Extra Large

Satellite Launch Report

By Phillip Clark, Molniya Space Consultancy

How to Use the Satellite Launch Report

The *Satellite Launch Report* is a complete list of satellite launches which took place during January 1998. The format of the listing is as follows:

First line: launch date and time (UTC), international designation of the satellite, satellite name and satellite mass.

Second line: date and time (in decimals of a day, UTC) of the orbital determination, orbital inclination, period, perigee and apogee. In some cases where a satellite has manoeuvred, more than one set of orbital data will be listed.

This data is followed by a brief description of the satellite's planned mission, the launch vehicle, launch site, etc. '*' next to satellite's mass indicates that the mass has been estimated, and that no official information has been published.

The *Satellite Times Satellite Launch Report* is extracted from more detailed monthly listings, *Worldwide Satellite Launches*, compiled by Phillip S. Clark and published by Molniya Space Consultancy, 25 Redfern Avenue, Whitton, Middx TW4 5NA United Kingdom.

Launch Date/Time Epoch	Int Des Incl	Period	Satellite Perigee	Mass Apogee
1998 Jan 7/0228	1998-001A		Lunar Prospector	233 kg
Trans-lunar orbit then selenocentric orbit				

Lunar Prospector is a lunar orbiter (the third Discovery mission, the first two being NEAR and Mars Pathfinder), operated by NASA Ames: dry mass is 126 kg. Trans-lunar injection (TLI) took place Jan 7, 1998, at 0323 UTC, leaving the Orbit Adjust Motor (OAM) in a low Earth orbit. Lunar Prospector performed lunar orbit injection (LOI) Jan 11, 1998, starting at 1145 UTC, with further maneuvers on Jan 12 and 13 and a series of trim manoeuvres on Jan 15 to reach a 90.0 deg, 118 minutes, 99-100 km selenocentric orbit. Spacecraft is expected to spend a year performing a global chemical survey of the lunar surface, as well investigating the lunar magnetic and gravitational fields. The spacecraft also carried a Celestis capsule containing some of the remains of the space geologist Eugene Shoemaker. Maiden flight of the Athena-2 launch vehicle (previously the vehicle was known as the Lockheed–later Lockheed Martin–Launch Vehicle), launched from Cape Canaveral: all three stages of the Athena-2 proper were sub-orbital, with an OAM entering low Earth orbit.

1998 Jan 10/0032	1998-002A		Skynet 4D	1,493 kg
1998 Jan 21.32	4.19 deg	1,426.82 min	35,559 km	35,651 km

Skynet 4D is a communications satellite launched for the United Kingdom Ministry of Defense: mass quoted is at launch, on-station it is ~850 kg at the beginning of operations. Satellite to be located over 6 deg E. Launched from Cape Canaveral using a Delta-2 (7925) vehicle.

Launch Date/Time Epoch	Int Des Incl	Period	Satellite Perigee	Mass Apogee
1998 Jan 22/1256			Ofeq 4	250 kg?
Failed to reach orbit				

Fifth Ofeq (Horizon) satellite to be launched, third to reach orbit. No details of the satellite, but it is possibly similar to Ofeq 3 (1995-018A). Satellite was probably planned to perform a photoreconnaissance and/or ELINT mission. Details of the failure have not been confirmed, but glimpses of the Shavit launch footage suggest that either the first stage burn failed at altitude or that the second stage burn did not achieve full thrust. No details of the planned orbit, but it might have been similar to that attained by Ofeq 3. Launched from Palmachim.

1998 Jan 23/0248	1998-003A		Endeavour (STS-89)	114,130 kg
1998 Jan 23.14	51.67 deg	90.54 min	296 km	306 km
1998 Jan 24.91	51.66 deg	92.20 min	378 km	387 km
1998 Jan 29.98	51.66 deg	91.96 min	359 km	383 km

Eighth Shuttle-Mir Mission (SMM-8) and the first and only visit of Endeavour to the Mir Complex. Crew comprises seven astronauts: T W Wilcutt (commander), J F Edwards Jr (pilot), J F Reilly (mission specialist, MS-1 and EVA astronaut EV-1), M P Anderson (MS-2, EV-2), B J Dunbar (payload commander, MS-3), S S Sharipov (Russian cosmonaut, MS-4) and A S W Thomas (MS-5): Thomas took over from Wolf (launched aboard Atlantis/STS-86) as the resident NASA astronaut on Mir, with Wolf returning aboard Endeavour as MS-6: Thomas scheduled to return aboard STS-91 mission in June 1998. Mass quoted is that projected at the time of landing. Payload bay carries Orbiter Docking System (mass 1,822 kg) and Spacehab Double Module (mass 5,859 kg). After launch from KSC, orbiter docked with the docking module attached to Kristall Jan 24 at 2014 UTC and undocked Jan 29 at 1657 UTC: landed at KSC at 2235 UTC two days later.

1998 Jan 28/1633	1998-004A		Soyuz-TM 27	7150 kg?
1998 Jan 29.74	51.58 deg	88.59 min	188 km	222 km
1998 Jan 31.93	51.66 deg	92.19 min	379 km	385 km

Three-manned spacecraft carrying T A Musabayev (commander), N M Budarin (flight engineer) and L Eyharts (French spationaut, conducting the Pegasus mission). Spacecraft docked with the -X (rear) Kvant 1 port of the Mir Complex Jan 31 at 1754 UTC. Musabayev and Budarin should remain on board the Mir Complex until August 1998, while Eyharts will return to Earth with Solovyov and Vinogradov aboard Soyuz TM-26 Feb 18, 1998. Launched from Baikonur using a Soyuz-U vehicle.

1998 Jan 29/1837	1998-005A		USA 137 (Capricorn)	2,500 kg?
1998 Jan 30	63? deg	720.7? min	1,000? km	39,500? km

GROVE
Complete Buyer's Guide

THE MOST RESPECTED NAME IN RADIO!

Save this Guide for your future product needs. We carry a complete line of radio scanners, shortwave receivers, satellite communications equipment, monitoring software, antennas, books, accessories, AND TWO GREAT MAGAZINES. Don't see what you need? Call us!

April 1998

More Grove product information can be requested by phone, fax, ground mail, or e-mail. Please visit us on-line at **www.grove.net/~grove**

NEW! FRS WALKIE-TALKIES!

Both of these tiny titans run full legal power (1/2 watt) in the new, license-free, 462/467 MHz Family Radio Service (FRS). Their outstanding 0.25 microvolt sensitivity provides reliable line-of site communications for up to two miles! Instantly select any of 14 separate channels--you can even scan them for activity--and even privacy-code them from dozens of professional CTCSS squelch tones for interference-free communications! Top-panel jacks accept convenient lapel speaker/mikes, and belt clips are included.

FR-465 Cherokee

Shirt-pocket size, offers "ring alert" for incoming calls, removable SMA-base rubber duckie, operates on five AAA alkaline or rechargeable cells (optional).

ACCESSORIES

BAT 6	AAA alkaline cells (5 required)	$.79
CAS 4	Leatherette carrying case	$19.95
PWR 13	Universal Plug-In Charger	$9.95
MIC 1	Mini Lapel Speaker/Microphone	$19.95

ORDER TR 1 only **$139.95**

75-510 Midland

Hand-size powerhouse has large, backlit LCD display for night viewing; four AA rechargeable batteries and AC charger included at no extra cost.

ACCESSORIES

BAT 1	AA Energizer Industrial	$.79
BAT11	AA NiCd cells (4 required)	$1.95
BAT13	AA NICd cells (4 required)	$2.75
MIC 1	Mini Lapel Speaker/Microphone	$19.95

ORDER TR 2 only **$149.95**

Note: Both models may be networked with other brands and models.

A casual glance through this month's new buyer's guide will reveal a number of new products, books, and accessories to improve your radio requirements. We have tested several of the charming little Family Radio Service (FRS) walkie-talkies and have chosen two models from Cherokee and Midland that we feel are particularly outstanding. Quite frankly, we don't know how they can build this kind of performance and quality into such low-cost, two-way radios. And no license is required, either.

Our new Maxon weather alert receiver offers excellent reception on all channels, and includes a weather emergency notification alarm. For fringe listening, it even has an external antenna jack. It's very inexpensive, too--what a great combination!

We have finally located an extremely effective filter for those annoying digital pagers. These units from PAR Electronics are rugged and effective against the VHF and UHF MHz paging signals. They were built for the two-way radio industry, but their extremely affordable price makes them ideally suited for scanner applications.

But we don't want to take all the fun away; look through these pages and find some more of these bargains yourself!

Judy Bob

Bob & Judy Grove

WEATHER ALERT MONITOR!

New!

Crystal controlled for superb stability, this tiny receiver allows you to select any of the seven nationwide NOAA National Weather Service channels for immediate weather information. Listen to 24 hour voice weather broadcasts, or select flashing light or siren for severe weather alerts. Sits on your desk or nightstand, or mounts on a wall. For strong signal areas, use the adjustable antenna and in fringe areas, plug in your outdoor antenna for reliable reception. Comes with AC adaptor, or may be operated from internal 9-volt battery (optional) during power outages.

ORDER RCV 25 only **$39.95**

UPS Second Day Air at Ground Rates on ALL PRODUCTS! Order Line and Product Support Info.: **1-800-438-8155**

Improved Drake R8-B

- *Selectable Sideband Synchronous Detection*
- *Increased scanning speed*
- *1000 memory channels*

The shortwave industry's most popular receiver has been upgraded to include selectable-sideband synchronous detection, increased scanning speed, and 1000 memory channels! The Drake R8B additionally offers excellent audio, frequency agility (100 kHz-30 MHz, expandable to 33-55 and 108-174 MHz with optional converter), friendly control panel, noise blanker, passband tuning, preamp/attenuator selection, universal power supply, dual clock timers, giant display, five filter bandwidths, six receiving modes, single-keypress mode and bandwidth selection, alpha-numeric display of station identification, overload immunity, tone control, tight frequency stability, RS232 computer control, and more! See complete specifications on page "E". **Accessories: ACC 43, MAN 2, and SPK 2 beginning on page "M"; ANT 2, ANT 24, p. "D"; SPK 13, p. "K".**

ORDER RCV 3 only **$1159.95**

Drake SW8

This combination desktop/portable world band receiver from R.L. Drake—with improved sensitivity, selectivity, noise reduction—offers continuous coverage 500 kHz-30 MHz, 87-108 MHz FM broadcast (stereo at headphone jack), and 116-136 MHz aircraft as well! Standard and synchronous detection AM, upper and lower sideband on medium and shortwave, direct frequency entry keypad, 0.5 microvolt sensitivity, dual 6/4 kHz selectivity on AM, sharp 2.3 kHz selectivity on SSB. Up-conversion eliminates images, while +10 dB intercept point suppresses intermod. Includes an amplified whip antenna on all frequencies. See complete specifications on page "E". **Accessories: CAS 10, p. "M"; ANT 2, ANT 24, and TUN 4A, pp. "C" and "D"; SPK 13, p. "K".**

ORDER RCV 19 only **$779.95**

AR7030 PLUS

PLUS
PERFORMANCE

The new AR7030 "PLUS" offers superior performance. Its 105 dB dynamic range, +35 dBm third-order intermod rating, and razor-sharp selectivity guarantee signal overload immunity under conditions that would stagger other high-end receivers, yet its 0.3 microvolt SSB sensitivity snags even the weakest signals. Improved intermod rejection is assured with new balanced mixer and enhanced attenuator, while high sensitivity is provided with tight tolerance (0.1%), low noise, synthesizer components. Choose selectivity from 2.2, 4.0, 5.3, or 9.5 kHz, and enter your favorite frequencies into 400 memory slots complete with alphanumeric tags and clock/timer.

Continuous 0-32 MHz frequency coverage, high-stability TCXO oscillator, all-mode reception, synchronous detection, superb audio quality, compact portability, 2.6 Hz tuning increments, interference-resistant shielding, passband tuning, noise compressor, dual VFOs, enhanced AGC, programmable attenuator, and numerous other features combine to make this one incredible, affordable receiver. See complete specifications on page "E". **Accessories: ANT 2, ANT 24, p. "D"; SPK 13, p. "K".**

ORDER RCV 17 only **$1269.95**

Bargain-Priced JRC NRD-345

Known for their luxury, high-performance receivers, Japan Radio company (JRC) has released a high quality, double conversion receiver at a low, competitive price! The new NRD-345 offers wide frequency coverage (100 kHz-30 MHz), multimode reception (AM, synch. AM, SSB), sharp selectivity (2/4 kHz), high sensitivity (0.3 microvolts), wide dynamic range (100 dB), strong audio (1 watt), dual VFOs, scannable memory (100 channels) with channel lockout, computer control (RS232C), dual clock timer (12/24 hour), precision tuning (5/100 Hz;, 1/10 kHz steps), and adjustable noise blanker. Additional features include selectable AGC timing, 20 dB attenuator, adjustable tone control, backlit S meter, large backlit LCD display, and dual-voltage (12 VDC / 120 VAC) power supply. See complete specifications on page "E". **Accessorices: ANT 2, ANT 3, p. "D"; SPK 13, p. "K".**

ORDER RCV 20 only **$799.95**

The Popular SONY ICF-2010

This is a full-featured radio for the serious shortwave listener—with a reputation of distinction among the "powerful portables." Synchronous detection allows interference-free reception on many stations difficult to hear on other radios. Narrow/wide selectivity switching; clock/timer allows up to 4 automatic on/off cycles per day for frequencies and times of your choice; 10-step LED signal strength meter, audio tone selection for speech or music; and 32 station direct-access keyboard combine to make this Sony product a remarkable value for beginners or seasoned SWL's.

Frequency range includes150 kHz-30MHz, 76-108, and 116-136 MHz. Requires 3D/2AA cells. See specificationson page "E". **Accessories: BAT 1, BAT 2 beginning on page "M"; ANT 3, ANT 32, ANT 21 and TUN 4A, pp. "C" and "D"; SPK 13, p. "K".**

ORDER RCV 2 only **$349.95**

Need something smaller?

This tiny Sony ICF-SW100 offers continuous 150 kHz-30 MHz and 76-108 MHz FM frequency ranges, Sony's famous synchronous detection, USB/LSB reception, 100 Hz tuning steps, 50 memory presets, 24 hour clock/timer, world time computer, station name display, and much, much more. See specifications on page "E". **Accessories: BAT 1, SPK 11 beginning on page "M"; ANT 21 and TUN 4A, pp. "C" and "D"; SPK 13, p. "K".**

ORDER RCV 24
$359.95

UPS Second Day Air at Ground Rates on ALL PRODUCTS!

NEWLY UPDATED SONY ICF-SW7600GS

Now includes an LPI Shortwave Active Antenna and AC adaptor!

19" antenna folds to compact 7" to fit in carrying pouch. Included with RCV 11 and also available separately— see below.

This compact marvel has synchronous AM detection, SSB, and even FM stereo coverage! DX/local switch reduces "pumping" on strong SSB signals.

Continuous 150 kHz-29.995 MHz frequency coverage plus 87.6-108 MHz FM headphone stereo, pushbutton tuning, tone control, external antenna jack, clock timer with sleep function, tilt bracket, direct-entry keypad and 22 scannable memory channels keynote the high-tech features of this potent portable! See specifications on page "E". Requires 4 AA cell batteries. **Accessories: ANT 2, ANT 3, p. "D"; TUN 4A, p. "C"; BAT 1, SPK 11, beginning on page "M".**

ORDER RCV 11 only **$249.95**

COMPACT ACTIVE LOOP ANTENNA. Sony's AN-LP1 signal booster (shown above) is also available separately. Plugs into any shortwave portable with 1/8" antenna jack. Ideal for travelers, apartment dwellers. Includes 12' remote cable, carrying pouch; requires 2 AA cells.

ORDER ANT 26 only **$89.95**

Sangean ATS909 Multiband Radio

This portable receiver sets a new standard with continuous coverage longwave, mediumwave, and shortwave reception plus FM (stereo with earphones), alphanumeric display for station identification, 306 channel memory, USB/LSB mode with 40 Hz step tuning, 29 memory banks with automatic search, world time for 42 cities, three independent timers, signal strength indicator, wide/narrow filter selection, RF gain, and tone control. See specifications on page "E". Accessories: **ANT 3, ANT 21, ANT 32, and TUN 4A, pp. "C" and "D"; BAT 1 (4 required), SPK 11, beginning on page "M".**

ORDER RCV 8 only **$259.95**

Versatile Sangeans

ATS-818CS w/cassette recorder
ORDER RCV 9 only **$219.95**

ATS-818 w/o cassette recorder
ORDER RCV 7 only **$149.95**

Imagine—record your favorite programs automatically with the dual-zone clock timer on any frequency from 150 kHz through 30 MHz, 87.5-108 MHz FM as well! This impressive portable has SSB and CW reception, 45 memory channels, wide/narrow filter selectivity, signal strength indicator, AC wall adaptor, and more! Requires 4 D cells. See specifications on page "E".

Receivers are the same, excluding the tape recorder specifications. **Accessories: ANT 3, ANT 21, ANT 32, and TUN 4A, pp. "C" and "D"; BAT 2, SPK 11, beginning on page "M".**

GE Superadio III for AM/FM DXing

This receiver for AM/FM DXers features smooth vernier dial and tuned RF on both AM and FM, while a ceramic IF filter and 7 tuned IF circuits provide outstanding selectivity. The two-way speaker system with separate bass, treble, and loudness controls assure solid, clean sound, and the drift-cancelling, automatic frequency control (AFC) circuit can be switched out for weak-signal hunting. The internal AM loop and FM whip antennas provide convenient portability, while external antenna jacks accomodate your long-distance antennas.

Powered by 120 VAC or six internal D cells (optional). **Accessories: ANT 3, ANT 21, ANT 31, ANT 32, and TUN 4A, pp. "C" and "D"; SPK 13, p. "K"; BAT 2, p. "M".**

ORDER RCV 5 only **$59.95**

GROVE TUN-4A MINITUNER PLUS

Here's a high performance, amplified, frequency-tunable antenna system for general coverage shortwave and medium wave monitoring. For indoor use, connect a short length of wire or the popular Grove ANT-6 Hidden Antenna. Connected to an outdoor antenna like the Grove ANT-2 Skywire or ANT-3 Mini Skywire, the TUN-4A MiniTuner Plus provides knockout signal strength and allows frequency preselection as well.

Continuous 400 kHz-30 MHz coverage, -20 to +20 dB gain/attenuation control, dual antenna switch, dual receiver output, amplified/unamplified preselection, band switch, fine tuning, and built-in lightning protection. Full instructions included. Requires 12VDC power (sold separately). **Accessories: ADP 6, ADP 11, ADP 27, ADPK 15, ANT 25, and PWR 19 beginning on page "M"; ANT 2, ANT 3, p. "D".**

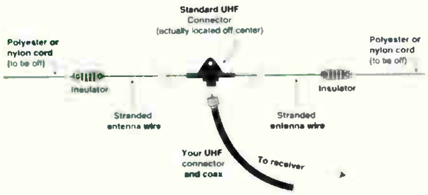
ORDER TUN 4A only **$99.95**

Other Grove Shortwave Receivers

Drake				
Drake SW2	RCV-18	Tabletop 100 kHz-30 MHz, AM, synch AM, USB/LSB 50 Hz tuning, 100 memory channels	$489.95	BRK-12, ACC9, BRK-13, ANT-3, ANT-15, SPK-13, TUN-4A
Grundig				
Yacht Boy 400	RCV-22	Portable, 160 kHz-30 MHz, 87.5-108 MHz, AM, FM, USB/LSB 5/1 kHz tuning 40 memory channels	$199.95	ANT-3, ANT-21, ANT-32, BAT-1, PWR-8, SPK-11, TUN-4A
Sangean				
Sangean ATS808A	RCV-13	Portable 150 kHz-30 MHz, 87.5-108 MHz, AM, FM, 5/1 kHz tuning AM, 54 memory channels	$129.95	ANT-3, ANT-21, ANT-32, BAT-1, PWR-10, TUN-4A
Sony				
Sony ICF-SW77	RCV-10	Portable 150 kHz-30 MHz, 76-108 MHz, AM sync AM, FM, USB/LSB 50 Hz/1 kHz tuning, 162 memory channels	$469.95	ANT-3, ANT21, ANT32, BAT-1, BAT-2, SPK13, TUN-4A, WP-4

Order Line and Product Support Info.: 1-800-438-8155

GROVE SKYWIRE



High performance and low cost. Comes fully assembled with Budwig center connector ready for your PL-259 (UHF male) equipped coaxial cable (50 or 75 ohm, see page j); includes two porcelain end insulators and complete instructions. Covers 500 kHz to 30 MHz.

HAMS! Ideal for transmitting when used with a transmatch. (1.8-30 MHz at up to 250 watts)

ORDER ANT 2 only $39^{95}

SPECIFICATIONS:
Length: 66 feet
Feedpoint impedance: 50 or 75 ohm (nominal)
Feedpoint location: 22 feet from end
Elements: 18 AWG (16 x 30) bare stranded copper
Connector housing: Heavy duty black phenolic

Limited Space? Try Grove's new *Mini-Skywire*

Similar to above, but 40-foot dual-dipole.

ORDER ANT 3 only $29^{95}

STONER-DYMEK

If a large, outside dipole is out of the question, choose the professional Dymek DA-100E, 50 kHz-30 MHz active receiving antenna! High sensitivity, low noise, wide dynamic range, step-selectable attenuator, static-discharge-protected, weatherproof remote amplifier/whip assembly. Includes AC power supply, 50 feet RG-58/U coax, remote amplifier, 4' stainless-steel whip, receiver-interconnect cable (RCA) for radios with screw terminals; for PL-259 or 1/8" miniplug connector, order ADPK 2 (see p. "m").,

ORDER ANT 24 only $179^{95}

Select-A-Tenna

Apartment dwellers and mobile home owners, boost your 530-1700 kHz AM broadcast reception up to 30 dB with the famous Select-A-Tenna! Improves adjacent channel rejection, reduces signal fading. Tuning knob selects your listening frequency.

No batteries, power, or connection required; the 11", high-Q loop antenna focuses its captive signals to your radio's internal ferrite loop. If your receiver requires an external antenna, a convenient 3.5 mm (1/8") jack and plug provided.

ORDER ANT 21 only $59^{95}

KIWA Medium Wave Air-Core Loop Antenna

Are you looking for the ultimate indoor antenna for medium wave reception on your communications receiver? Then look no more—this unique 12-inch, circular air-core antenna provides improved weak signal reception of medium wave broadcast signals and its electronically balanced circuitry minimizes pickup of electrical interference. Some of the other high performance features of the Kiwa loop include:

- Full 530-1705 kHz MW frequency coverage
- May be precisely rotated and tilted for maximum signal pickup and nulling of interfering stations.
- Equipped with local/DX pre-amp switch, variable output attenuator, and dual output amplifiers.
- May be powered by a low-noise AC supply, included, or by battery.
- Stands 17 inches (43 cm) high and weighs 16 pounds (7.25 kg).

ORDER ANT 31 only $349^{95}

JPS Noise Canceller/Active Antenna

Enjoy Crystal Clear Sound!

Imagine, just connect this simple device between your receiving antenna and shortwave receiver or transceiver, and null out locally-generated interference of virtually *any* kind! Computer hash, line noise, TV synch buzz—they all go away when the ANC-4 is adjusted to your receiver to receive 100 kHz-80 MHz!

Use the attachable whip (provided) or, even better, a second external antenna to sample local noise. A simple adjustment from the front panel reduces or even eliminates virtually any electrical noise interference you are likely to encounter! The new ANC-4 can even be used as a frequency-selective active antenna/signal booster! Whip, random wire antenna, DC plug and full instructions provided. Requires 12 VDC @ 300 mA power. **Accessory: PWR 13 on page "M".**

ORDER ACC-21 only $194^{95}

Exciting New KIWA Pocket-Loop Antenna

This highly efficient signal grabber is 12" across when deployed, yet collapses to a tiny pocket size for transport! Designed to receive and amplify signals from 530 kHz through 20 MHz in four bands, no antenna jack on your portable radio is needed; it space-couples to your radio's existing whip and internal ferrite rod!

ORDER ANT 32 only $119^{95}

NEW! KIWA POCKET REGENERATION MODULE adds up to 18 dB of frequency-selective gain to your Pocket Loop from 530 kHz to beyond 10 MHz! **Order ACC01, only $47.95.**

H800 Skymatch

Compact Active Antenna

Imagine a two-foot antenna that performs like a 100 foot antenna; and what if that compact powerhouse could receive signals from 10 kHz through 50 MHz? That's VLF, medium wave, shortwave, and even VHF low band all rolled into one! Operates either from 120 VAC or optional 9 volt batteries for portable or emergency use.

Wide dynamic range resists strong-signal-overload problems, while high sensitivity enhances weak signals. Mounts inconspicuously on a porch, outside a window, on a roof, in a tree, or even in the radio room (not recommended because of electrical noise pickup).

Includes integrated active antenna, 50 feet of coax lead-in, control box, and AC adaptor. Equipped with RCA jack. **May require adaptor ADP 32 or ADP 25, see p. "M".**

ORDER ANT 15 only $99^{95}

UPS Second Day Air at Ground Rates on ALL PRODUCTS!

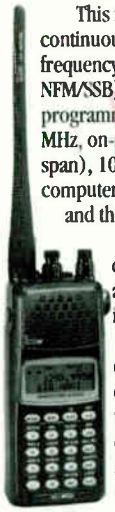
Grove's Shortwave Receiver Specification Guide

Prices and specifications subject to change without notice

Receiver	AR 7030 "Plus"	Drake R8B	Drake SW2	Drake SW8	Grundig Yt. By. 400	JRC NRD-345	Sangean ATS-808	Sangean ATS-818CS	Sangean ATS-909	Sony ICF-SW77	Sony ICF-SW100	Sony ICF-SW2010	Sony ICF-SW7600GS
Grove Order #	RCV 17	RCV 3	RCV 18	RCV 19	RCV 22	RCV 20	RCV 13	RCV 9	RCV 8	RCV 10	RCV 24	RCV 2	RCV 11
Grove Price	$1269.95	$1159 95	$489 95	$779 95	$199 95	$799 95	$129 95	$219 95	$259 95	$469 95	$359 95	$349 95	$249.95
Frequency Range	0-32 MHz	100kHz-30MHz (35-55/108-174MHz with optional converter)	100 Hz-30 MHz	100 kHz-30 MHz, 87-108.118-137MHz	160kHz-30MHz 87.5-108MHz	100 kHz-30 MHz	150kHz-30 MHz, 87.5-108 MHz	150kHz-30MHz 87.5-108MHz	150kHz-30MHz 87.5-108 MHz	150kHz-29.99MHz 87.5-108 MHz	150kHz-30MHz 76-108 MHz	150kHz-30MHz 76-108, 116-136MHz	150kHz-29.995MHz, 87.6-108MHz
Keypad Entry?	Remote control (incl)	Yes, plus tuning dial	Yes	Yes, plus tuning dial	Yes	Yes	Yes	Yes	Yes	Yes, plus tuning dial	Yes, plus tuning dial	Yes, plus tuning dial	Yes
Tuning Steps	2 665 Hz SSB, 20.62 Hz AM/FM	10/100Hz 1 kHz	50 Hz-5 kHz	50 kHz FM 100 Hz AM	1/5 kHz	5/100 Hz,1/10 kHz	50/100 kHz FM, 10/9/5/1 kHz AM	1kHz	40 Hz USB/LSB	50Hz/1kHz	100Hz/1/5kHz, 9/10kHz MW, 50kHz FM	100Hz/1kHz	1kHz
Display	Backlit LCD	Backlit LCD	Backlit LCD	Backlit LCD	Backlit LCD	Backlit LCD	LCD	Backlit LCD	Backlit LCD	Backlit LCD	Backlit LCD	Backlit LCD	Backlit LCD
Dimmer		Yes	Yes	On/Off	On/Off	No	No	Yes		On/off	On/Off	On/off	No
Receiving Modes	AM/synchronous AM/ USB/LSB/CW, data, NFM	AM, NFM, USB, LSB, CW, RTTY	AM, AM Synch, USB, LSB	AM, AM synch., WFM, LSB, USB	AM, LSB, FM, CW, USB	AM, AM synch, USB, LSB	AM, FM	AM, LSB, WFM, USB	AM, FM broadcast, USB, LSB	AM, AM synch., LSB, WFM, USB	AM, AM synch., USB, LSB, CW, WFM	AM, USB, LSB, WFM, synch. det	AM, WFM, USB, LSB, synch. det
Memory	400 channels	1000 channels	100 channels	70 channels	40 channels	100 channels	45 channels	45 presets	307 channels	162 channels	50 channels	32 channels	22 channels
Scan	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Banks		10	No	7	No	No	No	No	29	20	10	No	No
Search		No	No	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Delay		Yes	No	5 sec. per step	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No
Clock	Clock timer	Dual time zone	No	Dual mode	12/24 hr./sleep	12/24 hour clock/timer	24 hour UTC/local, alarm/timer	Dual time with record	3 separate timers with alarm	12/24 hr	24 hr./sleep	12/24 hr./alarm/sleep	w/ timer and sleep
Audio Output (Typical)	2 W @ 8 ohms	2.5 W @ 4 ohms		2 W @ 4 ohms	700 mW	1 Watt	440 mW @ 10 @ THO	800 mW		400 mW	250 mW	380 mW	
Record Audio Output	Yes	Yes	No	Yes	No	Yes	No	No	Yes	138 mV	245 mV	.775 mV @ 1000 ohms	Yes
Recorder Activator	Yes	No	No	No	No	No	No	Internal prog. cassette	No	Yes	No	No	No
Signal Strength Ind.	LCD Bargraph	Analog S-meter	Analog S-meter	Analog S-meter	LCD bargraph	LCD bargraph	No	Yes	LCD bargraph	LCD bargraph	No	LED bargraph	Single 'tune' LED
Computer Interface	RS232	RS232C	No	No	No	RS-232C	No	No	No	No	No	No	No
Conversion Scheme	Double up-conversion (45 MHz/455 kHz)	Double up-conversion	Double up-conversion (55 MHz/455 kHz	Double up-conversion	Double up-conversion	Double up-conversion	Double up-conversion	Double up-conversion	Double up-conversion	Double up-conversion	Double up-conversion	Double up-conversion	Double up-conversion
Sensitivity (typical)	0.5 uV	0.5 uV	0.5 uV	0.5 uV		0.3 uV							
Selectable Atten.	5 level	Yes	No	Yes	Yes	20 dB	Yes	RF gain control	RF gain control	Yes	Yes	Yes	Yes
IF Selectivity (-6/-60dB)	2.2/4/5.3/9.5 kHz	6/4/2.3/1.8 kHz; 500 Hz	6/12 kHz AM, 2.3/5 kHz SSB	(-6/-50 dB): AM Narrow 4/6 kHz SSB 2.3/4.5 kHz		4/10 kHz wide, 2/6 kHz narrow	Wide/narrow AM	Wide/narrow switch 6.5 kHz AM	Wide/narrow AM			Wide 9/18 kHz Narrow 4/18 kHz	
Passband Tuning	±4.2 kHz, all modes	+/-3 kHz	No	No	No	No	No	No	No	No	No	No	No
Adjustable Notch Filter	No	500-5000 Hz, 40 dB	No	No	No	No	No	No	No		No	No	No
Antenna Connector	SO-239 and 600 ohm	Dual, switched SO 239	SO-239 and screw terminal	SO-239, Push terminals, Integral whip	1/8" mini whip	SO-239 and 600 ohm	1/8" miniplug	1/8" miniplug	1/8" miniplug	1/8" miniplug	1/8" miniplug	1/8" miniplug	1/8" miniplug
Dimensions (W"xH"xD")	9.5x3.5x9	13.5x5.25x13	11x4.5x7.5	11.5x5.25x13	7.75x4.62x1.75	10x4x9'D	7.5x5x1.5'D	11.25x7.37x2.75	8.5x5x1.5	10.87x6.87x1.87	4.37z2.87z93	11.37x6.25x2.16	7.27x4.72x1.25
Weight	4 lbs. 13 oz	13 lbs.	5.8 lbs	10 lbs.	1 lb. 5 oz	7.7 lbs.	1 lb. 5 oz.	3 lbs. 13 oz	1 lb. 12 oz.	3.25 lbs.	8 oz.	3.75 lbs.	1.25 lbs
Power Requirement(s)	120 VAC (supply included) or 15 VDC @ 1 A (12 VDC w/ less perf.)	100/120/200/2450VAC, 11:16VDC @ 2A	12 VDC/120 VAC	6-9VDC/6 cells	6AA cells/9VDC	12 VDC/120 VAC	6 VDC @ 300 mA or 6 AA cells	120VAC/int cells 4D cells	4AA batteries or optional AC adaptor, 6 VDC	6VDC or 4C cells	120VAC or 2AA cells	120VAC or 3D/2AA cells	120VAC or 4AA cells
Warranty	One year	One year	One year	One year	One year	One year	One year	One year	One Year	One year	One year	One year	One year
Accessories Incl.	Manual, AC adaptor	Manual, AC adaptor	AC adaptor, wire antenna, manual	Tele. whip/AC adaptor, manual	Reel ant./case/ earphone/SW Guide/ 6AA batteries	AC acaptor, manual	Soft pouch/stereo earphones/external antenna adaptor	AC adapt./ ext. ant. adaptor/ SW Guide	AC adapt., carrying pouch, earphones, external antenna connection	Stereo earphones/ AC adapt./tele. ant/ SW Guide	Stereo earphones/AC adapt./tele. ant/soft pouch/SW Guide	Earphone/ AC adapt./wire ant./tele ant/strap/ext. ant adapt./SW Gd	Carrying case/LPI active antenna/AC adaptor

GROVE

ICOM R-10!



This incredible scanning receiver features continuous 500 kHz-1300 MHz (less cellular) frequency coverage, multimode (AM/WFM/NFM/SSB) reception, rotary tuning control, programmable tuning steps from 100 Hz-1 MHz, on-screen spectrum display (200 kHz span), 1000 channel non-volatile memory, computer control, and second-radio cloning--and these are just the beginning!

Wide-dynamic-range triple conversion, and sharp selectivity assure dramatic improvement in interference-free reception.

Eight alphanumeric characters can be entered to identify any channel, and ten characters can be used to identify banks. Voice scan control skips unmodulated carriers. Scan memory channels by bank, mode, or program. High-contrast display and powerful, dual-function keyboard provide incredible options to suit your listening requirements. Noise blanker and automatic noise limiter provide double noise reduction. Sleep timer and programmable attenuator are additional advantages. See specifications on page "L". **Accessories: ACC 3, ACC 4, ADPK 4, CAS 1-N, DCC 5 beginning on page "M"; ANT 8 and ANT 14 on p. "J"; SFT02 on p. "K".**

ORDER SCN 06 only **$399.95**

AR-8000B!

With wide frequency coverage—500 kHz-1900 MHz (less cellular), 1000 memory channels, AM/FM/SSB reception, selectable tuning steps from 50 Hz-999.995 kHz. An oversized, edgelit LCD window holds 44 bold alphanumeric characters.

Autostore, RS232 control, power saver, keyboard beep defeat, and selectable-channel display blanking. Dial tunes frequencies and channels. Dual VFOs and 30-channel-per-second scan/search speed.

Each channel may be programmed for frequency, mode, audio or carrier squelch with programmable 1-99 second delay, 10-dB attenuator, step size, channel offset, and channel designator. Any channel priority sampling, LCD, S-meter/spectrum display unit! See specifications on page "H".

Interchangeable NiCd/alkaline batteries (4AA NiCds and charger included); a universal external power jack for mobile use; an internal ferrite antenna for medium-wave reception; illustrated 115-page owner's manual. See specifications on page "L". **Accessories: ANT 8, ANT 14, p. "J"; CAS 2, BAT 1, BAT 13 on p. "M".**

ORDER SCN 27 only **$589.95**

ICOM R8500

One of the World's Very Best Scanning Receivers!

Here is one of the world's best tabletop receivers with continuous 100 kHz-1999.99 MHz frequency coverage (less cellular), tunable in precise 10 Hz steps—wide and narrow FM and AM, USB, LSB, CW. Add high sensitivity, IF shift, selectable AGC timing, audio peak filter to automatically enhance modes, built-in RS232C and CI-V for direct computer control, 1000 memory channels in 20 banks, 12 VDC / 120 VAC operation.

High stability crystal oscillators and multiple tuning speeds. Alphanumeric display aids in identifying memorized frequencies. Automatic memorizing of search-discovered active frequencies, skipping of unwanted channels, three antenna connectors for optimal choices for frequency ranges, even voice scan to ignore noisy channels, and even optional voice synthesizer. See specifications on page "L". **Accessories: ACC 6, ACC 7, ACC 8, ACC 72, ACC 74, BRK 4, BRK 5, MAN 1 beginning on page "M"; ANT 2, ANT 3 on p. "D"; ANT 7 on p. "J".**

ORDER SCN 01 only **$1699.95**

AR-5000 PLUS 3

PLUS PERFORMANCE

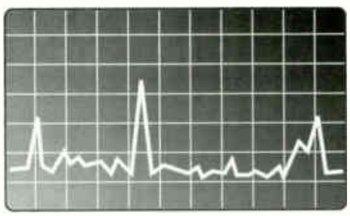
An upgrade of the revered AR5000, the new AR5000 PLUS III extended-frequency coverage receiver is tunable from 10 kHz through 2600 MHz (less cellular) and offers double and single sideband synchronous detection, 2000 memory channels, AM & FM automatic frequency control, 10 VFOs, 40 search banks, and more. For the first time, you can hear VLF time signals and naval communications, international shortwave broadcasting, worldwide single-sideband communications, civilian and military aeronautical transmissions, VHF/UHF public safety radio, ham repeaters, microwave earth satellites, and much, much more!

This triple-conversion luxury receiver offers outstanding sensitivity (0.15 microvolt SSB, 0.3 microvolt VHF/UHF FM, 0.6 microvolt AM), rapid 50-channel-per-second scan/search speed, 1 Hz to 1 MHz programmable tuning steps, all mode reception (AM/FM/LSB/USB/CW), selectable IF bandwidths (3/6/15/40/110/220 kHz), superb frequency stability (+/-1 ppm,0-50 deg. C.), mobile or fixed power (12 VDC / 120 VAC), and much, much more. See specifications on page "L". **Accessories: ANT 2, p. "D"; ANT 7, p. "J"; SDU 5000, p. "F"; and SFT 2, p. "K".**

ORDER RCV 12-P only **$2095.95**

AR-5000 also available. All the features of the AR-5000 PLUS 3, less synchronous detection, 1000 memory channels, AM & FM automatic frequency control, 5 VFOs, and 20 search banks. Order RCV 12, only **$1895.95.**

Superb SDU5000 Spectrum Display



An ideal companion for your AOR or ICOM AR5000 or ICOM R7100, R7000, or R9000, this colorful 3.1" spectrum display unit plugs into any receiver with a 10.7 MHz IF output jack. Imagine seeing a visual panorama of real-time signals up to 10 megahertz wide! Tune in those signals immediately as they appear--don't wait for chance during scanning, searching, or manual dialing. Provides NTSC, PAL, and composite video to an optional monitor. **Accessories: MAN 4, p. "N".**

ORDER SDU 5000 only **$934.00**

Computer Control your AR5000 and SDU5000!

AOR's Hawk 5000 software allows total system control of your SDU5000 and host receiver. On screen spectrum imaging, mouse-controlled cursor selection of signals and functions. Automate your receiving laboratory! Minimum computer requirements: 486 or above, Windows 3.1 or 95, 8MB RAM, serial port with lead COM1, 2, 3, or 4 (two ports recommended for serial mouse), VGA color monitor, 3-1/4" floppy drive, hard drive with 1MB space free.

ORDER SFT 08 only **$169.95**

UPS Second Day Air at Ground Rates on ALL PRODUCTS!

GROVE

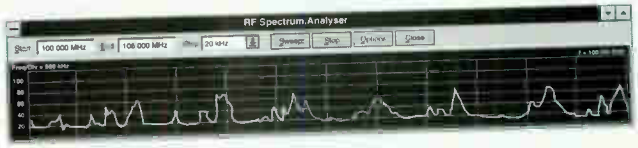
WiNRADiO WR-1000i

The receiver of your dreams on your computer screen!

This computer-controlled, simulated receiver and spectrum display (right) appear on your computer screen!

Turn your PC into a potent, wide-coverage monitoring station! User-friendly software allows all the usual receiver controls, plus much more. Rugged shielding resists interference from the host computer. Enjoy continuous 500 kHz through 1300 MHz (less cellular) frequency coverage; multimode reception of AM, wide and narrow FM, and SSB/CW; up to 16 memory banks with a virtually limitless number of channels; display records in memory by frequency, callsign, or comments field; scan by bank, grouping, or mode; and automatically search for activity by entering your choice of frequency limits.

Call up a full-fledged spectrum display and see signal presence on any span between 500 kHz and 1.3 GHz! Double-click the mouse on any signal spike and the receiver immediately tunes to that frequency! Storage feature allows recall of signal traces. BNC connector allows attachment of your antenna system, while a mini-jack permits connection of speaker or earphones. One-microvolt nominal sensitivity assures weak-signal pickup.



Easy installation, full instruction manual included (PC card must be installed in computer).. This unique receiving laboratory unleashes its power with Windows 3.1, requiring 386 or higher, 1 Meg RAM, 1 Meg hard disk space, VGA monitor; or Windows 95, requiring 486 or Pentium, 4 Megs RAM, and an SVGA monitor. See specifications on page "L" in this Buyer's Guide. **Accessories: TUN 4A, ANT 2, ANT 3 and ANT 15 on pp. "C" and "D"; ANT 1, 9, p. "I"; ANT 7 and CBL 50 and CBL 100 on page "J".**

ORDER RCV 16 only $499.95

Expand the Capability of your WiNRADiO with the WiNRADiO Digital Suite, shown below!

New 1998 FCC Database on CD-ROM!

The new Grove FCC Database is a spectacular compendium of all the licensees in the FCC Master Frequency Database (current 1998)! Faster and more extensive than its rivals. Fields include state, city, county, licensee name, callsign, latitude/longitude, service, class, power, antenna height and emission type! Locate public safety, railroad, business, broadcast, paging, maritime frequencies and more. Fast, menu-driven program makes you an expert soon after you log-on. **(Call for availability.)**

ORDER FCC-98CD only $39.95

NEW! *Digital Suite*

See weather facsimile, read packet and ACARS messages, decode DTMF and CTCSS tones, find specific signal types while skipping over unwanted stations, analyze audio waveforms (0-20 kHz), and digitally record and play back transmissions! Requires Soundblaster 16 or compatible sound card, Windows 95 or NT 4.0 or later. Free on-line updates and added modes as they are released! Audio interconnect cable included.

Loaded with advanced capabilities...

ORDER SFT 15 only $99.95

All elements of the Digital Suite appear as a new menu entry in the WiNRADiO receiver software after installation!

NEW! DSP UPGRADE

Simply open the case of your PCR1000 and plug in the all-mode UT-106 to add an automatic notch filter to remove annoying tones, whistles and noise cancellation as well. **ORDER ACC 16, only $159.95.**

Trade In, Trade Up!

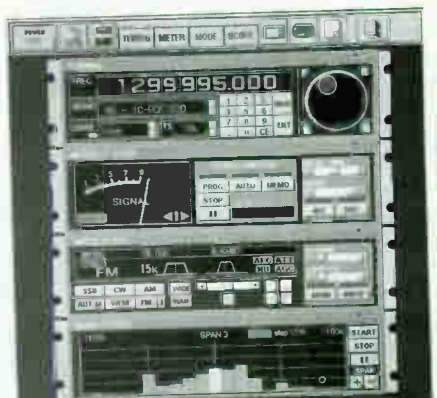
Grove Enterprises offers liberal trade-in allowances for your used receiving equipment. When you call to place your order for anything from Grove, simply describe what you have to our operators. They will tell you what your equipment is worth, substantially lowering your cost when you order from Grove!

All trade-in equipment is carefully checked out before resale, reconditioned if necessary, and carries a 90-day performance warranty. Give Grove a call now to find out how you can participate in our trade-in program, and see Bob's Bargain Bin on the World Wide Web **(www.grove.net/~grove/hmpgbbb.html)** for a current list of our used radio equipment.

ICOM PCR1000 Wide-Coverage Computer Receiver Module!

Adapt your desktop or laptop computer for superb, all-mode reception, 500 kHz-1300 MHz (less cellular; usable with reduced performance as low as 10 kHz)! Display up to 400 kHz of spectrum in real time; select mode, tuning step, filter setting. IF shift enhances selectivity; noise blanker resists pulse noise interference Other features include skip of unmodulated channels, CTCSS (subaudible tone "PL") squelch decoder, and 1 Hz tuning resolution.

Requires Windows 3.1 or 95, 486 or better, 10 MB hard disk, 16 MB RAM, serial interface, 640 x 480 pixel resolution or better. Accessories provided include program disk, telescopic antenna, RS232 interface cable, AC adaptor, and full instructions. See specifications on page "L". **Accessories: DCC 2, DCC 4, and DCC05 beginning on p. "M".**



Computer screen simulation.

ORDER RCV 21 only $499.95

Order Line and Product Support Info.: 1-800-438-8155

TrunkTracker BC895XLT

The new BC895XLT TrunkTracker is the most powerful monitoring tool available to the scanning enthusiast. Designed not only for serious scanning of conventional VHF/UHF land, sea, and air communications, but for automatically tracking Motorola 800 MHz trunking systems! Triple conversion design.

Featuring 29-54, 108-174, 216-512, and 806-956 MHz frequency coverage (less cellular), 300 memory channelss, trunk search and scan, selective lockout and delay, instant weather access with storm alert, 300 channels per second scanning, built-in subaudible tone squelch (CTCSS/"PL"), computer control port, rotary tuning dial, 10 priority channels, bargraph S meter, search autostore, data skip, and even a real-time trunking activity indicator.

Powerful 2.7 watt audio with external speaker and tape recorder jacks. Ruggedly built and compact, the 3-1/2 pound scanner measures 10-7/8"W x 3-3/8"H x 7-1/2"D and is powered by an AC adaptor (provided) or your optional mobile DC. Telescoping whip, manual are included. See detailed specifications on page "H". **Accessories: ACC 15, BRK 2 and DCC 3 on page "M"; SFT2 on p. "K".**

ORDER SCN 09 only **$349.95**

NOTE: Custom leather cases available from Bee Electronics for the Relm HS200, AR-8000, BC-3000, BC-220/230/235 and PRO-90, only $29.95 each! See the "Carrying Cases" category in the product listings on page "M" to find case for your particular handheld scanner.

Uniden BC3000XLT

Featuring continuous 25-550, 760-1300 MHz (less cellular) frequency range, 400 memory channels, 10 priority channels, 100-channel-per-second TurboScan, automatic storage of search-discovered frequencies, selectable-channel overload attenuator, mode and step selection, data skip, and reduced-intermod design.

Strong audio guarantees crisp reception in noisy environments; up to 50 frequencies may be locked out of the search function to eliminate unwanted interruptions; battery save circuit extends charge life during inactive reception periods; handsome, rugged styling makes this handheld scanner an outstanding choice. See specifications on page "L". **Accessories: BAT 15, CAS 6, DCC 7, and PWR 2 beginning on page "M".**

ORDER SCN 29 only **$369.95**

Wow—Lowest Price on TrunkTracker BC235XLT

Uniden's new BC-235 XLT will follow elusive conversations on your local 800 MHz Motorola trunking system from law enforcement dispatch and tactical channels, fire and rescue calls, ambulances, government agencies, and many other services. You can also listen to conventional scanner communications in the 29-54, 108-174, 406-512, and 806-956 MHz bands (less cellular). Pre-programmed service search.

The BC-235XLT is designed to track the Motorola Type I, II, IIi, Hybrid, Smartnet, and Privacy Plus analog trunking, which are extensively used in 800 MHz communications systems. (Note: trunking frequencies must be entered before they can be monitored.) Conventional scanner mode operation is similiar to the BC-230XLT. See specifications on page "L". **Accessories: ANT 8, ANT 14, ANT 22 on p. "J"; BAT 5, CAS-3 and DCC-7 beginning on page "M".**

ORDER SCN 10 only **$249.95**

Radio Shack Introduces Super-Value PRO-2050 Trunk Tracking Scanner

New!

Radio Shack has just released their base/mobile trunk-tracking scanner, with the features and specifications (less computer and 216-405 MHz capabilities) of Uniden's leading BC895XLT at outstanding savings! For full description, see BC895XLT on page "B" and BC895XLT specifications on p. "L". **Accessories: ACC 15, BRK 2, and DCC 3 beginning on page "M".**

ORDER SCN 16 only **$279.95**

Other Grove Scanners, Satellite Receivers

NOTE: All scanners sold by Grove have cellular frequencies deleted—825-849, 869-894 MHz. Complete specifications for many scanners may be found on page "g" in this Buyer's Guide.

Model	Order Code	Description	Price	Recommended Accessories
AOR				
PRO-90	SCN-11	Handheld Trunk Tracking Scanner, see specifications for BC-235 on p. "I". Does not include extra battery pack and drop-in charger	$259.95	ANT-4, ANT 8
Radio Shack				
PRO-2046	SCN-7	Mobile 29-54, 108-174, 406-512, 806-956MHz 100 channel	$239.95	ANT-20, ANT-30, ANT-13, SPK-15
Uniden				
BCT-7	SCN-21	Mobile 26.9-27.4 (CB),29.7-54, 108-174, 406-512, 806-956 MHz factory-programmed plus 100 ch.	$179.95	ANT-20, ANT-30, SPK-15
BC-230 XLT	SCN-24	Handheld 29-54, 108-174, 406-512, 806-956 MHz 200 channel	$239.95	BAT-5, CAS-3, DCC-7
Universal				
SCPC-200	RCV-28	SCPC audio receiver for home TVRO satellite dishes	$399.95	SPL-2
SC-50	RCV-29	Subcarrier FM² audio receiver	$399.95	

UPS Second Day Air at Ground Rates on ALL PRODUCTS!

GROVE

Uniden BC9000XLT

This superb desktop scanner is for serious monitors of the 25-550, 760-1300 MHz (less cellular) spectrum. The BC9000XLT features 500 memory channels, tuning knob, 16-digit alphanumeric display with adjustable brightness, powerful 2.2 watts of audio, tone control, and CTCSS tone squelch option.

Rubber-padded tilt feet combine with the large tuning knob for additional comfort during periods of serious signal searching. Search lockout of up to 50 frequencies prevent unwanted interruptions. This scanner means business. See detailed specifications on page "L". **Accessories: ACC 130, BRK 2, and DCC 3 beginning on page "M".**

ORDER SCN 30 only **$399⁹⁵**

RELM HS200

This advanced, wide-frequency-coverage scanner covers 26-54, 118-174, 406-520, 806-960 MHz (less cellular). Stores 200 memory channels in 10 banks and scans and searches at a lightning-fast 100 channels per second! All channels may be keyboard-programmed for PL/CTCSS (subaudible tone) or DPL/DCS (digital) squelch.

Ten priority channels with hierarchy, instant weather scan, undesired frequency lockout, replaceable or rechargeable battery operation (batteries not included), backlit keyboard and display, and even a signal strength bargraph. See specifications on page "L". **Accessories: ANT 8 and ANT 14 on p. "J"; BAT 1, BAT 13, CAS 11, and DCC 3 beginning on page "M".**

ORDER SCN 08 only **$249⁹⁵**

Relm MS 200 Mobile-Base Scanner

New!

This new, advanced scanner covers 29-54, 118-174, 406-520, and 806-960 MHz (less cellular), and provides 200 memory channels in 10 banks. High sensitivity (0.5 uV) and sharp selectivity (50 dB adjacent channel rejection) assist crowded band listening, while powerful 2 watt audio breaks through the noisiest listening environment.

Fast, 100-channel-per-second scanning/searching assures rapid signal acquisition, while PL/CTCSS and DPL/DCS squelch fine-tunes your listening requirements!

Features include priority, PC programming capability, alphanumeric display, weather scan/alert, and more! AC wall adaptor, cigarette lighter cord, attachable antenna, mobile bracket, and full instructions provided at no extra charge! See detailed specifications on page "L".

ORDER SCN 15 only **$279⁹⁵**

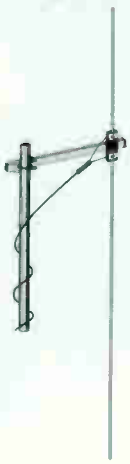
SCANNER INTERMOD FILTERS REDUCE INTERFERENCE BY 40dB!

That's right--now you can restore quiet monitoring on your scanner, drastically reducing that incessant "bleep bleep" interference from local paging transmitters. Simply specify whether the interference is from a 152, 158, or 462 MHz pager, and we'll send you a unit that knocks down that interference by 40 dB! Units may be cascaded for additional interference reduction. Equipped with BNC connectors. **Accessories: ADPK16, p. "M".**

ORDER FTR152, FTR158, or FTR 462 only **$59⁹⁵**

REACH OUT TO THE WORLD WITH GROVE SCANNER ANTENNAS

Grove OMNI II



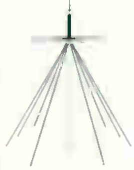
Designed by Bob Grove, this exclusive Grove product offers 25-1300 MHz coverage; lightweight, compact design, high performance, and low cost! Designed especially for wide-area metropolitan listeners, the 68" Omni can be mounted on a mast, in an attic crawl space, against a wall...just about anywhere convenient.

Comes with balun transformer, F connector, offset pipe, mounting hardware and instructions. **Accessory: CBL50 or CBL100, p. "J".**

ORDER ANT 05 only **$19⁹⁵**

NOTE: special shipping rates apply to these antennas: ANT 1, 4, 5, 7, 9, 13, 15, 24, and 30. Please see page "o" for details.

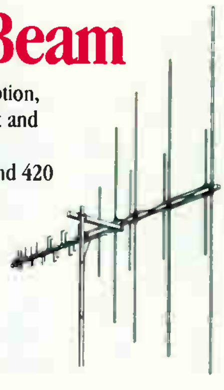
Professional Wideband Discone



The discone antenna is used by government and military agencies worldwide because of its wide bandwidth characteristics and non-directional coverage. The Diamond D130J discone consists of 16 rugged, stainless steel elements and is capable of transmitting up to 200 watts above 50 MHz, and provides continuous 25-1000 MHz (and above) reception. Accomodate any standard mast-pipe (1" to 2-1/8" diameter). **Accessory: CBL50 or CBL100, p. "J".**

ORDER ANT 09 only **$87⁹⁵**

Famous Grove Scanner Beam



Our world-renowned Scanner Beam enhances 30-50 MHz low band reception, 108-137 MHz aircraft, 137-174 MHz high band, 225-400 MHz military aircraft and satellites, 406-512 MHz UHF, and 806-960 MHz microwave mobile.

HAMS NOTE—can be used for transmitting up to 25 watts on 144, 220, and 420 MHz bands. 50/75 ohms nominal impedance.

May be used with inexpensive TV antenna rotator or fixed in favored direction. Local signals still come in loud and clear from all directions.

All mounting hardware included (requires TV type F connector). Approximate size 8'H x 5'W. **Accessory: CBL50 or CBL100, p. "J".**

ORDER ANT 01 only **$59⁹⁵**

THE SCANTENNA

SPECIAL: Now includes 50' of coax cable plus Motorola or BNC connector!

This omnidirectional scanner antenna will equal or outperform any competitor on the market, providing continuous frequency coverage from 25-1300 MHz. Public safety, civilian and military aircraft, hams, maritime, CB — anything in its frequency range! Requires TV type F connector. Approximate size 7-1/2'H x 4-1/2'W.

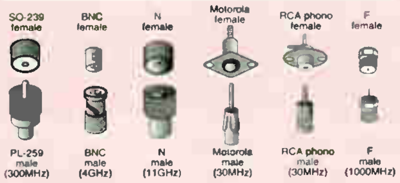
ORDER ANT 07 only $39⁹⁵

RG6-U Cable/Adaptors

Have you had trouble finding the right coaxial adaptors for linking your antenna and receiver? We can help! Simply tell us what adaptors you need, or what antenna and radio you will be using. We will provide you with a cable which is ready to attach between your antenna and receiver! Up to 2 adaptors FREE with cable purchase.

CABLE

CBL 25	25' RG 59U	$9⁹⁵
CBL 50	50'RG-6U	$14⁹⁵
CBL 100	100'RG-6U	$19⁹⁵



ADAPTORS AVAILABLE-$3.99 each

ADP 1	SO-239 Female to F male
ADP 2	F Female to PL259 Male
ADP 3	F Female to N Male
ADP 4	F Female to Male 1/8" Mini-Plug
ADP 5	N Female to BNC Male
ADP 6	SO-239 Female to Male 1/8" Mini-Plug
ADP 7	SO-239 Female to N Male
ADP 9	F Female to BNC Male
ADP 10	SO-239 female to BNC Male
ADP 11	SO-239 female to RCA male
ADP 12	BNC female to N male
ADP 13	BNC/BNC (right angle elbow)
ADP 14	F female to RCA male
ADP 15	N female to F male
ADP 17	BNC female to F male
ADP 18	F female to 2 wires
ADP 19	SO-239 female to 2 wires
ADP 22	Motorola female to BNC male
ADP 24	BNC female to PL259 male
ADP 25	RCA female to male miniplug
ADP 26	F female to F female barrel (qnty.2)
ADP 27	Banana Plug (qnty.4)
ADP 28	F female to PAL fem. Satellite700
ADP 29	3.5mm female to 2.5mm male mini plug (qnty.2)
ADP 30	Dual BNC female to BNC male T-adaptor (qnty.2)
ADP 31	BNC female to Motorola male
ADP 32	RCA female to male PL-259
ADPK 10	F female to Motorola male
ADPK 13	F male to F male 3ft.cable (qnty.3)
ADPK 14	F/Motorola cable, 3ft.(qnty.2)
ADPK 15	PL259 male to PL259 male 3ft.
ADPK 16	BNC male/ BNC male 3ft cable

Free shipping if ordered with other products; $2.50 for one or more shipped alone. If you are unsure which adaptor is needed, call Chanel or Sue at 1-800-438-8155 or e-mail them at tech@grove.net for assistance.

Grove PRE-5A VHF/UHF Signal Booster

Grove has integrated a high-performance preamplifier and control box into one convenient unit, offering superior performance. The new PRE-5A offers wide dynamic range and low noise for weak signal boosting, and overload (intermod) reduction unmatched in other 30-1000 MHz preamplifiers. Single knob operation offers continuous gain control from -10 dB attenuation to +18 dB amplification. Switched off, signals are automatically routed from the antenna directly to the receiver, bypassing the preamplifier.

Use the new PRE-5A with up to 100 feet of Grove low-loss coax to your antenna and enjoy improved VHF/UHF reception on scanners, TVs, FM stereos, and other receiving equipment (not to be used for transmitting). Powered by 12 VDC @500 mA; AC adaptor not included. **Accessories: PWR-21, ADPK-3, ADPK-6 and ADPK-9, pp. "M" and "N".**

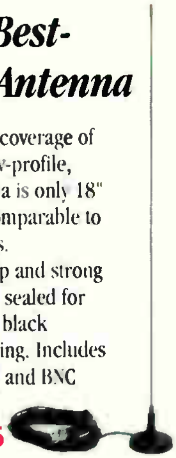
ORDER PRE 5A only $89⁹⁵

Universal Telescoping Scanner Antennas!

Extendable to 47-1/2 inches, the ANT-8 is made of chrome-plated brass and equipped with a standard BNC base. Receives 25-1300 MHz. ANT-19 extends to 21" and receives from 108-1300 MHz. ANT-8B has right-angle BNC adaptor. ANT-8N has right-angle N adaptor.

Order ANT 8 (47-1/2")	$16⁹⁵
ANT 19 (21")	$14⁹⁵
ANT 8B	$21⁹⁵
ANT-8N	$23⁹⁵

STEALTH Our Best-Selling Mobile Antenna



A unique design optimizes coverage of the 30-960 MHz bands; this low-profile, magnetic-mount mobile antenna is only 18" high, yet offers performance comparable to much bulkier scanner antennas.

Rugged, stainless-steel whip and strong magnetic base are hermetically sealed for waterproof construction, sleek black finished for unobtrusive mounting. Includes 14 feet of small-diameter cable and BNC connector.

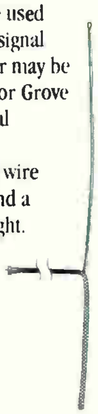
ORDER ANT 30 only $29⁹⁵

High Gain Flex Antenna

This "rubber duckie" really makes a difference on handheld scanners. The 12" Austin Condor is guaranteed to improve weak signal scanner reception—on all frequency ranges—over the original scanner antenna.

ORDER ANT 14	$29.95
ORDER ANT 14B (BNC right-angle conn.)	$34.95
ORDER ANT 14N (N right-angle conn.)	$36.95

HIDDEN ANTENNA



The Grove Hidden Antenna may be used alone with your scanner for improved signal reception over your attachable whip, or may be connected to the powerful GRE PRE-1 or Grove PRE-5 for considerably increased signal strengths.

This five-foot, thin-profile, flexible wire antenna can be hung in a corner, behind a drape— just about anywhere out of sight. Comes fully assembled with 20 feet of coax and F male connector, with adaptors for PL259 (UHF) and BNC connections.

ORDER ANT 06 only $19⁹⁵

High Gain 800 MHz Portable Antenna

The Max Systems antenna will make a tremendous improvement in 806-960 MHz reception over the whip provided with your hand-held or desktop scanner! (Not usable in other frequency ranges.)

Equipped with standard BNC connector; rugged ground-plane construction for optimum performance. Only 7-1/2" tall.

ORDER ANT 22 only $29⁹⁵

With straight connector for handhelds

ORDER ANT 23 only $34⁹⁵

With right-angle connector for desktop use (right)

UPS Second Day Air at Ground Rates on ALL PRODUCTS!

SOFTWARE FOR SCANNERS/SHORTWAVE RECEIVERS

Scan Manager Pro v.1.1

Powerful software for hams and SWLs from KC4ZGL. If you have a modern IBM compatible computer equipped with Windows 3.1 or higher, you can edit databases and control all Kenwood, Icom, Drake R8A/B (R8 not supported) and Yaesu (except FT-767) transceivers and receivers! Display your data in powerful spreadsheet style, controlled and edited by keyboard or mouse. Scan Manager 1.1 Pro includes SWL Manager 2.0. When ordering, specify radio, computer and call sign.*

Order SFT 13, only $68.95

Scancat-Gold for DOS

Use your 640k (or better) computer to control most AOR, Kenwood, ICOM, Yaesu, JRC, Lowe, Watkins-Johnson, Radio Shack (with OS456/535 boards) with this fast, all-new software program! Operates from the RS-232 port, and works in DOS on ANY PC Compatible computer system.*

Order SFT02, only $94.95

Scancat-Gold for Windows®

Computer control (all Features of our DOS program) **plus, now supports the Uniden BC895, ICOM PCR1000 and R-10.** Windows program includes "Graphical Receiver Tuning" with mouse, slide rule or on-screen knob. No conversion direct support for DBASE (including Grove's FCC CD-ROM), FOXPRO, ACCESS, and BTRIEVE files. Built in import of TEXT files. Interactive database, maps and scanning features, and **much** more.*

Order SFT 02W, only $99.95

The Windows® version of ScanCat-Gold places a mouse-controllable scanner/receiver image on your computer screen!

Scancat-Gold for Windows® SE Upgrade

Our "SE Upgrade" for Scancat-Gold-Windows supports all of our standard windows features, **PLUS** - adds these unique **extras**.

1. Unlimited capabilities for "Spectrum Analysis." "SE" will examine your logging database, plot each frequency, and "paint" the entire analysis on your screen, displaying it from lowest to highest frequency. Even tunes or scans your radio with a click of the mouse!

2. Record **individual** sound transmissions databased by frequency, time stamp and airtime. Point and shoot on any record for instant "playback" of all the action as it happened. Works with any Windows compatible sound card!

Scancat-Gold for Windows 7.0 or greater required for SE Upgrade (such as SFT02W above).*

Order SFT 02-SE, only $59.95

****Because software is easily copied, it is not refundable. Defective copies will be replaced at no charge.***

SP-200B Sound Enhancer

Increase the intelligibility and sound quality of voice, music, and data **on any scanner or shortwave receiver**. The SP-200B combines a powerful audio amplifier, 4" speaker, bass and treble equalizers, and a variable passband notch/peak filter to reject interfering tones or boost desirable audio. An adjustable noise limiter reduces irritating pulse interference, a variable-hang 0-45 second squelch removes background noise between sound transmissions. Tape recorder activator, too! Powered by 12 VDC.

Housed in a stylish, handcrafted, oak cabinet. **Accessory: PWR 4 on page "M".**

ORDER SPK 13 only **$199.95**

Optoelectronics Cub Frequency Counter

The Optoelectronics Cub is ideal for surveillance countermeasures, frequency hunting, ham, and CB. Wide frequency coverage (1 MHz - 2.8 Ghz) and advanced features (digital filtering, high-visibility LCD, frequency autocapture and hold, selectable gate times, 10 hour battery charge life. Rechargeable battery/AC charger incl.

ORDER CRT 9

$144.95

Global E-Mail Capability is Right in Your Hand!

The world's first hand-held global satellite communicator, the GSC 100 gives you the ability to **send and receive e-mail messages to and from anywhere on Earth.** And, with its **integrated GPS receiver,** the GSC 100 not only lets you know where you are, it guides you anywhere you want to go.

ORDER GPS-100

$1499.95

Multipurpose Leatherman® Pocket Tool

As handy and capable as a Swiss Army knife, the Leatherman® incorporates full-size needlenose/regular pliers, wire cutters, knife blade, ruler, can/bottle opener, large and small slot screwdrivers, Phillips screwdriver, metal/wood file/saw, awl/punch—all in a sturdy 4" stainless steel frame.

Comes with leather belt case and 25-year warranty.

ORDER TOL 1 only **$39.95**

LEATHERMAN TOOL ADAPTOR

This adaptor makes your Leatherman a 1/4", tilt-lock, hex drive! Includes six Philllips, Robertson, Torx, and slotted bits, convenient holder, *and* a rugged, leather belt case! Only **$19.95** when ordered with the TOL-1 Leatherman tool (**$24.95** if ordered separately). Order TOL-2.

Order Line and Product Support Info.: 1-800-438-8155

NOTE: Cellular-Capable Scanners are available only to government agencies and cellular service providers by direct inquiry. These scanners include special versions of the SCN 27 (p. "F"), RCV 12 (p. "F"), RCV 16 (p. "G"), SCN 06 (p. "F"), and SCN 01 (p. "F").

Wide Band-Receiver Specification Guide

Prices subject to change without notice

Scanner	AR 5000	AR 8000B	ICOM R10	ICOM R8500	ICOM PCR 1000	WINRADIO
Grove Order #	RCV 12	SCN 27	SCN 6	SCN 1	RCV 21	RCV 16
Grove Price	$1,895.95	$589.95	$399.95	$1699.95	$499.95	$499.95
Frequency Range	500kHz-1900 MHz (less cellular)	500kHz-1900 MHz (less cellular)	500 kHz-1300 MHz, (less cellular)	100 kHz-1999.99999 MHz (less cellular)	500 kHz-1300 MHz, (less cellular)	100 Hz minimum
Keypad Entry?	Yes, plus tuning dial	Yes	Alphanumeric	Yes	Yes	Yes
Tuning Steps	Programmable, 10 kHz-1 MHz	50 Hz-999.995 kHz	100 Hz-999.99 kHz	10 Hz-1 MHz custom	1 Hz minimum	50 kHz-1 kHz
Display	Backlit LCD	Backlit LCD	Backlit LCD	Backlit LCD, alphanumeric display	Your monitor, 640 x 480 pixels or better	On screen (PC)
Dimmer	Yes	On/Off	On/Off	Yes	Your monitor	N/A
Receiving Modes	AM/NFM/WFM/USB/LSB/CW	AM/NFM/WFM/USB/LSB/CW	AM/NFM/WFM/USB/LSB/CW	AM/FM (w/ AFC)/USB/LSB/CW/RTTY	AM/NFM/WFM/USB/LSB/CW	AM/NFM/WFM/SSB
Memory	1000 channels	1000 channels	1000 channels	1000 channels	Unlimited, determined by computer	Unlimited, determined by computer
Scan	45 channels/sec. w/ priority	30 channels/sec.	6 ch./sec.	40 chan./sec.	6 ch./sec.	50 ch./sec. FM modes
Banks	20/40	20	18	20		16
Channel Lockout	Yes	Yes	Yes	Yes	Yes	Yes
Priority	Any channel	Any channel	Yes	Yes	Yes	Yes
Search	50 channels/sec.	30 channels/sec.	17 ch./sec.	40 channels/sec.	Yes	Yes
Delay	Programmable	Programmable	Programmable time, channel	Yes	Programmable	Programmable
Clock	Yes	No	No	No, sleep timer		Yes
Audio Output (typical)	1 W	180 mW	120 mW	2W	200 mW	200 mW
Record Audio Output	Yes	No	No	Yes	No	No
Recorder Activator	Yes	No	No	Yes	No	
Signal Strength Ind.	Analog S-meter	LCD bargraph	LCD bargraph	Analog S meter	Yes	Yes
Computer Interface	RS232	RS232	CI-V	RS232C and CI-V	RS232C	Expansion slot
Conversion Scheme	Triple up-conversion (622.2/10.7 MHz, 455 kHz)	Triple up/quad. on WFM	Triple up-conversion (429/266, 10.7 MHz, 455 kHz)	Triple conv.	Triple up-conversion (266.7/10.7 MHz, 450 kHz)	Triple up-conversion
Sensitivity (NFM)	0.6 uV	0.3 uV	0.45 uV	0.5 uV	0.3 uV	0.35 uV
Selectable Atten.	Yes	Yes, chan. selectable	Programmable, 20 dB	-10/-20 dB	Yes	Yes
IF Selectivity (-6/-60 dB)	3/6/15/40/110/220 kHz	SSB (-6/-50 dB): 4/15 kHz; AM/NFM: 12/25 kHz; WFM 180/800 kHz	(-6 dB) SSB 4 kHz, AM/NFM 15 kHz, WFM 150 kHz	5.5/12/150 kHz FM, 2.2/5.5/12 kHz AM, 2.2 kHz SSB/CW	2.8/6/15/50/230 kHz	AM/SSB 6 kHz, NFM 17 kHz, WFM 280 kHz
Antenna Connector	BNC	BNC	BNC	SO-239	BNC	BNC
Dimensions (W"xH"xD")	8.5x3.5x10	6x2.75x1.5	2.25x5x1.25	11.25x4.5x8.25	5x1.25x7.75	PC expansion slot
Weight	7 lb. 10.5 oz.	13 oz.	11 oz	18 lbs.	2.2 oz	N/A
Power Requirement(s)	13.8 VDC @ 1 A or 120 VAC @ 60 Hz	4AA cells (NiCds supplied)	4.8-16 VDC; AC adaptor included	12 VDC/120 VAC	12 VDC @ 700 mA, AC adaptor included	PC bus powered
Accessories Incl.	AC adaptor	AC adaptor/flex antenna/DC cord/carrying strap/belt clip, AA bat. (4)	Belt clip, AC adaptor, flex whip, rechargeable batteries, manual	AC acaptor	Whip antenna, computer cable, program disk, AC adaptor	3-1/2" disk, wire antenna

Grove's Scanner Specification Guide

Prices subject to change without notice

Scanner	Radio Shack Pro 2046	Relm HS-200	Uniden BC-230XLT	Uniden BC-235XLT	Uniden BC-895XLT	Uniden BC-3000XLT	Uniden BC-9000XLT	Uniden BCT-7
Grove Order #	SCN 7	SCN 8	SCN 24	SCN 10	SCN 9	SCN 29	SCN 30	SCN 21
Grove Price	$239.95	$249.95	$239.95	$249.95	$349.95	$369.95	$399.95	$179.95
Frequency Range	29-54, 108-174, 406-512, 806-956 MHz (less cellular)	26-54, 118-174, 406-520, 806-960 MHz (less cellular)	29-54, 108-174, 406-512, 806-956 MHz (less cellular)	29-54, 108-174, 406-512, 806-956 MHz (less cellular)	29-54, 108-174, 216-512, 806-956 MHz less cellular	25-550, 760-1300 MHz (less cellular)	25-550, 760-1300 MHz (less cellular)	CB/29.7-54/108-174/-406-512/806-956 MHz (less cellular)
Keypad Entry?	Yes	Yes	Yes	Yes	Yes	Yes	Alphanumeric	No
Tuning Steps	5/12.5 kHz	5/12.5/25 kHz	5/12.5 kHz	5/12.5 kHz	5/12.5/25 KHz	5/12.5/25/50 kHz	5/12.5/25/50 kHz	5/12.5 kHz
Display	Backlit LCD	Backlit LCD	Backlit LCD	Backlit LCD	Backlit LCD	Edgelit LCD alphanumeric	Backlit LCD	Backlit LCD
Dimmer	No	No	On/off	On/off	No	On/off	High/low/off	No
Receiving Modes	AM, NFM	AM/NFM	NFM, AM (aero) det. by freq. range	AM/NFM	AM, NFM	WFM, NFM, AM (selectable)	WFM, NFM, AM	AM (air), NFM
Memory	100 channels	200 channels	200 channels	300 channels	300 channels	400 channels	500 channels	Pre-programmed by service plus user-selected frequencies
Scan	34 channels/sec.	100 ch./sec.	100 channels/sec.	100 channels/sec.	100-300 channels/sec.	100 channels/sec.	100 channels/sec.	100 channels/sec.
Banks	10	10	10	10	10	20	20	12 service bands
Channel Lockout	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Priority	Yes	10 channels	10 channels	10 channels	10 channels	10 channels	10 channels	No
Search	300 channels/sec.	Yes, with lockouts	300 channels/sec.	Yes	Yes	300 ch./sec.	300 ch.sec.	Yes
Delay	2 sec. any chan.	2 sec. any chan.	2 sec. any chan.	2 sec. any chan.	2.5 sec., selectable channel	2/4 sec., any ch.	2 sec., any ch.	2 sec., all channels
Clock	No	No	No	No	No	No	No	No
Audio Output (typical)	2 W	400 mW nom.	180 mW	180 mW	2.7 W	320 mW	2.2 W	3 W
Record Audio Output	No	No	No	No	Yes	Spkr. & earph. jacks	Yes	No
Recorder Activator	No	No	No	No	3.5 mm (1/8") earphone jack	No	Yes	No
Signal Strength Ind.	No	LCD bargraph	No	No	LCD bargraph	No	No	No
Computer Interface	No	No	No	No	RS232C	No	No	No
Conversion Scheme	Dual conv.	Double conv.	Double conv.	Triple conv.	Triple up-conversion	Triple-up conv.	Triple-up conv.	Double conversion
Sensitivity (NFM)	0.7 uV	0.5 uV	0.5 uV	0.3 uV	Unspecified	0.5 uV	0.5 uV	0.5 uV
Selectable Atten.	No	No	No	No	No	No	Yes, chan. selectable	No
IF Selectivity (-6/-60 dB)	22/30 kHz, -6/-50 dB	-50 dB adjacent channel	N/A	N/A	Unspecified	N/A	N/A	N/A
Antenna Connector	BNC	BNC	BNC	BNC	BNC	BNC	BNC	BNC
Dimensions (W"xH"xD")	7x2x7.5	2.5x6x1.5	6x2.5x1.7	2.5x6.5x1.75	10.875x3.375x7.5	7.4x2.7x1.5	10.5x3.38x7.5	5.25x1.62x7
Weight	2 lbs. 3 oz.	15 oz.	12.5 oz.	12.6 oz.	3lbs. 8 oz.	13 oz.	4lbs.	1lb. 11 oz
Power Requirement(s)	12 VDC	4 AA cells or 12 VDC (adaptor/charger incl.)	Rechargeable battery, 12VDC	Rechargeable battery, 12VDC	12 VDC (AC adaptor included)	6.5 VDC	12 VDC (AC adapt. incl.)	12 VDC
Accessories Incl.	DC cord/Mobile mounting bracket	Flex antenna/AC charger-adaptor/belt clip/earphone/carrying strap	Flex antenna/belt clip/earphone/extra battery/AC charger-adaptor	Flex antenna/belt clip/earphone, extra battery/AC charger-adaptor	Telescopic whip, AC adaptor, manual	Rechargeable bat. pack/AC wall adaptor-charger/belt clip/flex antenna/earphone	AC adaptor/tele. whip	Mobile bracket, DC cord, cigarette lighter cord, AC adaptor, telescopic whip, mobile whip

Grove Accessories, Books and Items not Otherwise Pictured in this Guide

Listed by Grove order code, many of these items are cited in the product descriptions of items sold on previous pages of this Guide

ACCESSORIES

ACC-1	REGENERATION MODULE FOR ANT-32	$47.95
ACC-2	NIGHTLOGGER II TAPE RECORDER ACTIVATOR	$69.95
ACC-3	OPC-478 COMPUTER INTERFACE CABLE, ICOM R10	$44.95
ACC-4	OPC-474 CLONING CABLE, ICOM R10	$17.95
ACC-6	CR-293 HIGH STABILITY CRYSTAL, ICOM R8500	$295.95
ACC-7	FL-52A CW NARROW FILTER, ICOM R8500	$189.95
ACC-8	UT-102 VOICE SYNTHESIZER, ICOM R8500	$57.95
ACC-9	DRAKE SW-2 REMOTE CONTROL	$48.95
ACC-11	MAGELLAN GPS 3000/4000 DATA MODULE/ANTENNA KIT	$149.95
ACC-12	SWIVEL MOUNTING BRACKET, MAGELLAN GPS 2000/3000/4000	$19.95
ACC-13	INSTRUCTIONAL VIDEO, MAGELLAN GPS-2000	$14.95
ACC-14	INSTRUCTIONAL VIDEO, MAGELLAN GPS-3000	$14.95
ACC-15	COMPUTER INTERFACE CABLE FOR BC-895	$29.95
ACC-43	VHF CONVERTER, DRAKE R8A/B (33-55, 108-174 MHZ)	$219.95
ACC-50	FAX INTERFACE, O'GARA PHN-5	$95.00
ACC-51	DATA INTERFACE, O'GARA PHN-5	$295.00
ACC-53	RECHARGEABLE NIMH BATTERY, O'GARA PHN-6	$335.00
ACC-54	AC-DC CONVERTER, O'GARA PHN-6	$175.00
ACC-55	12 VDC MINI CHARGER, O'GARA PHN-6	$160.00
ACC-56	SOFT CARRYING CASE, O'GARA PHN-6	&95.00
ACC-57	HARD CARRYING CASE, O'GARA PHN-6	$325.00
ACC-58	REMOTE ANTENNA, O'GARA PHN-5A	$1395.00
ACC-59	ADDITIONAL ACCESS CARDS, O'GARA COMPACT-M, PHN-5	$85.00
ACC-60	ANTENNA WALL MOUNTING BRACKET, O'GARA PHN-6	$400.00
ACC-61	ANTENNA CABLE (10 METERS), O'GARA PHN-6	$320.00
ACC-62	ANTENNA CABLE, (20 METERS), O'GARA PHN-6	$480.00
ACC-63	INTERNAL RECHARGEABLE BAT PACK O'GARA PHN-6	$128.00
ACC-64	UNIVERSAL AC/DC CONVERTER, O'GARA PHN-6	$335.00
ACC-72	TV-R7100 TV/FM ADAPTER, ICOM R7100/8500	$339.95
ACC-74	CT-17 LEVEL CONVERTER, ICOM R7000/7100/8500	$134.95
ACC-79	AUDIO CASSETTE ADAPTER, SCANNERS/SW RECEIVERS	$9.95
ACC-94	ADHESIVE REPLACEMENT KIT, ANT-13	$4.95
ACC-96	CTCSS SQUELCH DECODER, BC-890	$59.95
ACC-101	BUDWIG CH-239 SW DIPOLE CONNECTOR	$9.95
ACC-130	CTCSS TONE BOARD, UNIDEN BC-9000&PRO-2045	$46.95
ACC-156	SAC-8000 INTERFACE CABLE, AR-8000/OPTO SCOUT	$34.95
ACC-157	OPTO'S LYNX COMPUTER INTERFACE, AR-8000	$129.95
ACC-168	WEATHER-PROOF FLEX TAPE, 22 FT ROLL	$1.95

ADAPTORS & ADAPTOR KITS

ADP-25	RCA FEMALE TO MALE MINIPLUG, ANT-15/24	$3.95
ADP-32	RCA FEMALE TO MALE PL-259, ANT-15/24	$3.95
ADPK-1	ADAPTER KIT UHF/F, FTR-6/7/8/9 PRE-5A, ATT-1	$9.95
ADPK-2	PL259 AND 1/8" MINIPLUG ADAPTOR KIT; ANT-24	$9.95
ADPK-3	ADAPTER KIT BNC/F, FTR6/7/8/9 PRE-5A, ATT-1	$9.95
ADPK-4	OPTO SCOUT TO R-10 INTERFACE KIT	$8.95
ADPK-6	ADAPTOR KIT MOT/BNC, FTR6/7/8/9 PRE-5A, ATT-1	$9.95
ADPK-9	ADAPTOR KIT N/F, FTR6/7/8/9 PRE-5A, ATT-1	$12.95

ANTENNAS VHF/UHF

ANT-10DS	AUSTIN FERRET VHF/UHF RECEIVE/TRANSMIT	$249.95
ANT-13	22" VALOR GLAS-MASTER, 30-1200 MHZ	$29.95
ANT-18	300-512 MHz, 2 1/2" FLEX CLOSE RANGE ANTENNA	$19.95
ANT-20	GROVE NO-TENNA, 1-1000 MHZ BASE/MOBILE	$19.95

ANTENNAS SHORTWAVE

ANT-12	ALPHA DELTA ANT KIT, SO-239 CONNECTOR, INSULATORS	$29.95
ANT-16	23' REEL FOR SW PORTABLES	$14.95
ANT-25	25' RANDOM WIRE W/RCA & PL-259 ADAPTORS	$7.95
ANT-26	SONY COMPACT ACTIVE LOOP ANTENNA	$89.95
ANT-32	KIWA POCKET LOOP 530 kHz - 30 MHz	$119.95
ANT-33	BUDWIG CH-239 SW DIPOLE CONNECTOR & INSULATORS (2)	$19.95

BATTERIES

BAT-1	ENERGIZER INDUSTRIAL "AA"	$.79
BAT-2	ENERGIZER INDUSTRIAL "D"	$1.19
BAT-3	ENERGIZER INDUSTRIAL "C"	$1.09
BAT-4	ENERGIZER INDUSTRIAL "9V"	$2.25
BAT-5	BP-180 800 mAH CHARGEABLE, UNIDEN BC-230/235, PRO-90	$29.95
BAT-6	"AAA" ALKALINE BATTERIES	$.75
BAT-9	METROWEST LONG LIFE PACK, UNIDEN BC-200/205	$79.95
BAT-11	SAFT RECHARGEABLE "AA" NICAD, 600 MAH	$1.95
BAT-13	RECHARGEABLE "AA" NICAD BATTERIES, RADIO SHACK	$2.75
BAT-14	RECHARGEABLE PACK, UNIDEN BC-200/205	$39.95
BAT-15	RECHARGEABLE PACK, UNIDEN BC-2500/3000	$31.95
BAT-16	POWER POCKET RECHARGEABLE LEAD/ACID 12 V, 2 AH	$59.95

BOOKS (See listings and displays on following pages)

BRACKETS

BRK-1	HAND-HELD RADIO MOBILE MOUNT, SINGLE	$9.95
BRK-2	MOBILE MOUNTING BRACKET FOR BC-890/9000XLT, PRO2045	$15.95
BRK-3	UNIVERSAL BELT CLIP CAN BE USED WITH BRK-6	$4.95
BRK-4	MB12 MOBILE MOUNTING BRACKET, ICOM R8500	$35.95
BRK-5	MB-23 CARRYING HANDLE, ICOM R7100/8500	$12.95
BRK-6	MOBILE HANGER FOR BELT CLIPS UP TO 1"W	$4.95
BRK-7	HAND-HELD RADIO MOBILE MOUNT, DOUBLE	$12.95
BRK-9	WINDOW ANTENNA MOUNT KIT BNC CONNECTOR	$28.95
BRK-12	DRAKE SW-1,2 CARRYING/TILT HANDLE	$6.95
BRK-13	DRAKE SW-1,2 MOBILE MOUNTING BRACKET	$14.95
BRK-14	AOR-5000 DOUBLE RACK MOUNT	$149.95

CARRYING CASES

CAS-1-N	ICOM R10 HEAVY-DUTY DURAS NYLON CASE	$29.95
CAS-2	LEATHER CASE FOR AR-8000	$29.95
CAS-3	LEATHER CASE FOR UNIDEN BC-230/235, PRO-90	$29.95
CAS-4	LEATHERETTE CARRYING CASE FOR FR-465 CHEROKEE	$19.95
CAS-6	LEATHER CASE FOR UNIDEN BC-3000XLT	$29.95
CAS-7	MAGELLAN GPS-2000 CARRYING CASE	$9.95
CAS-10	DRAKE SW-8 CARRYING CASE	$49.95
CAS-11-L	RELM HS-200 LEATHER CASE	$29.95

CABLE

CBL-2	50 FT 3-CONDUCTOR CABLE FOR ROT-01 ROTATOR	$5.95
CBL-3	100 FT 3 CONDUCTOR CABLE FOR ROT-01 ROTATOR	$8.95

CHARTS

CHT-1	RADIO SPECTRUM COLOR WALL CHART, 1996	$9.95

CLOCKS

CLK-1	24 HOUR SETH THOMAS 13" WALL CLOCK	24.95
CLK-2	MFJ-108B LOCAL/UTC DUAL DIGITAL CLOCK	$19.95
CLK-4	MFJ-112 WORLD MAP DESK CLOCK	$24.95

COLLECTIBLES

COL-1	SPINNING VANE RADIOMETER	$6.95
COL-3	EDISON WALL PLAQUE	$6.95
COL-5	RADIACMETER (1960 PERSONAL RADIATION DETECTOR)	$9.95
COL-6DS	TWIN CYLINDER STEAM ENGINE, BUILT ($20.00 UPS)	$449.95
COL-7	JENSEN HOBBY STEAM ENGINE KIT	$99.95
COL-8	VICTORIAN STYLE CARBON FILAMENT BULB	$6.95
COL-9DS	TWIN CYLINDER, STEAM POWER PLANT ($25.00 UPS)	$574.95
COL-10	POST OFFICE BANK SMALL (3-5/8"x 5"Hx3-3/4")	$39.95
COL-11	POST OFFICE BANK LARGE (5-3/8"x 6-1/4"Hx3-3/4")	$79.95
COL-12	POST OFFICE BOX DOORS, SMALL (3-5/8"x 5")	$19.95
COL-13	POST OFFICE BOX DOORS, LARGE (5-3/8"x 6-1/4")	$24.95

COUPLERS

CPL-63B	AUTO ANTENNA MULTICOUPLER, AM/FM SCANNER (BNC)	$16.95
CPL-63M	AUTO ANTENNA MULTICOUPLER, AM/FM SCANNER (MOT)	$14.95
CPL-SC	DUAL SCANNER MULTICOUPLER KIT (BNC, PL-250, MOT, F)	$29.95

FREQUENCY COUNTERS

CTR-9	OPTOELECTRONICS CUB (1 MHz - 2.8 GHz)	$144.95

CONVERTERS

DCC-2	3-SOCKET CIGARETTE LIGHTER ADAPTOR	$12.95
DCC-3	MOBILE DC ADAPTOR (1.5,3,4.5,6,7.5,9.12 V, 800 mA)	$12.95
DCC-4	OPC-131 DC POWER CABLE FOR ICOM PCR1000	$12.95
DCC-5	CP-12 DC ADAPTOR W/ NOISE FILTER FOR ICOM R10/PCR 1000	$29.95
DCC-7	MOBILE DC ADAPTOR FOR UNIDEN BC-3000/230/235	$15.95

FILTERS

FTR-152	152 MHZ INTERFERENCE SCANNER FILTER	$59.95
FTR-158	158 MHZ INTERFERENCE SCANNER FILTER	$59.95
FTR-462	462 MHZ INTERFERENCE SCANNER FILTER	$59.95

GPS SATELLITE EQUIPMENT

GPS-100	MAGELLAN GCS-100 GLOBAL E-MAIL/GPS RECEIVER	$1499.95
GPS-2000	MAGELLAN GPS 2000XL, OUTDOOR (BASIC)	$149.95
GPS-3000	MAGELLAN GPS 3000XL, MARINE	$249.95
GPS-4000	MAGELLAN GPS-4000 XL, OUTDOOR (EXTRA FEATURES)	$249.95

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HEADPHONES		
HDP-3	ICOM HP-4 LIGHTWEIGHT	$22.95
HDP-4	RACETRAC CLASSIC PROFESSIONAL	$59.95
HDP-5	RACETRAC PLATINUM PROFESSIONAL W/DOUBLE HEADBAND	$88.95
LIGHTNING PROTECTORS		
LAR-1B	GAS DISCHARGE LIGHTNING/SURGE PROTECTOR (BNC)	$19.95
LAR-1F	GAS DISCHARGE LIGHTNING/SURGE PROTECTOR (F)	$19.95
LAR-1M	GAS DISCHARGE LIGHTNING/SURGE PROTECTOR (MOTO)	$19.95
LAR-1P	GAS DISCHARGE LIGHTNING/SURGE PROTECTOR (PL-259)	$19.95
LAR-2	SINGLE OUTLET-SURGE PROTECTOR (120 VAC)	$3.95
LAR-03	SIX OUTLET SURGE PROTECTOR (120 VAC)	$4.95
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MAN-1	SERVICE MANUAL, ICOM R-8500	$57.95
MAN-2	SERVICE MANUAL, DRAKE R8B	$39.95
MAN-4	SERVICE MANUAL, AOR SDU 5000	$34.95
MAN-6	SERVICE MANUAL, AR-5000	$89.95
MICROPHONES		
MIC-1	MINI LAPEL SPEAKER/MICROPHONE FOR FR-465 CHEROKEE	$19.95
MIC-3	CLIP-ON MICROPHONE, 1/8" PLUG, 10' CORD	$4.95
PHONES		
PHN-2	MAGELLAN'S MINI-M PHONE	$4000.00
PHN-4	CALLER ID AD100	$69.95
PHN-5	O'GARA COMPACT-M SATELLITE PHONE	$4995.00
PHN-5A	O'GARA COMPACT-M SATELLITE PHONE W/ REMOTE	$5145.00
PHN-6	O'GARA MOBIL-F-ONE SATELLITE PHONE	$4495.00
PREAMPLIFIERS		
PRE-1	GRE SUPER PREAMPLIFIER (100-1000 MHz) HANDHELD	$49.95
POWER SUPPLIES		
PWR 1	PORTABLE POWER STATION	$59.95
PWR-2	PSU-101,DESKTOP STAND/CHARGER, +12VDC	$59.95
PWR-4	+12 VDC ADAPTOR, 800 MA,2.1 mm PLUG	$14.95
PWR-6	PLUG-IN CHARGER FOR FR-465 CHEROKEE	$19.95
PWR-12	AC ADAPTOR, 500mA +/- 3/4.5/6/7.5/9/12V, 5 PLUGS	$4.95
PWR-13	SAME AS WR12 BUT UL APPROVED	$9.95
PWR-15	METRO WEST PRO-CHARGE FOR BAT-9	$49.95
PWR-19	+12VDC APAPTOR ,200mA, 2.1 mm PLUG	$7.95
PWR-21	+12VDC ADAPTOR, 500 mA, 2.1 mm PLUG	$9.95
ROTATORS/ANTENNA		
ROT-1	ANTENNA ROTATOR	$59.95
SOFTWARE		
SFT-1	ICOM CS-R10 CLONING ONLY	$12.50
SFT-3	KLINGENFUSS GUIDE TO UTILITIES CD-ROM	$34.95
SPEAKERS		
SPK-2	DRAKE EXTERNAL, DRAKE R8/8A/8B	$48.95
SPK-4	RADIO SHACK PRO-X5 OPTIMUS, 30W MAX.	$45.95
SPK-6	VALOR'S CLASSIC NOISE CANCELLER	$16.95
SPK-8	RADIO SHACK PILLOW SPEAKER	$5.95
SPK-9	RADIO SHACK CLIP-ON MINI SPEAKER	$10.95
SPK-11	NAVAL HTS-3 AMPLIFIED SPEAKER	$29.95
SPK 13	GROVE SOUND ENHANCER	$199.95
SPK-15	VALOR'S SUN VISOR EXTENTION SPEAKER	$16.95
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SPL-1	TV/FM TWO WAY SPLITTER BOX, F FEMALE	$2.95
SPL-2	UNIVERSAL SATELLITE SCPC, ICOM R7100/8500	$64.95
SWITCHES		
SWC-1	DAIWA COAXIAL TWO-WAY SWITCH	$25.95
TRIFIELD METERS		
TST-1	TRIFIELD ELECTRIC/MAGNETIC METER	$119.95
TST-2	TRIFIELD NATURAL EM METER	$199.95
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WHITE PAPERS BY LARRY MAGNE		
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(See some of our best selling books at right)

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BOK58-98	1998 ARRL HANDBOOK (GEN-A)	$32.00
BOK-32	ARRL RADIO FREQUENCY INTERFERENCE HANDBOOK (GEN-A)	$17.95
BOK-103	ARRL REPEATER DIRECTORY (FRQ-SCN)	$8.00
BOK-35	COLLECTOR'S GUIDE TRANSISTOR RADIOS, M. & S. BUNIS (COL)	$15.95
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BOK-95	INSTALL AIM & REPAIR YOUR SAT. SYST., F. BAYLIN (SAT-A)	$9.95
BOK-34	KLINGENFUSS 97 SW FREQ. DIR., JOERG KLINGENFUSS (SWL/FRQ)	$36.95
BOK-53-97	M-STREET JOURNAL, ROBERT UNMACHT, ED. (FRQ-AM/FM)	$48.95
BOK-78	MASTER FREQUENCY FILE, J. TUNNELL & R. KELTY (SCN/FRQ)	$29.95
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BOK-63	MONITOR AMERICA, RICHARD BARNETT (SCN/FRQ)	$29.95
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BOK71	PHILCO RADIO'S 1928 - 1942, MICHAEL PROSISE (COL)	$29.95
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Subject Codes for Books:
SWL—Shortwave
SCN—Scanners
ANT—Antennas
COL—Collectors
FRQ—Frequency Directory
GEN—General Interest
SAT—Satellite

Intended Readership Levels:
A—Advanced
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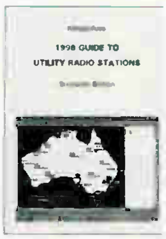

1998 Guide to Utility Radio Stations, *by Joerg Klingenfuss.* This 16th edition covers worldwide non-broadcast radio services on shortwave: aero, diplo, maritime, meteo, military, police, press, and telecom. Lists just about everything: abbreviations, addresses, call signs, codes, explanations, frequency band plans, meteofax, NAVTEX, and press schedules, modulation types, all Q and Z codes, and much more. **Order BOK 54, only $39.95.**

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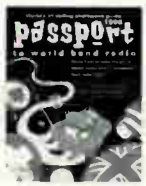

Passport to World Band Radio, 1998, *Edited by Lawrence Magne.* Over 500 pages, features a listener's program guide, arranged both by frequency (2-26 MHz) and easy-to-follow time chart. Listings show transmitter output power, language, favored listening times for North America, and program contents. Reviews of the most popular shortwave receivers and listening accessories. Special alphabetized section of station addresses, contact personnel, phone/fax numbers.**Order BOK 18-98, only $19.95.**

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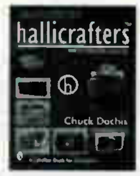

Radios by Hallicrafters, *by Chuck Dachis.* Now long gone, no manufacturer inspired the awe of shortwave hobbyists and hams as did Hallicrafters, the grand masters of communications receivers of the vacuum tube era. Containing over 1000 photos of Hallicrafters receivers, transmitters, TVs, accessories and literature, this new, informative directory includes descriptions of every known model made by allicrafters, including dates, accessories and pricing. **Order BOK 65, only $29.95.**

Based upon the Supreme Court rulings of McLeod vs. Dillworth (1944), Bellas Hess (1967) and the proposed Brooks legislation (H.R. 2230), effective September 1, 1990, Grove Enterprises will no longer collect sales or use taxes apparently invalidly levied by states against residents when they purchase from us in North Carolina. We have neither economic presence nor nexus in these states as established by the U.S. Supreme Court.

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U.S.Postal Service delivery is typically within 10 days of shipment. If you do not receive your parcel by the end of this time frame, call us to put a tracer on your order.

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Total Order	$1-$99	$100-$499	$500-$999	$1000 and up
Shipping Charges	$5.50	$9.50	$15.50	$19.50

***NOTE:* Due to their bulk, some antennas cost more to ship than other products. After you have calculated your total order including shipping charge, please add the following additional shipping cost for any antenna listed below:**

ANT 4, 5, 9, 13, 15, 24 and 30 .... add $5.50
ANT 1, 7 and 31 .... add $11.00

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CITY ____________ STATE ______ ZIP ______

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Billing Address:

NAME: ____________

STREET ADDRESS: ____________

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CITY ____________ STATE ______ ZIP ______

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- ❒ CHECK
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Classified payload frown for the National Reconnaissance Office and reportedly a follow-on to the Satellite Data System data relay satellites, used to relay intelligence gathered from reconnaissance satellites: the name Capricorn has been equated with this mission. Alternatively, the satellite might be related to the Cobra Brass payload, an infra-red, early warning satellite technology experiment. No orbital data have been issued for this mission. Launched from Cape Canaveral using an Atlas-2A.

Updates for Previous Launches

International Designation	Comment
1981-119A	INTELSAT 503 was maneuvered off-station over 156-157 deg E approximately Jan 19, 1998.
1982-097A	The two-line orbital elements suggest that INTELSAT 505 was maneuvered from ~75 deg E to ~71 deg E during the first half of January 1998.
1983-059B	Anik C2 was maneuvered off-station over 245 deg E to a retirement orbit approximately Jan 7, 1998. Add the following retirement orbit: 1998 Jan 7.88 4.93 deg 1,452.73 minutes 35,935 km 36,289 km
1985-055A	INTELSAT 511 was maneuvered off-station over 179 deg E Sep 5, 1997, and has been drifting since that date.
1987-029A	Palapa B2P was maneuvered off-station over 140-141 deg E approximately Jan 18, 1998.
1987-100A	Raduga 21 performed its last station-keeping maneuver Sep 30, 1997, over 190 deg E and has now drifted off-station: it seems probable that the satellite is no longer operational.
1989-020A	After drifting since October 1997, JCSat 1 was relocated over ~110 deg E during January 1998.
1989-027A	TELE-X was maneuvered off-station over 5 deg E and appears to have entered a retirement orbit. Add the following orbital data: 1998 Jan 22.80 0.81 deg 1,451.10 minutes 36,068 km 36,091 km
1991-018A	METEOSAT 5 was maneuvered off-station over 350 deg E approximately Jan 18, 1998.
1992-010B	ARABSAT 1C was relocated over 55 deg E approximately Jan 11, 1998.
1992-044A	The weekly Satellite Situation Report dated January 30, 1998, carried a decay notice for GEOTAIL, indicating a decay date of Oct 19, 1992. It is not clear whether this is a real decay date or whether it is a USSPACECOM "administrative decay" and in reality the satellite is still in orbit.
1996-008A	NEAR performed an Earth fly-by at an altitude of 530 km Jan 23, 1998 at 0723 UTC.
1996-021A	The two-line orbital elements continue to show Astra 1F in a drift orbit with a period of 1,435.1 minutes and with a longitude in excess of 40 deg E. However, a telephone call to SES in Luxembourg (the satellite operator) has confirmed that the satellite is still located over 19 deg E, and therefore USSPACECOM must be tracking something else and assigning the data to Astra 1F in error.
1997-027A	INSAT 2D suffered serious power supply problems, resulting the loss of its Earth lock Oct 4, 1997, and the satellite had to be abandoned. The last set of two-lines showing the satellite on station over ~73 deg E were issued for Nov 22, 1997, and the next set of data to be issued (in January 1998) showed that the satellite had been maneuvered out of geosynchronous orbit: the date of the maneuver is not known. Add the following retirement orbit: 1998 Jan 15.82 0.30 deg 1,374.22 minutes 33,155 km 35,978 km
1997-069E	Iridium 38 has not maneuvered to the operational orbit with a period of about 100.4 minutes, but during January 1998 the orbit appears to have been slightly adjusted downwards: 1998 Jan 1.19 86.42 deg 100.24 minutes 768 km 772 km; 1998 Jan 8.64 86.42 deg 100.18 minutes 763 km 771 km
1997-071B	Add the following orbital data for Cakrawarta 1: 1998 Jan 10.50 0.12 deg 1,436.03 minutes 35,776 km 35,794 km The satellite is located over 108 deg E.
1997-075A	JCSat 5 was maneuvered off-station over 139 deg E approximately Jan 4, 1998.
1997-076A	Astra 1G reached its operational longitude of 19 deg E in late December 1997.
1997-078A	Galaxy 8I was maneuvered off-station over 280 deg E Jan 27, 1997.
1997-081A	Progress M37 undocked from the rear (-X) port of the Mir complex Jan 30, 1998, at 1253 UTC.
1997-082E	Add the following orbital data for Iridium 49: 1998 Jan 9.64 86.40 deg 100.40 minutes 777 km 778 km
1997-083A	INTELSAT 804 was briefly stationed over ~46 deg E during Jan 16-22, 1998, and was finally stationed over its operational longitude of 64 deg E Feb 1, 1998.

Galileo Encounters With Jovian Satellites

The following is an updated list of the encounters between the Galileo Jupiter orbiter (1989-084B) and the Jovian satellites following the spacecraft's entry into Jovian orbit. Both completed and future encounters are listed. The data are based upon material available for the Jet Propulsion Laboratory's World Wide Web site.

Encounter Date/Time (UTC)	Satellite	Distance
Jun 27, 1996/0629	Ganymede	835 km
Sep 6, 1996/1900	Ganymede	262 km
Nov 4, 1996/1334	Callisto	1,118 km
Dec 19, 1996/0653	Europa	698 km
Feb 20, 1997/1703	Europa	587 km
Apr 5, 1997/0710	Ganymede	3,095 km
May 7, 1997/1557	Ganymede	1,596 km
Jun 25, 1997/1348	Callisto	415 km
Sep 17, 1997/0019	Callisto	538 km
Nov 6, 1997/2032	Europa	2,042 km
Dec 16, 1997/1205	Europa	200 km
Feb 10, 1998/1757	Europa	3,562 km
Mar 29, 1998/1323	Europa	1,649 km
May 31, 1998/2112	Europa	2,521 km
Jul 21, 1998/0507	Europa	1,837 km
Sep 26, 1998/0350	Europa	3,598 km
Nov 22, 1998/1147	Europa	2,281 km
Feb 1, 1999/0210	Europa	1,495 km
May 5, 1999/1406	Callisto	1,311 km
Jun 30, 1999/0746	Callisto	1,050 km
Aug 14, 1999/0839	Callisto	2,288 km
Sep 16, 1999/1735	Callisto	1,053 km
Oct 11, 1999/0436	Io	500 km
Nov 26, 1999/0400	Io	300 km

Orbital Data for Mars Global Surveyor

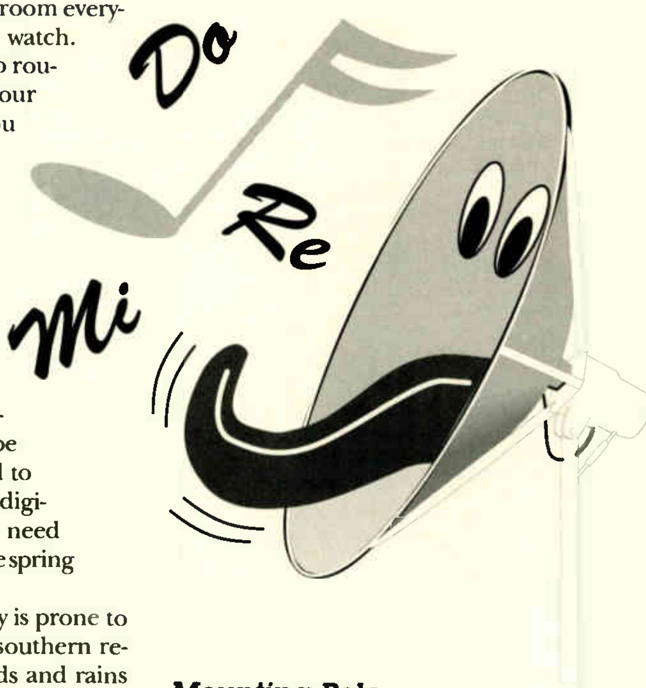
The following list continues the one prevously published in *Satellite Times*: orbital data are shown for every fifth day. The data are derived from material available on the Jet Propulsion Laboratory's World Wide Web site.

1997 Dec 21.44	93.47 deg1,682.70 minutes	112 km	37,652 km
1997 Dec 26.02	93.47 deg1,613.68 minutes	110 km	36,427 km
1997 Dec 31.49	93.43 deg1,547.91 minutes	109 km	35,242 km
1998 Jan 5.74	93.53 deg1,473.69 minutes	107 km	33,886 km
1998 Jan 10.72	93.61 deg1,401.62 minutes	108 km	32,544 km
1998 Jan 15.48	93.58 deg1,333.33 minutes	107 km	31,253 km
1998 Jan 20.91	93.60 deg1,274.99 minutes	106 km	30,133 km
1998 Jan 25.24	93.58 deg1,220.26 minutes	106 km	29,066 km
1998 Jan 30.21	93.59 deg1,160.84 minutes	105 km	27,889 km
1998 Feb 4.73	93.60 deg1,111.35 minutes	105 km	26,893 km

By Ken Reitz, KS4ZR
KS4ZR@compuserve.com

It's Spring Tune-Up Time!

Satellite television technology is fascinating, and in the showroom everything runs like a Swiss watch. But, like a car, you need to do routine maintenance to keep your system running like new. If you installed a satellite TV system last summer, now is a good time to think about doing a tune-up.



Throughout the course of a year the four seasons can really take a toll on a satellite system. With heavy snow, driving rains, wind and the busy activities of all the little creatures of the wild, you may not be getting all the signal you used to from your system. Small dish digital systems are less likely to need much attention, but some of the spring cleaning tips still apply.

Each region of the country is prone to weather peculiarities. In the southern regions it'soften the heavy winds and rains which can have a detrimental effect on your viewing. In the northit's the weighty business of snow, the freezing and thawing of the ground, and late winter winds which can create problems. The effect of all this meteorological activity is to loosen up your installation just enough to affect your reception quality.

Where's the Problem?

Day by day the signal from your dish appears to be the same. Unless there's a specific event, like someone backing into your dish or someone else cutting the LNB cable (who *are* these neighbors anyway?!), slow degradation of the signal is not noticeable. Sometimes what looks like an ailing LNB may actually be a dish alignment problem. What appears to be your receiver's memory going south may actually be a loose dish mount. Here's what to look for.

Mounting Pole

In northern climates the spring thaw causes the ground to heave. Mounting poles which are not properly installed may tilt slightly through this process. To find out if your mount is still plumb, (straight up and down) place a three foot level on the pole and check that the bubble in the level is between the marks. Do this in three places around the pole. If it is out in any direction adjustments will have to be made.

In southern climates saturation rains may loosen the soil around the pole and cause it to tilt. Installations which were improperly done will suffer the most. The mount pole must be at least schedule 40 thickness, the hole for the mounting pole must be at least 4 feet deep and have at least three 80 pound bags of concrete around it. This may sound like over-kill but you'd like this to be a permanent installation.

Polar Mount

The dish is attached to the polar mount which sits on top of the mounting pole. Usually there are two or three large hex-head bolts which keep the mount from turning on the pole. This is the way the north/south alignment is secured on your dish. If all three of these bolts aren't tight, it's possible that your dish may be able to rotate just a little on the mounting pole.

The edge of the dish is like a huge lever and it takes no strength at all to rotate the whole assembly on the mounting pole. This is exactly what happens in those very strong wind storms we all tend to experience in March.

When you first do an installation, take a felt marker and draw a line across the bottom of the mount and onto the pole. Periodically check this mark. If the two don't match up, your dish has drifted on the pole.

Actuator Arm

Linear dish drives usually have two clamps which secure the drive to the mount. A threaded gimbal bolt usually attaches to the dish itself. This is how the dish is moved. When dc power is applied to the motor, it turns a screw which pushes the arm out of the tube. Since the tube is firmly attached to the mount and the arm is firmly attached to the dish, the whole dish pivots on two sets of bearings and moves east and west.

But, if the clamps are loose, or the gimbal bolt is not tight, there may be some play in the dish which will cause it to be slightly off each satellite. The on-screen result will be "tearing" in the whites, "noise" in the bright colors, or "sparklies" in the blacks.

To determine if there's any slop in your actuator or mount, stand in front of the dish and place your hands on the bottom rim. Try to rock the dish from side to side. There shouldn't be any movement. If there is, track down the loose fittings and tighten them all.

Feed Horn

If your feed horn is attached to your dish with a tripod or quad-leg mount there should be little reason for anything to get loose. Buttonhook designed feed horn supports are another matter entirely. Check to see that the feed horn is actually over the center of the dish, that the face of the feed horn is parallel with the bottom of the dish. Professional installers have tools for doing just this, but you can do the same with a tape measure.

Next, check to see that the throat of the feed horn still has its plastic cover. If not, get a replacement. This is important, because it keeps wasps, spiders and other creepy things out of the throat and away from the probe which is the actual satellite antenna. Any insect presence in the feed horn such as wasp nests and spider webs can create interference to microwave signals. The throat cover prevents that problem.

Moisture is the greatest enemy of microwaves. To inspect your cables for moisture, turn the power to the system off, unscrew the cable to the LNB. Check the connection for corrosion or moisture. The bare copper should be bright. If it isn't you may scour it lightly with a fine emery cloth and blow out the dust. If there is any sign of moisture inside the fixture dry it off entirely and screw the connector back on. Cover the connection with Coax-Seal (available from Radio Shack).

You may want to unbolt the LNB from the feed horn and examine the wave guide. There must be a rubber gasket around the flange of the LNB. This makes the connection water proof. If there is any moisture in the wave guide, you've got a leak which will seriously degrade your picture.

As to feed horn protective covers: this is a matter of debate among installers. Some swear by them and install them as a matter of course. Other installers intentionally leave them off believing that the excess heat built up inside the cover prevents the circuitry in the LNB from running as cool as it should. Over the years I've used both and haven't noticed an advantage either way. I do know that removing the covers during maintenance and repairs is an extra burden.

Peaking Your Dish

There are several ways to "fine tune" or "peak" your system. One is to haul an extension cord, your receiver and a TV set out to the dish site. Now, with a 10 or 12 foot length of RG/6 with cable connectors attached, remove the system coax from the LNB and attach the short length to the LNB and the receiver. With everything connected, turn on the power and make adjustments watching the picture on the TV. This is a tough job on a sunny day. Consider placing the TV set in a box on its side to make the picture more visible.

A less involved way is to use a small signal meter in line between the LNB and the system coax. This allows you make adjustment while watching the needle on the meter. Any increase in signal strength is good and any decrease is bad.

Another way is to have an accomplice inside while both of you chat back and forth on hands-free, voice operated (VOX), 47 MHz handi-talkies. This system has many drawbacks including getting such subjective comments as "Oops! Too far, now go back a bit...that's better, but not as good..." Skyvision sells a number of peaking and installation tools through their mail order service (800-543-3025).

The Nature of Interference

One of the biggest sources of interference in satellite signals is from blockage by trees or shrubs. Such natural shields grow slowly and you may not appreciate that the little tree on your neighbor's property has now grown up and is blocking the last three satellites to the west. Many people planted shrubs around their dish to give it a little camouflage. In some cases these shrubs are now above the rim of the dish and cutting down on the signal area. It's time to get out the clippers and do a little trimming.

Another powerful source of interference is man-made and directly related to long distance phone service providers. These sources are the tall microwave towers one sees dotting the landscape. They operate near C-band frequencies and thus create an "out of phase" signal source which gets into your feed horn to disrupt the "in phase" signals from the satellite at which your dish is aimed. The result is that, on certain channels, the signal barely gets above the noise threshold of your receiver, while all the other channels remain perfect. This type of interference is known as "terrestrial interference," often referred to as "TI."

Getting rid of TI is an ordeal. There are microwave filters which can be added at the feed horn to "trap" the out-of-phase signals. These are usually very expensive. Another technique is to build fences of fine, metal hardware cloth to the side of the dish from which the offending signal is emanating. This can be done with 2x2 frames nailed to 4x4 posts in the ground. The key is to have small enough mesh in the hardware cloth to stop C-band wavelengths from getting through. TI is not a problem at Ku-band because the long distance services don't use those frequencies. Oddly, the best solution, and certainly the easiest, is to use the internal TI filtering available in many satellite receivers. This system is usually comprised of a button on the remote control, labeled "TI on/off." Engaging the button narrows the bandwidth of the receiver and, in mild cases of TI, gets rid of the problem. Another receiver solution is to use the video fine tuning and shift the center frequency of a particular channel. This problem will continue until all long distance service is carried on fiber optic cable.

Above all, don't try peaking your dish during the periods of solar outages which occur at the fall and spring equinoxes. This is when the sun is lined up directly behind all the satellites in the Clarke Belt as it makes its way through the day. If the sun is behind the satellite on which you are trying to peak your dish, you will think you're doing everything wrong when it's really the massive RF power of the sun taking over your receiver.

It's not just weather that can be the source of weak signals. Some satellite dealers do a poor job of installation. By spending a little time doing minor adjustments you will be amazed at the extra signal strength you can gain. This extra gain will pay big dividends when you are trying to tune in weak Intelsat satellites, Mexico's Morelos or Solidaridad satellites, or picking up very narrowband transmissions such as those used in Single Channel Per Carrier (SCPC) signals.

ST DOMESTIC TVRO

By Doug Jessop

News from NATPE

As promised in last month's issue of *Satellite Times*, here is a sneak peak at what will be gracing the airwaves in the coming months. Every year the annual dance between television programming executives and the people that produce and market the shows meet at the National Association of Television Programming Executives NATPE) convention. The offerings from year to year vary from "more of the same," regurgitated drivel and the occasional gem.

Talk shows continue to dominate the crop of syndicated show. With the success of *Rosie O'Donnell* (Monday-Friday G9 tr 22 at 10 a.m. and T5 tr 24 at 12 p.m.) and *Live with Regis and Kathie Lee*, the kinder and gentler talk show is back with *Donny & Marie*. Yes, the same Donny and Marie you remember from the 70's. Except for the fact that Donny ticked off Rosie on national television, this show is being very well received by the broadcasting community and is considered the show most likely to succeed.

Comedy veterans moving to the talk show circuit seem to be the "in" thing this season with both Roseanne and Howie Mandel joining the talk show fray.

It seems that viewers just can't help looking at a train wreck. Recently, *The Jerry Springer Show* (Monday-Friday G4 tr 21 at 6 a.m.) surpassed perennial talk show queen of the hill Oprah Winfrey (Monday-Friday T5 tr 16 at 10 a.m. and G4 tr 12 at 4 p.m.) for the first time in the all important ratings.

Sally Jessy Raphael (G4 tr 22 Monday-Friday 12:30 p.m.) aired its 3,500th episode recently, making the program, in its 15th season, TV's longest-running nationally syndicated talk show.

Game shows are back with a vengeance. *Wheel of Fortune*'s (Monday-Friday T5 tr 16 at 12 p.m. and Thursday G4 tr 22 at 9:30 a.m.) audience hasn't really grown over the years, unless you count the average age of their viewer. Distributor, KingWorld has the goal of jazzing up the show with various road trips around the country. Can I buy a vowel?!

Hollywood Squares is on the "A" list for new game shows. At press time, Whoopi Goldberg had been confirmed as the all important center square celebrity for the updated classic.

In the continued wave of nostalgia, UPN (noted on Galaxy 4 in the past) has purchased the rights to *The Love Boat* and are in the process of updating the show with a new production that has the Captain as a recently divorced man with a teenage son. Just wait for the testosterone to run amok on this show. Where is Julie when you need her? Apparently, UPN also made a run at getting the rights to redo *Fantasy Island*, but was outbid by ABC.

Hormone driven dating shows are still around with the likes of *Love Connection*, *Change of Heart*, *Dating Game/Newlywed Hour* (Monday-Friday T5 tr 16 at 11 a.m. and T5 tr 24 at 4 p.m.)

Judge Wapner, where are you...? In addition to the *Judge Judy* (Mon-

Donnie and Marie Osmond.

Scene from The Dating Game.

Host Pat Bullard of the Love Connection.

day-Friday G4 tr 14 at 7:30 a.m. and 2:30 p.m.) show, District Court Judge Mills Lane is getting in the ring (pun intended; Lane also happens to be the same guy that was the boxing referee that stopped the infamous ear biting fight with Mike Tyson). The show is touting a *Court Cam* where a camera crew will go to the scene of each conflict and bring back footage relevant to the case. Producers of the show also plan to visit with Judge Lane in chambers after the verdict is announced to get an idea as to what guided him to his decision.

For sci-fi/fantasy fans, it appears that *The Highlander* (G4 tr 21 Saturday at 10 a.m. and Wednesday at 8 a.m.) is passing on the sword to a new immortal. She is being billed as "a beautiful and ageless warrior on a quest to rid the world of evil." *Highlander: The Raven* appears to be taking a page out of the *Hercules* and spin-off *Xena* playbook. *Xena* which was originally a small walk on part in *Hercules* now outperforms *Hercules* in the national ratings.

A number of new shows fall into the "don't look now category." Pamela Lee is back and "ready for action" with new show entitled *VIP* ... uhh, yea, right. *Forgive or Forget*, a feel good show that gets people together to try and patch things up. *The Crow: Stairway to Heaven* tries to capitalize on the rather dark movies.

Boomer Esiason has accepted an offer by ABC Sports to replace Frank Gifford in the broadcast booth for *Monday Night Football* (W1 tr 10, S4 tr 8, and C1 tr 2). The network would not comment on negotiations with Esiason, which are ongoing, but said that Gifford is moving from the broadcast booth to pregame host to spend more time with his family.

NBC Entertainment President Warren Littlefield announced that the network's police drama, *Homicide: Life on the Street* (W1 tr 6, S4 tr 6, C1 tr 8/14 and various Ku-band transponders on W1) has been renewed for the 1998-99 season. Tom Fontana, who has received critical praise for his work on HBO's prison drama *Oz*, will continue to produce *Homicide*.

Citing undefined "personal issues" facing *Grace Under Fire* (G4 tr 5 Monday at 3 p.m. and W1 tr 10, S4 tr 8, C1 tr 2) star Brett Butler, the ABC sitcom halted production for the second time this season. Producers Carsey-Werner said that the show will hopefully "resume production at some point in the near future." Sources are saying that this flare-up may mark the beginning of the end for the show, which has been sputtering in the ratings for their fifth season. "Grace's" two-year contract with ABC runs out this year and the two production stops may not bode well for the show.

Pamela Lee Anderson.

Syndicator King World has inked a deal with crime author Nicholas Pileggi, who collaborated with Martin Scorsese on the movies *Goodfellas* and *Casino*. Under the agreement, Pileggi and producer Ken Solarz will write the first two scripts of *Murder Inc.*, King World's first one-hour dramatic series.

The cast of NBC's *Friends* (W1 tr 6, S4 tr 6, C1 tr 8/14 and various Ku-band transponders on W1), less pregnant member Lisa Kudrow, jumped over the pond and taped an episode in London. The episode, scheduled to air in May, will have David Schwimmer's character, Ross, meet a woman from England and then go to visit her. Co-producer David Bright said a wedding may be in the picture but no one is "positive about that."

ER's (W1 tr 6, S4 tr 6, C1 tr 8/14 and various Ku-band transponders on W1) executive producer John Wells said that its not likely George Clooney will be appearing on the popular drama after next season, when the actor's five-year contract expires."My assumption if that he probably won't be back," said Wells. "He's been fairly clear in saying that he planned to honor his original commitment, but that he wanted to pursue his feature (film) career."

FX has acquired exclusive television rights to all 241 episodes of Fox's *Beverly*

Hills, 90210, currently in its 9th season on the Fox Network (various transponders on T4/T5 and Wednesday 5 p.m. on T5 tr 9).

Fox has ordered *Hollyweird,* a pilot created by movie director Wes Craven (*Scream, Nightmare on Elm Street*) and television producer Shaun Cassidy (*American Gothic*). The series, targeted for next season, is about two twenty-somethings who host a cable TV program about bizarre crimes in Los Angeles.

Officials at Nick at Nite's TV Land (C3 tr 18) report that the network will air a rare *Rat Pack* concert featuring Frank Sinatra, Sammy Davis, Jr., Dean Martin and Johnny Carson on April 20. The concert was close-circuited to theaters in 1965 to benefit a halfway house in St. Louis.

By the time you get this issue of *Satellite Times* in your hot little hands, Ziff-Davis should have launched ZDTV, a 24-hour computer channel. Ziff-Davis is, of course, the computer magazine giant. Skeptics are wondering how in the world demand could be there for a channel just dedicated to computer stuff. In this writer's opinion, ZDTV is most likely at the right place at the right time. Just look at the explosive growth of the Internet and associated increased sales of computers.

Changes at GI

NextLevel Systems, Inc.which is changing its name back to General Instrument Corporation, announced the acquisition of Fuba Communications Systems GmbH (FCS), a leading European manufacturer of high quality cable television equipment, based in Germany.

General Instrument is the world leader in analog and digital systems that provide video, audio and high-speed Internet/data services over cable and satellite television networks. GI announced that major North American cable operators expect to purchase at least 15 million of GI's advanced digital set-top devices over the next three to five years at an estimated value of US$4.5 billion.

GI's cable and satellite TV operations have approximately 7,000 employees and annual sales of approximately US $1.8 billion. With the name change to General Instrument Corporation, the Company's ticker symbol on the New York Stock Exchange was changed to GIC from NLV.

Loral Inks New Direct-to-Home Television Deal

Loral Space and Communications Ltd. has formed a strategic alliance with India-based Modi Entertainment Networks (MEN), a K.K. Modi Group company, to jointly pursue business opportunities in direct-to-home (DTH) satellite broadcasting in India.

Loral is a high-technology company that primarily concentrates on satellite manufacturing and satellite-based services. It was through its subsidiary, Space Systems/Loral, one of the leading manufacturers of the world's communications and weather satellites, that Loral recently established a joint venture with Mabuhay to provide DTH services to the Philippines.

Loral Skynet, also a subsidiary, is a leading U.S. satellite communications service provider that owns and operates the Telstar satellites. Skynet is also under contract to provide tracking, telemetry and control for Echostar's DTH satellites.

Roseanne

Howie Mandel

In addition, Loral manages and holds a 39 percent equity interest in Globalstar, the global, mobile satellite-based telephony system, scheduled for service initiation in late 1998. Loral also is the developer of CyberStar, a geostationary satellite-based, open protocol, digital telecommunications system that will offer a variety of low-cost, high-speed, data and telecommunications services worldwide, initially from leased Ku-based satellites.

Loral recently entered into a definitive agreement to acquire Orion Network Systems Inc., a corporate data networking and satellite services company, in a transaction expected to close in the first quarter of 1998. Most recently, Loral's joint venture bid with Telefonica Autrey was selected as the winner of the auction to acquire a 75 percent stake in Satelites Mexicanos, S.A. de C.C. (SatMex). SatMex's assets consist of three operating satellites, and one under construction, along with a state-of-the-art tracking, telemetry and control site and three government concessions for orbital slots.

Sources for this edition of *Domestic TVRO* include a variety of friends in the business as well as *Broadcasting & Cable, Electronic Media, Los Angeles Times, San Francisco Chronicle, New York Daily News, New York Post* and *Wired.* ST

Doug Jessop has been in the broadcasting industry since 1979 and was the creator of the North American Satellite Guide. He can be reached at **http://www.searcher.com/STcomments.html**.

By George Wood
wood@rs.sr.se

NBC Shakes Things Up

Most of the news on European satellites is the rapid expansion of digital packages. Virtually all the new channels and transponder switches nowadays are in the digital realm. But there are still some interesting things happening on the analog transponders.

Following the CNBC Europe/EBN merger, the new CNBC is being broadcast on both Astra and Eutelsat's Hot Bird 1. However, NBC says eventually the channel will broadcast only on Hot Bird. This leaves a prime Astra transponder free. The obvious choice—putting NBC Europe on Astra to give Rupert Murdoch's Sky One some competition—is unlikely, as NBC seems uninterested in direct-to-home distribution of its channel. Instead, NBC has been promising to introduce new channels to Europe. The most likely possibility is the news channel msNBC. Another is a new channel, based on the network's archives of drama, comedy, and documentaries.

The merger has greatly strengthened CNBC, which has taken on several of the more popular EBN programs, such as the daily *Media Report*. However, former *Media Report* presenter Ed Mitchell has a new job, co-hosting the new *Europe Today* weekdays between 6:00 and 9:00 a.m. Central European Time (CET). This is simulcast on both CNBC and NBC Europe, and is a loose reworking of the *Today* show.

When NBC bought the failing Super Channel a few years ago and began to turn it into NBC Europe, *Today* was one of the highlights of the format, along with Jay Leno's *Tonight* show. Originally *Today* program was broadcast live (or perhaps slightly delayed) at 6:00 p.m. CET. But eventually NBC Europe shifted the program to morning of the following day, with updated newscasts from ITN in London replacing the American news from the day before.

Now, the newly fortified CNBC Europe has created its own *Europe Today*, using the *Today* logo (with "Europe" added), and a few news stories from NBC, but otherwise quite different from the original. It's a straight news and business news format, with co-anchors behind a desk, flanked by a shifting group of special correspondents.

Fortunately NBC hasn't lost its wits, and the original *Today* show remains in the schedule, once again returning to the afternoon via a live relay at 3:00-4:00 p.m. CET.

The CBS *Morning* program used to be relayed to Europe by Sky News, slightly delayed in the afternoons. Originally two separate half hours were carried, with a half hour of Sky News in between. For a while, the CBS feed to Sky was in the clear on Intelsat-K, complete with American commercials. Later Sky News cut CBS back to just half an hour, and now the program has regrettably vanished completely from the schedule.

What to me is the biggest loss and the worst morning TV blunder in European satellite TV is the change initiated by the BBC. The respected British broadcaster started satellite broadcasts originally as relays (fortunately in the clear) for Danish cable networks. Back then it was called BBC Europe. However, the success of CNN during the Gulf War led the BBC to launch a better organized European cable and satellite subscription channel called BBC World Service Television. This featured programs from both the BBC 1 and 2 TV channels; the absolute highpoint for many viewers was the relay of the BBC *Breakfast News* every morning. Watching that show, with its local weather and traffic news, one felt like a tourist waking up in a London hotel room. Almost as enjoyable was the excellent evening show, BBC *Nine O'Clock News*.

But a couple of years ago the BBC split World Service Television into the clear, 24 hour news channel *BBC World* and the subscription, general entertainment *BBC Prime*, with classics from the archives (making it a virtual clone of the domestic satellite station UK Gold). Along the way, both the *Breakfast News* and the *Nine O'Clock News* vanished, without a word of explanation. Sometimes trying to make a channel more international destroys its the charm and character.

European satellite broadcasting has in general been a history of a greater choice of new channels, many crossing the Atlantic from the US. The latest trend, however, has been the disturbing disappearance of several stations.

In January, Landmark Communications began closing the four European versions of The Weather Channel in English, German, Dutch, and Italian. The rival, English-language only Weather Network is considering taking over some of the European operations. Landmark has followed up by trying to sell its European Travel Channel.

Now Country Music Television Europe is ceasing broadcasts to Europe on March 31. Reports on its losses over the past two years vary between 10 and 20 million dollars, and instead CMT will concentrate on the South American market. (It's unclear what will happen to Country Music Radio, but fortunately MCE has two separate country channels among its digital audio offerings,)

The failure of a Russian rocket over Christmas has triggered a complicated shifting around of European satellites. British Sky Broadcasting was supposed to start its new digital service from the Astra 2A satellite at 28 degrees East, which was scheduled to launch in August 1997. The Russian Proton launch had already been pushed back by six months, when the failure of a Proton during the Christmas period prompted the Russians to cancel all further launches until they could find the problem. The Astra 2A launch will be in May at the earliest.

So in mid-February Luxembourg's SES moved all the transponders from Astra 1E at 19 degrees East over to the new Astra 1G satellite. Then everything on Astra 1D was switched over to Astra 1E. Now Astra 1D is moving to 28 degrees East to take the place of the delayed Astra 2A. Tests at the new location will begin in mid-March. Astra 1D will provide 18 transponders for digital transmissions in the 11.70-12.10 GHz range.

SES has confirmed the following digital transponder allocations on Astra 2A:

BSkyB	14 transponders
BBC	2 transponders
Flextech	2 transponders
Discovery	1 transponder
UKTV	1 transponder
Viacom	1 transponder
Turner Broadcasting	0.5 transponder

In addition at least 2.5 transponders will be used for multiplexing of TV, radio, and multimedia services from several other UK-targeted broadcasters. SES will permanently operate two Astra satellites at 28 degrees East. Astra 2B will launch with Ariane towards the end of the year. Together 2A and 2B will provide 56 active transponders.

Meanwhile, BSkyB has confirmed that its digital service will launch in June, but at what is being called a "modest" level. The "meaningful" launch of the 200 channel service has been pushed back to October, and Sky is promising a major pre-Christmas marketing campaign for the service. Apparently this is not so much owing to the problem with the Astra satellite as to a shortage of the new digital decoders. Because of the special British Broadcasting services, existing MPEG-2 receivers are unsuitable for the Sky package, and Sky has placed orders for its special settop boxes with Amstrad, Pace, Matsushita, and Grundig, reportedly for more than 400,000 decoders. Both Pace and Amstrad they will have "initial quantities" of decoders available in June.

Britain's Flextech (owned by TCI) may be taking on BSkyB with its own digital satellite service. According to the *Observer* newspaper, Flextech, which owns the rights to several BBC channels as well as the Discovery channel and UK Living, is negotiating with BSkyB to include its channels in the Sky package. But if the deal falls through, the *Observer* quotes sources close to the company who say Flextech may market its own satellite package, reportedly with the backing of Microsoft and Turner Broadcasting.

EUTELSAT

Meanwhile, there's a pay-per-view rival to BSkyB's new Sky Box Office. Four UK cable operators–NTL, Diamond Cable, General Cable, and Telewest–have gotten together to launch Front Row as an alternative to Sky Box Office. This is available on satelite, but is only offered on cable to Cable and Wireless customers. Front Row is being delivered to cable headends from Sirius 2 on 12.303 GHz in encrypted MPEG-2. Comtel, another British cable company, is to start its own PPV service later this year.

Music Choice Europe, which outlasted DMX to capture the spots for radio channels on Europe's various digital satellite services, has gotten together with Sky to offer its service to British analog viewers/listeners. If it isn't an April Fool's joke (a subscription digital service offering free analog channels?!), starting April 1 there will be seven MCE channels in the standard Astra Panda 1 analog stereo on various Astra transponders. There is no extra cost for the service, even though it is in the clear (which means anyone in Europe with an Astra dish should be able to tune in). Eventually there will be 60 channels of MCE on Astra 2A at 28 degrees East, as part of Sky's basic digital service.

What Satellite TV reports that Viacom's MTV and VH-1 have finalized plans to launch six new 24 hour channels, which will probably be part of BSkyB's digital service: MTV Rocks (hard rock and heavy metal), MTV Indie, MTV Ritmo (Spanish pop), VH-1 Soul (blues and soul), VH-1 Country, and VH-1 Smooth (Jazz and New Age).

Back at 19 degrees East, SES has ordered a new "Super Satellite"–Astra 1K. France's Aerospatiale will build the monster, which will be Europe's largest communications satellite when it's deployed by the end of the year 2000. Astra 1K will provide back-up capacity for the other Astra satellites at 19 degrees East, and will expand geographical coverage to include Central and Eastern Europe. The satellite will carry an incredible 52 Ku-band transponders, at higher power than the current Astra transponders. It will also carry additional Ka-band capacity (two transponders), backing up and extending the coverage of the upcoming Astra 1H satellite.

INTELSAT

According to CNBC's *Media Report* SES plans to use the Ka-band for home users to transmit back to the satellite, making fast two-way Internet access possible. (The problem with Internet services by satellite, as introduced in Europe by SES, Eutelsat, Scandinavia's Viasat and Canal Digital, and others, is that the return path still has to occupy a telephone line, which in Europe is billed by the minute, even for local calls.)

Eutelsat and Hungarian domestic broadcaster Antenna Hungaria say they are launching Central Europe's first satellite-based Internet service this spring, as part of a new Hungarian digital package. The platform can be used to deliver digital TV, radio, multimedia content, and corporate data, as well as Internet access.

In other digital news:

Fox Sports World has started in clear MPEG-2 on PAS-3R (43 degrees West) on 12.568 GHz (SR 7030, FEC 3/4).

A new package in clear MPEG-2 from Turner Broadcasting has opened on Astra on 12.670 GHz (SR 22000, FEC 5/6): Cartoon Network, CNN International and TNT.

The French newspaper *Les Echos* says Luxembourg-based CLT (which has merged with Germany's Bertelsmann) is expected to leave the TPS digital satellite venture and join rival Canal Plus. There have been suggestions that TPS and Canal Plus could merge, but this has been blocked by TF1, the main partner in TPS.

There's been an improvement is subscription sales for Germany's DF-1 (ironically, after the European Commission sought to block DF-1's merger with rival Premiere, which would bring about Germany's desparately needed unification of digital TV standards). The Kirch digital package's Wolfram Winter says there are now nearly 120,000 subscribers.

The Greek MAD TV, along with five radio channels, is to be available by subscription across Europe. A digital receiver with an Irdeto CA module is required, but not the German D- box, which is programmed to only receive DF-1 and Premier.

An Austrian package is testing on 12.692 GHz (SR 22000, FEC 5/6) in clear MPEG-2: ORF1, ORF2, TW1 (Tourism and Weather Channel), SF1 and several radio stations. ORF1 and ORF2 will be encoded.

The Benelux verison of Hallmark has ceased digital transmissions on Astra 12.344 GHz.

Thai TV 5 Global Network is now broadcasting via a second digital transponder on Hot Bird 3 on 12.111 GHz (SR 27500, FEC 2/3). Also in that same multiplex is Spain's TVE Internacional and the news channel TVE 24 Horas, Germany's Onyx TV, RTBF feeds from Belgium, an Internet service, and two test cards. The entire package is in the clear.

Disney/ABC's Scandinavian Broadcasting System has announced that it has reached an agrement with Canal Digital, the joint venture between Canal Plus and Norway's Telenor, in which SBS's Swedish, Norwegian, and Danish TV channels will be made available to viewers as part of the Canal Digital platform throughout the Nordic region. Under the agreement, Kanal 5, TV Norge, and TV Danmark will be included in Canal Digital's basic tier programming.

Kanal 5 left Kopernikus 2 (28.5 degrees East) 12.521 GHz on February 1. The Scandinavian Canal Plus package left Astra 11.954 GHz on February 1.

Swedish newspapers are speculating about a pending merger between Norway's satelite operator Telenor and Sweden's Telia (the country's largest cable operator). There's even one report that British Telecom, having failed to acquire MCI, has been invited to invest in the venture. One aspect that has not been commented on is how a merger might affect the current competition between Telenor's digital satellite offerings at 1 degree West and Telia's new digital cable package, relayed by Sirius 2 from 5 degrees East. Telia's spokesman Hans G. Larsson says there is a possibility the satellite channels may be made available for DTH viewing in the the future.

Telia is relaying 25 MCE audio channels on 11.747 and 12.130 GHz on Sirius 2. The other Telia transponders are 12.169, 12.360 and 12.399 GHz.

Also on Sirius 2, Denmark's DK4 has moved from 12.380 to 12.635 GHz in clear MPEG-2 (SR 14994, FEC 7/8). BET on Jazz has started on 12.380 GHz in clear MPEG-2.

Joining the Telenor offerings at 1 degree West, Fox Kids Norway has started on Thor 2 on 11.229 GHz (initially in clear MPEG-2, but this will certainly change) at 06:00-18:00 hrs CET.

Only Swedes abroad and foreign households with a Swedish connection will be allowed to subscribe to the new SVT Europe channel on Sirius 2 (12.380 GHz, SR 27500, FEC 3/4, Viaccess). This means the 10,000 Swedish households outside the range of the SVT terrestrial transmitters but still forced to pay for TV reception licences, will NOT be allowed to subscribe to SVT Europe.

SVT Europe followed on the heels of a similar public service Finnish channel called TV Finland, and now Norway has introduced a similar service for Norwegian's abroad called NRK International. The digital pay channel is provided through Telenor and Nordic Satellite Broadcasting. Programming consists of programs simulcast or previously broadcast by NRK- 1 and NRK-2. A radio channel called NRK Europakanalen is included on an uncoded audio subcarrier. This is a mixture of domestic channels P1, P2, P3, and Radio Norway International and has been heard in Europe through NRK's medium wave transmitters (of which Kvitsoy 1314 kHz is the main outlet).

NRK International is being carried on Intelsat 707 at 1 degree West on 11.174 GHz, in Conax-encoded MPEG-2. Both NRK-1 and NRK-2 were already available on satellite in encrypted MAC, but the subscription cards are only sold in Norway.

Meanwhile, Denmark's public broadcaster DR1 is back on Intelsat 605 (27.5 degrees West) on 11.494 GHz in clear MPEG-2 (SR 4340, FEC 7/8).

Back in the analog world, the Sci-Fi Channel and CNBC Europe are stopping their shared transponder transmissions from TV-Sat at 1 degree West. They continue on Sirius 2.

Gay TV has begun sharing Astra transponder 34 with Television X and UK Living. It's on the air at 05:00-06:00 hrs CET and is encoded in Videocrypt.

Germany's regional channel Hessen Fernsehen has begun regular transmissions on Astra transponder 40.

On Eutelsat, Bosnia's BHT has moved from Eutelsat II-F2 (11.080 GHz) to Eutelsat II-F1 (11.658 GHz), at 21:30-23:30 hrs CET in clear PAL. Meanwhile, OBN from Sarajevo is on Eutelsat II-F3 11.128 GHz in clear MPEG-2 (SR 3125, FEC 3/4).

The Italian adult channel Satisfaction Club TV is now only on Eutelsat II-F2 and has discontinued broadcasts on Hot Bird 2.

The Iranian IRIB's Jaam-e-Jam TV Network began regular transmissions on Hot Bird 3 on 12.437 GHz on December 6. This offers 21 hours a day in Farsi, plus three hours in English or Arabic.

This Country Ain't Big Enough for All Three of Us

DirecTV Japan began broadcasting its initial 63 channel service on December 1. The service is supposed to reach 90 channels, and in late February, DirecTV announced a list of new channels and prices due to begin in April.

In order to take on the threat from DirecTV, rivals Japan Sky Broadcasting and PerfecTV announced officially on February 3 that they would merge in early April to create Japan's largest DBS platform. PerfecTV, which has been on the air since autumn 1966, had signed up 500,000 subscribers by December, still short of its original target. JSkyB, owned by Rupert Murdoch's News Corp, along with Sony, Fuji Television, and Softbank, was expected to offer 100 channels from April.

Among new channels starting on PerfecTV on April 1 is a new, non-stop news channel from Japan News Network, the news affiliate network of TBS. JNN News Bird will be included in the service's "Perfec Pack" basic tier, increasing the number of channels in the package to 31.

Japan's JCSAT 1B satellite (also known as JCSAT 5) has replaced JCSAT 1A (or JCSAT 4) at 150 degrees East. JCSAT 4 is moving to 124 degrees East.

The CNBC/Dow Jones merger finally brought together CNBC Asia and Asia Business News on February 2, several days after CNBC Europe and EBN merged. They may have been waiting for the end of the Chinese New Year celebrations.

Rupert Murdoch's News Corp has agreed to enter into a joint satellite broadcasting venture with South Korea's Dacom Corp. Details for the domestic consortium have yet to be worked out. Dacom plans to launch a satellite in October next year

The final location for India's new Insat 2R is 55 degrees East. DD 1 is on 3.811 GHz in PAL. BBC World is on 4.195 GHz in clear MPEG-2 (SR 5800, FEC 3/4) on Apstar 1 (138 degrees East). Star News has started regular transmissions on Asiasat 2 (100.5 degrees East) on 3.740 GHz in clear PAL. Intelsat 804 replaced Intelsat 801 at 64 degrees East on February 1.

The Australian Broadcasting Corporation has signed a contract with PanAmSat to use PAS-2 for distribution of news and programming to its studios, and some transmitters around Australia. ABC will use 27 MHz bandwidth on the PAS-2 Ku-band Australia/New Zealand beam. The service is expected to move to the PAS-8 Pacific Ocean Region satellite later this year. PAS-8 will carry 24 C-band and 24 Ku-band transponders and is scheduled for launch on a Proton rocket in the third quarter of 1998. It will be located at 166 degrees East. PAS-2 is located at 169 degrees East.

Thanks to this month's contributors: Christian Lyngemark and his *SATCO DX*, James Robinson, Richard Karlsson, Martyn Williams and *TS-Asia*, Micharl Murray, Bernt Erfjord, Curt Swinehart, and *What Satellite TV*. ST

Worldwide Web Weather Sites

NOTE: Table 2 of the *Inexpensive Weather Satellite Reception* article by Philip Chien was missing from the February 1998 issue of *ST*. It is presented below.

Laura Halliday VE7LDH's weather page. Interesting information about one person's approach to inexpensive weather satellite imagery: **http://mypage.direct.ca/v/ve7ldh/wxsat.html**

Chuck Vaughn AA6G's page—excellent images: **http://www.aa6g.org/weather.html**

An excellent set of links to assorted weather satellite pages:
http://ecco.bsee.swin.edu.au/chronos/metsat/metsat-own.html
http://ourworld.compuserve.com/homepages/hffax/TOC4.HTM

Tutorial on building a portable APT station including a portable turnstile antenna.
http://psbsgi1.nesdis.noaa.gov:8080/EBB/pubs/sympos/symp33.html

An excellent reference for scanner modifications to increase the bandwidth for weather satellite reception. **http://ecco.bsee.swin.edu.au/chronos/metsat/cheekmods.html**

A schematic for a 137 MHz filter: **http://ourworld.compuserve.com/homepages/sesteban/ifilter.htm**

FTV (DOS): **http://www.geocities.com/SiliconValley/2504/**

WXSAT (windows): **http://members.aol.com/jkktl/ham.htm**

RadFax (Macintosh): **ftp://ftp.demon.co.uk/pub/ham/mac/RadFax09.sea.hqx**

Latest two line elements for weather satellites: **http://www.grove.net/~tkelso/**

A link to a site for decoding HRPT images directly: **http://www.msoft.it/noaa95/**

Meteosat WEFAX: **http://diana.ecs.soton.ac.uk/~pm/Weather/Meteosat/System/metdis.txt**

GMS WEFAX: **http://climate.gsfc.nasa.gov/~chesters/text/gms.wefax.schedule.html**

Sources mentioned:
Weather Satellite Handbook (Grove Bok 56) and *The Satellite Experimenters Handbook* (Grove Bok 85). Available from Grove Enterprises, P.O.Box 98, Brasstown, NC 28902. Call toll free in the US and Canada 800-438-8155 or international 704-837-9200, email: order@grove.net. Website URL: **http://www.grove.net**

User's Guide for Building and Operating Environmental Satellite Receiving Stations, July 1997 edition published by NOAA. Call: Wayne Winston 301-457-5681

The KD2BD 9600 Baud Modem, Part III

(continued from page 23)

should not load down the FM detector and cause distortion or lack of sensitivity when receiving FM voice signals while remaining connected to the transceiver as is the case with some other modem designs.

Transmit data from the modem is injected into the varactor diode associated with the transmitter's modulator through an RF isolation network. Figure 3 shows a representative isolation network consisting of a 47k ohm resistor and 100 pf capacitor. The isolation network allows signals from the modem to control the capacitance of the varactor diode while preventing RF that appears across the diode from being fed back into the modem.

True frequency modulation is produced when the varactor diode used as the FM modulator is connected in series or parallel with a crystal whose associated oscillator directly affects the transmitter's operating frequency. Transmitters that modulate a varactor diode associated with a phase locked loop (PLL) voltage controlled oscillator (VCO) cannot produce FM at low modulating frequencies and should not be DC coupled to this or any other 9600 baud modem. Transmitters that produce phase modulation will not produce high-quality FSK signals, and should be avoided.

Varactor diodes used for FM modulation are typically supplied a temperature-compensated DC operating bias voltage in addition to transmit audio. The exact method used to do this varies from manufacturer to manufacturer. The DC output voltage of the modem must match the DC bias voltage present on the varactor diode so as not to alter its operating bias or affect the center frequency of the transmitted signal. Potentiometer R71 adjusts the modem's DC bias output voltage level. This level is also affected to some extent by R70, the Deviation Level Control. The proper setting of these controls can be easily made by determining the DC bias voltage present on the varactor diode and the sensitivity of the FM modulator.

Determining Varactor Sensitivity

A 10k linear taper potentiometer placed across a 9 or 12 volt DC voltage source can be used to vary the bias voltage across a varactor diode and determine how the changing bias voltage effects the final operating frequency of the transmitter. The negative end of the battery and potentiometer combination should be connected to the transceiver's ground, and the wiper of the pot can be connected to the varactor diode through an isolation network such as the one shown in Figure 3. Varying the potentiometer will directly vary the operating frequency of the transmitter, and a voltmeter placed between the wiper of the pot and ground will measure the voltage being applied to the varactor.

Using a frequency counter to measure the operating frequency of the transmitter, first determine and record the DC voltage required for the transmitter to produce an RF carrier 3.5 kHz below what the transmitter is set to, and then determine and record the DC voltage required to produce an RF carrier 3.5 kHz above what the transmitter is set to.

Attach a DC-coupled oscilloscope to the output of the modem. With the modem powered and attached to the host TNC, adjust the Deviation and FSK Center Frequency controls to produce a waveform with a peak-to-peak voltage equal to the minimum and maximum voltages determined in the varactor sensitivity tests. Once these controls are properly set, the modem may be connected to transmitter, and the result will be a properly centered FSK signal with a peak carrier deviation of +/-3.5 kHz.

Modem Operation

If the modem is to be used for terrestrial packet radio communications, there is no need to make automatic frequency control (AFC) connections between the modem and the RF transceiver. The same is true if the modem is to be used for satellite communications and the frequency of the ground station receiver is under the control of satellite tracking and Doppler correcting software. If corrections for Doppler shift are not made, then the modem's automatic frequency control feature may be used to keep the ground station receiver properly tuned to the satellite's downlink transmissions.

Two separate digital AFC signal polarities are provided by the modem. Please consult the operating manual of the transceiver used in conjunction with this modem to determine whether a positive pulse or a switch to ground is necessary to tune the receiver lower in frequency via the microphone connection, and make the appropriate connections between the modem and the ground station transceiver.

The AFC Adjust control, R8, may be properly set by tuning to an unmodulated carrier and adjusting the control until the voltages on pins 12 and 13 of U4D are equal, or until the voltage on pin 14 just toggles between a voltage close to +Vcc and a voltage close to ground.

Proper tuning of the ground station transceiver may require manipulation of switch SW1, depending on the heterodyne scheme of the transceiver used in conjunction with the modem. Once the proper setting is determined, the switch needs no further adjustment unless the transceiver is changed to a different make or model.

Switch SW2 needs to be front panel mounted and is used to turn the automatic frequency control feature on and off. FSK signals received from satellites should be first tuned in manually with the AFC turned off. After the signal is acquired, the AFC can be turned on and the modem will track the downlink signal for the remainder of the satellite pass. Proper tuning is indicated when the highest upscale deflection of the Signal Quality meter is achieved.

Communication with any of the current 9600 baud satellites employing the FTL0 file transfer protocol (such as UoSAT-OSCAR-22, KITSAT-OSCAR-23, or KITSAT-OSCAR-25) requires that the computer connected to the TNC used at the ground station run FTL0 client software such as PB/PG, The Microsat Software Groundstation Software Suite (MSGSS), WiSP, or equivalent software. Pacsat satellite communication software may be found on the Internet at: **ftp.amsat.org**. Pacsat ground station software is not, however, required to communicate with the packet radio bulletin board carried onboard the FUJI-OSCAR-29 satellite or the *Mir* space station.

Saving Even More Money

The cost of commercial radio communication equipment can be quite prohibitive to prospective amateur satellite operators. While modern transceivers provide many versatile functions and features, few of these features are required for digital satellite communication. Considerable money can be saved by taking a more simplistic approach to amateur satellite communications rather than solving problems with a checkbook.

Considering the fact that most 9600 baud OSCAR satellites have one or two uplink channels in the 2-meter FM band, a sophisticated uplink transmitter is not required to access the 9600 baud satellites. An old 2-meter mobile FM transceiver or a Hamtronics VHF-FM exciter may be modified to produce FSK along with this modem. Downlink reception is possible using a modified programmable UHF scanner (along with a low-noise preamplifier).

Ed Krome, K9EK, described an effective and low-cost method of receiving 9600 baud satellite downlink signals using a 70-cm to 10-meter downconverter feeding a Ramsey Electronics 10-meter FM tunable receiver kit in the March/April 1992 issue of the *AMSAT Journal*. The bottom line is that amateur satellite communications does not need to be expensive. Some technical savvy and a little "ham ingenuity" can go a long way towards saving many thousands of hard-earned dollars.

Conclusion

Digital OSCAR satellites bring worldwide communications to all corners of the globe at low cost, and even permit unattended and automated ground station operation. Many digital OSCAR satellites not only function as store-and-forward message switches, but also carry earth imaging cameras and scientific experiments that survey the near-earth environment.

The KD2BD 9600 Baud Modem brings to the amateur radio community a new hardware design capable of providing high performance 9600 baud packet radio communications that permits access to these exciting digital satellites in the sky for less than the cost of a desk microphone. It is hoped that the KD2BD 9600 Baud Modem will find good use in amateur radio stations around the world, and that its design will promote a further understanding of the digital communication methods used in the amateur radio service, and foster increased experimentation, development, and refinement of communications techniques used in both terrestrial and extraterrestrial communications.

See you on the birds! ST

TABLE 1: PARTS LIST FOR THE KD2BD 9600 BAUD MODEM

Reference	Description
R1, R2, R24, R37, R51, R52	100k ohm 1/4-watt 5% tolerance resistor
R3, R14, R15, R16, R17, R63, R64, R65, R66	18k ohm 1/4-watt 5% tolerance resistor
R4, R18, R19, R21, R27, R31, R32, R39, R40, R43, R45, R47, R48, R53, R54, R55, R57, R58, R68	10k ohm 1/4-watt 5% tolerance resistor
R5, R6	1 megohm 1/4-watt 5% tolerance resistor
R8	10k ohm multi-turn trim pot
R7, R23	50k ohm trim pot
R70, R71	10k ohm trim pot
R9, R12, R13, R61, R62	27k ohm 1/4-watt 5% tolerance resistor
R10	120k ohm 1/4-watt 5% tolerance resistor
R11, R20	220k ohm 1/4-watt 5% tolerance resistor
R22	150k ohm 1/4-watt 5% tolerance resistor
R25, R28, R44, R67	4.7k ohm 1/4-watt 5% tolerance resistor
R26, R59	33k ohm 1/4-watt 5% tolerance resistor
R29	1.2k ohm 1/4-watt 5% tolerance resistor
R30	3.0k ohm 1/4-watt 5% tolerance resistor
R33, R34	220 ohm 1/4-watt 5% tolerance resistor
R35, R36, R42, R46, R69	1k ohm 1/4-watt 5% tolerance resistor
R38, R41	22k ohm 1/4-watt 5% tolerance resistor
R49	47k ohm 1/4-watt 5% tolerance resistor
R50	51k ohm 1/4-watt 5% tolerance resistor
R56	1.5k ohm 1/4-watt 5% tolerance resistor
R60	56k ohm 1/4-watt 5% tolerance resistor
C1	180pf 5% tolerance monolithic capacitor
C2	150pf 5% tolerance monolithic capacitor
C3, C4, C5	0.22uF 25-volt tantalum capacitor
C6, C8, C10, C12, C28, C30, C32	470pF 5% tolerance monolithic capacitor
C7, C9, C29, C31, C33	0.001uF 5% tolerance monolithic capacitor
C11	120pF 5% tolerance monolithic capacitor
C14, C25	0.0068uF 10% tolerance disk ceramic capacitor
C13, C17, C18, C22, C23, C24	0.1uF 25-volt tantalum capacitor
C15, C16, C26	100pF 5% tolerance monolithic capacitor
C19	0.01uF 10% tolerance disk ceramic capacitor
C20	0.047uF 10% tolerance disk ceramic capacitor
C21	1uF 25-volt tantalum capacitor
C27	680pF 5% tolerance monolithic capacitor
D1, D2, D5	1N914 silicon switching diode
D3	Red LED (Automatic Frequency Control)
D4	Yellow LED (Data Carrier Detect)
Q1, Q2, Q5, Q6, Q7, Q8, Q9, Q10	2N3904 Small signal NPN transistor
Q3, Q4	2N3906 Small signal PNP transistor
U1, U2, U4, U9	TL084 Quad Bi-FET Operational Amplifier
U3, U6	CD4070B CMOS Quad Exclusive-OR Gate
U5, U15	CD4013B CMOS Dual "D" Flip-Flop
U7, U16	CD4006B CMOS 18-Stage Static Shift Register
U8	D4046B CMOS Micropower Phase Locked Loop
U10	CD4016B CMOS Quad Bilateral Switch
U11	LM3914 Dot/Bar LED Display Driver
U12	LM78L05 +5 volt 100mA voltage regulator
U13	LM78L08 +8 volt 100mA voltage regulator
U14	CD4040B CMOS 12-Stage Ripple Counter
M1	100uA Panel Meter (Signal Quality)
SW1	SPDT Switch (AFC A/B)

ST ON THE AIR

By Steven J. Handler

Pulling the Plug on Shortwave Radio

Will WorldSpace revolutionize shortwave listening with new technologies such as this satellite receiver? Read on...

Will we witness the death of shortwave radio before the start of the new millennium? International shortwave radio as a medium of communicating news, saw its debut in the roaring twenties. No longer were Americans limited to the brief news reports that their local AM radio stations and networks would carry. The 1930s saw countries around the world establishing international broadcasting stations to echo their viewpoints around the world. With the drums of war beginning to boom in Europe in the mid and late 30s, international broadcasters brought up-to-the-minute and sometimes even live news to the living room and kitchens of Americans an ocean away.

After World War II many nations, especially those under communist rule, began to use shortwave radio broadcasts to influence world opinion and communicate their version of the news. In addition, in many areas of the world such as Central and South America, shortwave stations sprang up, often as an adjunct to local AM radio stations. Shortwave broadcasting allowed these small local radio stations to develop a regional following because broadcasting by shortwave allowed them to reach a much larger geographic area than a traditional AM radio station could cover.

I discovered the joy of shortwave radio more than three decades ago. My first window to the world of international broadcasting was a super regenerative receiver from Allied Radio. I wax nostalgic remembering one of my early catches, the Voice of America, with its unmistakable patriotic "Yankee Doodle Dandy" musical sign-on. From there, my desire for the bigger and better receiver lead me to Hammerlund, Hallicrafters, and ultimately, Sony.

I enjoyed listening for those far away stations in exotic and far off places such as Papua New Guinea. Yet, for me, the attraction of shortwave was not the thrill of the catch of distant stations. I found myself yearning to hear the news as it was happening, not from my local AM or FM radio station, but rather straight from reporters at the source.

A Picture's Worth Many Words

As time progressed, the major American television networks began to expand their news bureaus around the globe. No longer did I have to wait until a particular international shortwave station's appointed broadcast time. Nor did I have to suffer the snap, crackle, and pop of atmospheric static as it attacked my favorite broadcasts. Once good quality news from around the world was available on my TV set, I was freed from searching for shortwave stations, thinking about propagation, and concerning myself with such esoteric issues as maximum usable frequencies. Best of all, I didn't have to rely on a reporter's description of events. I could see news at it was happening, for myself.

With international television news gathering becoming more sophisticated and prevalent on the tube, I found myself consulting that trusty shortwave radio less and less.

They're Dropping Like Flies

For those who still ply the international shortwave radio bands in search of international broadcasters, the ranks of available stations are thinning. This appears to have occurred at least in part because of better news availability on television. "Downsizing" is a trend that started out in the business world and has now spread its tentacles to government–operates shortwave radio stations. As a result of staff and budget cuts, shortwave broadcasters sought less expensive and more effective ways of getting their news and points of view to international audiences.

What does any of this have to do with satellites? It is the availability of C- and Ku-band satellites that has helped speed the descent of shortwave radio down the slippery slope to oblivion.

Operating international shortwave radio stations is very expensive. To ensure worldwide propagation, many major stations use multiple relay sites around the globe. Today, effectively getting the word via shortwave takes hundreds of employees. You need news gathering staff, announcers, on the air programming talent, engineering staff, accounting, maintenance, and support staff. In addition to labor costs [manpower in the generic sense of the word, no slight to my female readers], there is a tremendous capital cost to operating a shortwave station. It can take many millions of dollars to purchase powerful shortwave radio transmitters, antennas, and broadcasting equipment. In addition you need to purchase or rent not only the headquarters facility, but a number of relay sites worldwide. Enter satellites to the rescue.

International shortwave broadcasters are not in business to cater to the small and elitist group of DXers plying the shortwave airwaves. These DXers are not the target, rather international broadcasters seek regular listeners who will patronize their programs on a regular basis. Shortwave stations, much the same as television networks, look for an audience who regularly tunes in to their programs.

Money Talks

International broadcasters have come to the realization that it is less expensive to pay for a single or even a series of satellite uplinks and transponder audio channels than the series of 500 kW behemoths required to put a dent in the shortwave spectrum. In addition, by using satellite audio channels, they have banished the bogey man of shortwave listeners, the static monster. Also gone is the annoyance of propagational fading that lurks on the shortwave spectrum. In short, satellite allows them to deliver their programming cheaper and with much better fidelity and clarity.

The shortwave spectrum's loss is the C-band owner's gain. Dozens of international radio broadcasters' signals are now available via your dish. The British Broadcasting Corporation (BBC) is the dean of high quality news and information programming. Their popular World service can be heard via satellite on Satcom C3, channel 7, using the 5.4 MHz audio subcarrier.

Our own Voice of America (VOA), whose broadcasts include many high quality educational, cultural, and musical programs, can be found on GE-3 (W3) channel 3, using the 6.12, 7.32 and 7.66 MHz audio subcarriers as well as the 5.94 MHz audio subcarrier for the programs in a slower, special English version that is easier for those not totally fluent in English. I find that the VOA tends to support the American government's point of view. For my two cents the VOA's news coverage doesn't match the objectivity of the BBC's World Service.

Deutsche Welle, the Voice of Germany, airs two audio networks, both in German, using GE-1 (W1). Deutsche Welle 1 can be found on channel 22 using the 7.04/7.22 MHz audio subcarriers (stereo) and Deutsche Welle 2 can be found on the 7.38/7.56 MHz audio subcarriers (stereo).

They're Great

World Radio Network (WRN) offers a virtual treasure trove of international radio broadcasts that C-band owners can listen to. Formed in 1992, WRN uses satellites as well as the RealAudio and StreamWorks via the Internet to serve its listeners. It delivers international broadcasts 24 hours a day from 25 of the world's leading public and international broadcasters.

WRN launched its North American service on New Year's Day in 1994. WRN One, their English broadcast to North America, currently airs via Hughes Communications', Galaxy 5 satellite using the 6.80 MHz audio subcarrier on channel 6, which carries Atlanta Superstation WTBS. They bring more than plain vanilla news to your dish. Programming covers arts and culture, music, sports, science, and more. Their English language bill of fare includes broadcasts from Radio Nederlands, Radio Sweden, Radio Australia and other global favorites.

In addition to their English language programs to North America, World Radio Network offers the WRN Two network that delivers multi-lingual programs to North America using the 6.2 MHz audio subcarrier on the Galaxy 5 satellite, channel 6 (WTBS).

WRN operates using state of the art computer technology. According to WRN, their broadcast operations are automated using a number of PCs that select the required program feed and mix it with announcements. In addition to rebroadcasting programs as they are received at WRN's facility, other programs are recorded for later broadcast. Pro-

TABLE 1

World Radio Network Worldwide Satellite Broadcasts

WRN 1 Europe		
Astra 1B	19 degrees East	transponder 22 (VH-1) 11.538 GHz V-Pol
audio subcarrier 7.38 MHz. All programs in English.		
WRN 2 Europe		
Eutelsat II-F1	13 degrees East	transponder 25 (NBC) 10.987 GHz V-Pol
audio subcarrier 7.38 MHz		
WRN 3 Europe		
Astra 1B	19 degrees East	transponder 16 (Sky Movies) 11.436 GHz V-Pol
audio subcarrier 7.38 MHz Astra Digital Radio (AOR)		
Astra 1C	19 degrees East	transponder 33 (ZDF) 10.964 GHz H-Pol
ADR Kanal B audio subcarrier 7.56 MHz. All programs in German.		
WRN 1 North America		
Galaxy 5	125 degrees West	transponder 6 (TBS) 3.820 GHz V-Pol
audio subcarrier 6.8 MHz. All programs in English.		
WRN2 North America		
Galaxy 5	125 degrees West	transponder 6 (TBS) 3.820 GHz V-Pol
Audio Subcarrier 6.2 MHz. Multi-lingual broadcasts.		
WRN 1 Africa		
Intelsat 707	1 degree West	3.9115 GHz Right-hand Circular-Pol
Symbol Rate 8.022 Mbaud, FEC 3/4, MPEG2 Audio Stream "WRN1"		
WRN1 Asia-Pacific		
AsiaSat-2	100.5 degrees East	4.000 GHz V-Pol
MPEG2 DVB, Symbol Rate 28.125 Mbaud, FEC 3/4, Select WRN1 from audio menu.		

grams for rebroadcast are received by WRN in a number of ways. These include C- and Ku-band satellites, as well as by a digital fiber circuit at 64-kilobit per second, dial-up ISDN circuit, PC modem audio file transfer, telephone frequency extender and also by DAT tape.

In addition to the North American service, WRN broadcasts to other areas around the globe using other geostationary satellites such as the Astra, Intelsat, Galaxy, Asiasat and Eutelsat spacecraft (see Table 1). Through their various satellite broadcasts, WRN has the potential to reach tens of millions of listeners.

As shortwave broadcasters continue to face budget reductions, a decline in shortwave radio users and increased technological costs to get their signals through, they may continue to expand their use of program delivery via satellite.

TABLE 2

WRN One English Language Programs to North America Galaxy 5 (125 degrees West) channel 6 (WTBS) using the 6.8 MHz audio subcarrier. WRN program details can be heard at 0625, 1525 & 1955 All times are Eastern

0000	RTE Dublin, Ireland–Irish Collection
0100	Channel Africa (Mon-Sat), Copenhagen Calling (Sun)
0130	BBC Europe Today (Mon-Fri)
0130	UN Radio (Sat)
0130	Glenn Hauser's World of Radio (Sun)
0200	Polish Radio Warsaw
0230	Radio Canada International
0300	ABC Radio Australia
0400	Voice of Russia
0500	Radio Prague
0530	Radio Netherlands
0630	YLE Radio Finland
0700	ABC Radio Australia
0800	RTE from Dublin, Ireland
0900	Radio Prague
0930	SABC Channel Africa (Mon-Sat)
0930	UN Radio (Sun)
1000	YLE Radio Finland
1030	Radio Vlaanderen–Brussels Calling
1100	Radio France International
1200	Caribbean Tempo from CANA Radio (Mon-Fri)
1200	Glenn Hauser's World of Radio (Sat)
1200	Norden This Week and Health Watch (Sun)
1215	Vatican Radio World News (Mon-Fri)
1230	ORF Radio Austria International
1300	BBC Europe Today (Mon-Fri)
1300	Radio New Zealand International (Sat)
1300	Copenhagen Calling (Sun)
1330	RTE Dublin, Ireland
1400	Radio Vlaanderen
1430	Radio Netherlands
1530	Radio Sweden
1600	Voice of Russia
1630	Polish Radio
1700	RTE Dublin, Ireland–Ireland Tonight at 1800
1900	Radio Netherlands
2000	ABC Radio Australia
2100	YLE Radio Finland
2130	Radio Sweden
2200	Radio Prague
2230	Radio Austria International
2300	Polish Radio Warsaw
2330	Radio Budapest

The Future is Almost Here

Nowhere does this trend more clearly manifest itself than with WorldSpace. Founded in 1990 by its Chairman and CEO, Noah Samara, it promises to bring new satellite technology to global radio. They plan to use powerful L-band (1452 - 1492 MHz) satellites (AfriSpace at 21 degrees East, AsiaSpace 105 degrees East, and AmeriSpace at 95 degrees West) to beam direct satellite broadcasts to listeners.The AfriSpace satellite, first of three satellites, is scheduled to be launched in October of this year on an Ariane 4 rocket. AsiaSpace and AmeriSpace will follow in January and May, 1999, respectively.

As part of their project, they are creating a portable satellite digital radio that will provide CD audio quality reception and deliver over 100 channels. Plans call for these radios to be approximately the size of a small radio/cassette player and will cover, in addition to L-band, AM/FM/shortwave. An initial purchase price of $200 is forecast by WorldSpace, with the cost projected to drop dramatically as the production quantities increase. Sanyo, Hitachi, Victor-JVC, and Panasonic are four companies that are developing Worldspace digital receivers.

I predict that the ability to deliver by satellite, high quality, direct to consumer programming as proposed by Worldspace, can have no other effect than to accelerate the trend for international broadcasters to vacate the shortwave bands. Just as the lumbering dinosaurs became extinct, I think, international broadcasting by shortwave will follow. In some cases, broadcasters may switch to satellite delivery of their programs, still others will fall silent, never to return–*On The Air.* ST

TABLE 3

WRN Two Multi-Lingual Programs to North America Galaxy 5 (125 degrees West) channel 6 (WTBS) using the 6.2 MHz audio subcarrier. All times are Eastern.

0030	WRN Announcements
0200	YLE Radio Finland (Mon-Sat)
0255	YLE, Church Service (Sunday only)
0400	WRN Announcements
0600	YLE Radio Finland, News in Finnish. (On Saturdays a phone-in for children in Finnish until 0630).
0610	Easy listening–with announcements in Finnish and English.
0630	News of the past 24 hours in Finnish.
0700	WRN Announcements
0800	Radio na Gaeltachta (News in Irish)
0900	Radio Prague in Czech
0927	WRN Announcements
1000	Regional broadcasts from various parts of Finland in Finnish, live relays of the YLE regions
1030	News in Finnish.
1100	Variable programming in Finnish–often light music.
1200	Radio Netherlands in Dutch
1300	Voice of Russia in Russian
1400	Radio Vlaanderen International in Dutch
1430	WRN Announcements
1630	ORF Radio Austria International in German
1700	Radio Budapest in Hungarian
1800	Polish Radio Warsaw in Polish
1830	Devotional programming in Finnish.
1855	News in Finnish.
1900	News of the past 24 hours in Finnish.
1925	News in Swedish.
1930	YLE in French.
1945	Light music in Finnish.
2030	Easy listening. Announcements partially in English. (Saturdays a phone-in for children in Finnish)
2100	Documentaries, Theater of the Air etc in Finnish. Sunday nights, classical selections with a preview in English.
2200	YLE in English
2230	News roundup in Finnish.
2300	WRN Announcements

FINAL FRONTIER

By Philip Chien

Astronaut Training

A space shuttle crew spends about a year training for their spaceflight. Each time the shuttle flies it costs taxpayers about US$500 million, and puts a US$2 billion shuttle at risk. So NASA has to train the astronauts as perfectly as possible. The crew's first objective–come home alive, preferably with the shuttle intact. Second is to accomplish the mission's objectives.

There's no way any given astronaut or even entire shuttle crew could know everything there is to know about the space shuttle and its systems. Each of the crewmembers has specific responsibilities and all important tasks are covered by multiple astronauts. But the astronauts are just the folks who get to climb aboard the shuttle and fly in space. Behind them are hundreds of experts on the shuttle's systems and its payloads. For a year the training team hones the astronauts's skills, teaching them how to operate the shuttle and their experiments.

Astronauts start by training on individual trainers, learning each of the shuttle's systems. As the crew's responsibilities are defined they learn about their specific responsibilities. The entire crew trains together in integrated sims, which include the flight control team and may also include teams at payload control centers located in Greenbelt, Maryland, Huntsville, Alabama, or even international locations.

But most of the training is on what to do when things go wrong. If a computer isn't working how do you replace it with another computer? If the backup computer fails how do you operate the system manually? If the shuttle's radios are unable to communicate with mission control can you use the amateur radio transceiver to contact mission control via an amateur radio ground station?

While that may sound implausible, it has happened. On the STS-47 flight, astronaut Jay Apt, N5QWL, realized that there was a problem when he hadn't heard anything for a while. A SAREX educational contact was scheduled fairly soon and after Jay contacted the school he asked them to pass on a message to mission control that everything was functional on the shuttle and a data recorder was taping the information which would normally be transmitted.

The simulations help the crew work together as a team–both aboard the shuttle and with their ground controllers. And it gives everybody confidence that they'll be able to handle real problems if they occur during their mission.

Shuttle commander Terry Wilcutt invited me to watch the STS-89 crew's final set of entry simulations at the Johnson Space Center in Houston, Texas. These seven runs marked the final time his crew simulater how to land the shuttle under various emergency conditions. Besides practicing a normal end-of-mission landing at the Kennedy Space Center, this training would also be useful if an emergency landing was required.

A shuttle countdown can go into a hold if something isn't right. For almost all problems while the shuttle's in space you can wait and think before making a decision. But during shuttle landing or launch, decisions have to be made almost instantaneously–and a wrong decision can result in the loss of the shuttle and its crew. So launch and entry simulations are considered the most critical.

Simulation Pays Off

Simulations have proven their usefulness during actual missions. The wildest situation the shuttle ever got into–and out of–was the 51-F launch of *Challenger* on July 29, 1985. The ascent seemed normal until one of the shuttle main engines suddenly shut down, forcing the shuttle to perform an "Abort to Orbit." The booster engineer correctly identified the problem as a problem with the temperature sensors and informed the flight director who gave the instructions for the crew to prevent the other engines from shutting down, too.

Everything was done instinctively–based on the many years of training for the booster officer and the crew. Had they not reacted in time it's likely that another engine would have shut down and the shuttle would have had to make an emergency landing. The quick and correct decisions resulted in the shuttle making it to orbit–lower than planned, but safe–and the crew was able to accomplish a highly successful mission.

The simulation supervisor (simsup) is the person responsible for orchestrating the simulations. It takes a special person

The motion base Shuttle Mission Simulator in Johnson Space Center's Mission Simulation and Training Facility.

to devise emergencies and surprises to train the shuttle crew and the flight control team. There are rules to the simulation: the simsup can only create scenarios which can be solved–there's no training value in a "no win" situation. But simsup can create false leads and other problems which appear to be something else to try to fool the astronauts or flight controllers. When the astronauts crash the simulators they learn–so they can safely land the actual shuttle. The simulation team monitors the test and uses their computers to enter problems which the flight controllers and crew have to solve. Feedback from postflight debriefings goes into creating better and more realistic sims.

The flight control team for the shuttle's landing participates in the simulations using their actual consoles and software. The only difference is, instead of electrically hooking the flight control room to the shuttle in orbit, it's connected to the simulators less than half a mile away in building 5, the training facility. Building 5 houses the motion based shuttle mission simulator, similar to high-end amusement park rides and aircraft simulators. It's a high-fidelity, hydraulically powered, 3-D simulator with incredibly realistic computer-generated views out of the window. Astronauts have kidded that the key difference between the simulator and real shuttle is in the simulator the switches needed for emergencies are worn, while in the actual shuttle they look brand new.

The motion based simulator is run by a team of engineers which monitor the simulator's systems, and the views which the shuttle crew sees. I watched Terry Wilcutt's crew land the shuttle–safely–seven times from the control room. The astronauts and their flight controllers were able to successfully solve each of the problems tossed at them and keep the shuttle flying safely.

Shuttle landings are flown manually by the commander with assistance from the pilot. In addition the flight engineer (MS2 in "NASAese") monitors the shuttle's displays from a position behind and between the pilots. Another astronaut in the aft flight deck seat follows checklists and is ready to provide whatever information's needed. The remaining crew sit on the shuttle's middeck and have no responsibilities during a normal shuttle landing.

For the STS-89 landing the flight deck crew consisted of commander Terry Wilcutt, pilot Joe Edwards Jr., flight engineer Mike Anderson, and mission specialist Bonnie Dunbar. The other members of the crew consisted of mission specialist Jim Reilly, Russian cosmonaut Salizhan Sharipov, and Dave Wolf who was returning from a four month stay aboard Mir. The entry flight director was John Shannon, and the entry capcom was astronaut Susan Still.

Each simulation starts when the shuttle's at 200,000 ft., about 14 minutes before the shuttle lands. (That's right–it takes only 14 minutes for the shuttle to descend from five times the altitude of a jetliner to landing). A debriefing is held after each run where the performance of the crew and flight controllers is discussed and comments are made about how everything went.

On one run the nose wheel steering was lost. So the flight controllers had to make a decision whether or not to try to recover the nose wheel steering or to use the main landing gear brakes to steer the shuttle after it landed. Other failures involved the ammonia cooling system, the fuel cells, communications, and basically every critical system on the shuttle. The simulations are designed to train the flight controllers as much as they're designed to train the astronauts.

Certainly the astronauts and flight controllers made mistakes, even this close to their mission. The astronauts were asked to enter an illegal set of commands in to their computer, and nobody caught the mistake. But even without a properly entered "state vector" (the information which determines the shuttle's position and velocity), they were still able to land the shuttle.

For the final run of the morning, the simulation team gives everybody a break. It's always nice to end the simulations on a positive note and give the crew a more realistic landing simulation where everything's not going wrong. By this time the crew's been in training for over a year and has gotten to know each other fairly well, so they're confident and relaxed, working together as a team. I was certainly surprised when I heard the astronauts mention an upcoming car show that weekend and that they couldn't attend because they would be in isolation! I turned to the training team leader, Gail Barnett, and kidded "You think you should toss in a couple of problems just to get their attention back on the sim?"

The Real Thing

Four days later Terry Wilcutt and his crew flew from Houston to the Kennedy Space Center for their final preflight preparations. The pilots flew the shuttle training aircraft to hone their flying skills and as final rehearsals for how the actual landing will look. But for the most part the crew got to relax, have a final set of preflight physicals, and host a barbecue for their closest family members.

Endeavour was launched on January 22. During its five days docked to *Mir* over 4,000 lbs of supplies were transferred to *Mir* along with astronaut Andy Thomas. His place on the shuttle was taken by astronaut Dave Wolf returning from *Mir*.

On January 31 the weather in Florida was perfect and the shuttle was given instructions to return home. The astronauts fired their engines over Indonesia–half way around the world. As the shuttle descended through the atmosphere I remembered what happened during the simulations. And like the final sim everything went perfectly. Terry took manual control of the shuttle and guided it to a picture perfect landing.

Joe Edwards and Mike Anderson were rookies when the shuttle launched, but experienced space travelers as they helped land the shuttle. Joe said "One of the real treats of the entry at 250,000 feet it seems like a low level tactical jet–you're cooking pretty fast going across the planet. You can see the beauty of the planet–the blue ocean, Vietnam, the South China Sea, even if I had a videotape it wouldn't quite as beautiful as it was." Mike added, "From my perspective the entry was a lot like we trained; the simulators do a pretty good job." He added that the only surprises were the G-forces and a transsonic buffet which aren't simulated. ST

ST WHAT'S NEW

by Wayne Mishler, KG5BI

ORBCOMM satellites offer platform for new wireless service

Eight new satellites went into orbit late last year, and two more early this year, to form a platform for what Magellan Systems Corporation describes as the world's first wireless two-way satellite communications system. Tests are proceeding as planned and the new satellites are on schedule to go into commercial operation about the middle of June.

With these launchings, Magellan's parent company, Orbital Sciences Corporation, has put into orbit 12 of 36 satellites planned for the system which is expected to be complete by the end of 1998. The satellite is shown under construction at right, and fully deployed (light background image, far right).

The new satellites greatly expand the messaging capability of Magellan's portable GSC 100, the world's first hand-held global satellite communicator offering worldwide, two-way, text messaging service via the ORBCOMM network.

With the GSC 100, available from Grove Enterprises, users can send and receive GlobalGram™ text messages to and from any Internet e-mail address or other ORBCOMM communicator anywhere in the world. To send a message, the user simply types the text on the GSC 100, keys-in the destination e-mail address, and transmits the message. On receive, messages are stored until the GSC 100 handset is activated and the satellite is queried for unread messages.

The portable communicator will store 100 messages, and includes an address book that will store 150 entries. The GSC 100 provides communication and navigation from anywhere to anywhere, using Magellan's integrated Global Positioning System (GPS) receiver.

Cost of using the system includes a one-time activation fee of $49.95, monthly access fee of $29.95 which includes 10 messages (up to 500 words each) and 30 message checks, a penny per character usage fee, and a 20-cent per message check (after monthly allowances).

Magellan says users who activate their GSC 100 units with ORBCOMM by Sept. 30, 1998, will receive special pricing for the first six months of service, featuring no monthly access fee and no limit on the size of the first 10 messages.

The ORBCOMM satellites were carried into their 45-degree, 810-kilometer orbit by Orbital's Pegasus XL rocket, which is air-launched from the company's L-1011 carrier jet aircraft. The launches originated from NASA's wallops flight Facility in southeastern Virginia. they were their fifth and sixth successful launches this year.

ORBCOMM extends services to Central America

Officials of the mobile satellite service provider, ORBCOMM, have signed an agreement that will bring that company's telecommunications services to a half-dozen countries in Central America.

The agreement with ORBCOMM de Mexico extends ORBCOMM's services to Mexico, Guatemala, El Salvador, Honduras, Nicaragua, and Belize. ORBCOMM de Mexico offices are located in Monterrey, Mexico. This completes ORBCOMM's coverage of the Western Hemisphere, and serves as a milestone in the company's plans to eventually encompass the globe.

ORBCOMM de Mexico says it will offer telecommunications services beginning mid-1998, using the parent company's existing USA-based system infrastructure. Early-on the new company expects to provide telecommunications services for the transportation, oil and gas production, and manufacturing industries.

"Mexico and Central America comprise a thriving region renowned for its transportation, oil and manufacturing industries," says Alan Parker, ORBCOMM president and CEO.

ORBCOMM's LEO satellite system offers two-way messaging services, and tracking and monitoring of mobile and fixed industrial assets.

New DSS® model opens door to ethnic programming

DIRECTV is developing a new DSS® model to receive Ku-band programming from a PanAmSat's Galaxy III-R satellite with mini-dish reception of 175 channels and a blue-ribbon lineup of foreign-language programming for customers around the world.

Initially DIRECTV plans to lease from PanAmSat four Ku-band transponders on Galaxy III-R, which serves Latin America and the Caribbean, and eventually add 120 channels dedicated to special interest programming. There are plans for that satellite to serve additionally as a platform for high definition television later this year.

Galaxy III-R is located at 95 degrees west. Additional access is available at 101 degrees west.

"This new platform provides DIRECTV with a powerful capability to provide a broad array of diverse programming to currently underserved consumers," says Larry Chapman, executive vice president of DIRECTV.

"Using the new (Hughes) equipment, subscribers will not only have access to unique and previously unavailable programming, but will also receive all of the

DIRECTV programming available at our 101 degree location."

"Galaxy III-R will provide DIRECTV with comprehensive U.S. coverage to introduce a range of new service offerings with signal reception using mini-dishes," says Lourdes Saralegui, PanAmSat executive vice president.

The new Hughes DSS model will include a 21 by 35 inch elliptical satellite dish, to receive new Galaxy III-R programming as well as all existing DIRECTV programming. The new system uses the same digital technology as the 18-inch dish systems.

"Like our award-winning DirecDuo dish, the new Hughes DSS antenna will receive signals from two separate orbital locations," says Paul Gaske, senior vice president of Hughes Network Systems.

For its initial rollout, DIRECTV will use Galaxy III-R to distribute six ethnic programming channels owned and operated by Ethnic American Broadcasting Company (EABC). These include WMNB-TV (Russian), Network Asia covering the Indian subcontinent, Ukrainian Broadcasting Network (UBN), Ciao TV Italian Superchannel backed by Berlusconi's Mediaset, and both the Egyptian Satellite Channel (ESC), and Nile TV (Arabic).

The agreement with DIRECTV provides EABC with enough capacity to distribute as many as 20 popular ethnic channels from countries around the world.

The company will offer a variety of subscription packages containing the ethnic channels and other services.

"Our expertise in serving ethnic markets will open a new world of customers to DIRECTV, and bring the finest entertainment on television to our ethnic customers on the best platform in the industry," says David Moro, president and CEO of EABC.

DIRECTV and Galaxy Latin America are also developing Hispanic programming for the U.S. market.

Satellites changing the face of shortwave radio

London-based World Radio Network, WRN1, a round the clock English language news channel, is becoming the first British radio station to take part in an Eastern European pilot digital audio broadcasting service.

World Radio Network has been on the air since 1993. It runs programs from more than 20 of the world's leading international non-commercial radio stations. It covers Europe, Africa, the Middle East, Asia, the Pacific, and North America. And now its services are available for direct-to-home reception via satellite.

It is not alone in the transition.

Polish Radio is undertaking trials in Warsaw using a transmitter at the Palace of Culture, the capital's tallest building. This station's national channels are now being carried digitally in the pilot program.

"Poland has been running digital audio broadcasting trials for some time, and now we are able to bring high-quality English language service to complement Polish Radio's popular national channels," says Simon Spanswick, WRN director of corporate affairs.

"Digital radio represents the future of the radio medium," says Spanswick. "It offers superb sound quality without any of the hiss and interference that can affect FM or the distortion and fading of AM broadcasts. It also offers a wide range of programming"

The first consumer digital radio receivers are expected to be available in stores this spring. More than 20 manufacturers have unveiled prototype receivers including in-car radios and home hi-fi tuners and midi systems.

PanAmSat will provide Internet link to Japan

One of Japan's largest Internet service providers will use PanAmSat's PAS-2 Pacific Ocean Region satellite for delivery of Internet data from the U.S. to Japan, according to a recent announcement by PanAmSat.

Bekkoame's 27 MHz of Ku-band capacity on the PAS-2 Northeast Asia beam will enable users to receive the satellite's signal by installing a one-meter antenna.

"The satellite's capacity will support a network of Internet connections throughout the country that will unilaterally speed service for ISPs, their customers, corporations and their staffs and others," says David Berman, PanAmSat senior vice president for program distribution.

Bekkoame joins dozens of other companies and ISPs in 30 countries that use PanAmSat satellites to access Internet data from the U.S.

Pre-paid communications via CabCARD® popular with truckers

CabCard®, a Personal Communication system for truckers, is 37,000 strong and growing, according to reports from its provider, QUALCOMM Inc.

This is a pre-paid service with discounted long distance phone, voice-mail, and e-mail sent directly from the cabs of trucks using the OmniTRACS mobile communications system.

"The broad acceptance of CabCARD has surpassed our estimates," says John Sarto, president of QUALCOMM's OmniTRACS divison.

The service is so popular among drivers that it is giving trucking companies who use it an edge in recruiting over non-users, QUALCOMM points out.

"Without a doubt this will help with the recruitment and retention of experienced, qualified drivers," says Mike Skousen, executive administrator of C.R. England. Trucking companies also benefit by being able to send pre-programmed e-mail directly to their trucks via touch-tone phone. With this feature of CabCARD, messages can be sent to drivers even when a computer or other e-mail devices are not accessible.

If you are thinking about adding the service in your fleet, you can telephone QUALCOMM at 619-658-5878 or e-mail them at **shind@qualcomm.com**. ST

EARTH WATCH

By Larry Van Horn

NEAR and Dear

The images presented in this month's *Earth Watch* were acquired by the multispectral imager on the Near Earth Asteroid Rendezvous Spacecraft (NEAR) on January 23, 1998. They were acquired between 11 and 15 hours after the spacecraft swung by Earth on its way to the asteroid 433 Eros. NEAR was launched on February 17, 1996 (see *Satellite Times* July/August 1996 page 10).

Its close encounter with Earth bent the spacecraft's trajectory out of the orbital plane of the major planets, and directed it toward the asteroid 433 Eros. The spacecraft will begin its approach to Eros in late 1998, enter orbit on January 10, 1999 to conduct the first-ever comprehensive study of a near-earth asteroid, and finally land on the asteroid in February 2000. Obtaining and processing the images and other data acquired during NEAR's Earth swingby provided a dress rehearsal for the mission's major activities at Eros.

Built and managed by The Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland, NEAR was the first spacecraft launched in NASA's Discovery Program of low-cost, small-scale planetary missions. Photos courtesy of the JHU/APL Office of Public Affairs.

E A R T H   A N D   M O O N

This mosaic shows images of Earth and the moon acquired by the multispectral imager on the NEAR on January 23, 1998, 19 hours after the spacecraft swung by Earth.

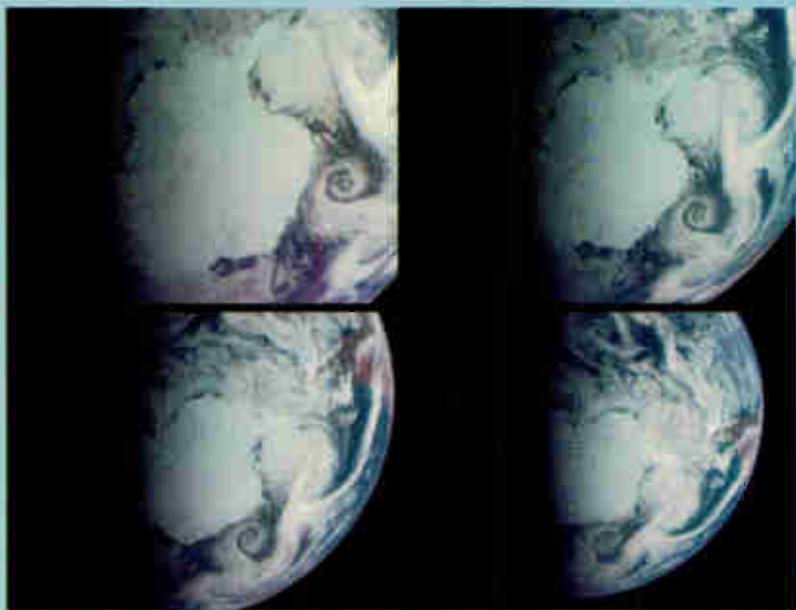
The images of the Earth and the Moon were taken from a range of 250,000 miles (400,000 kilometers), approximately the same as the distance between the two bodies. This unique perspective, never seen before, shows both our planet and its moon at the relative size that each appears when viewed from the other. Also, both Earth and the Moon are viewed from above their south poles, a perspective not attainable from either body because the moon orbits high above Earth's equator. In the Earth image, the south pole is at the center and the continent of Antartica is surrounded by sea ice and storm fronts.

The image mosaic is constructed from blue, green, and infrared filters. These colors highlight differences between rock types, water, and vegetation. On Earth, the red area at the upper right side is desert and vegetation in Australia. Snow, ice, and clouds appear as subtly different shades of white and light blue. The moon's blandness, compared to Earth, arises from its lack of an atmosphere, oceans and vegetation. For viewing purposes, the moon is shown five times brighter than in reality, and ten times closer to Earth than it actually is.

ANTARCTICA AND THE SOUTHERN OCEAN

The south pole is at the center of the image, and the continent of Antarctica is surrounded by sea ice and storm fronts. The smallest feature visible is approximately 12 miles (20 kilometers) in size.

The red area on the right side of the image is vegetation in southern South America, and the adjacent brown area is desert. Snow, ice, and clouds appear as subtly different shades of white and light blue depending on the size of the grains of snow and ice and the types of clouds.



These four images were taken at 80 minute intervals, as the spacecraft's distance from Earth increased from 92,000 miles (148,000 kilometers) to 160,000 miles (256,000 kilometers). They clearly show the earth's clockwise rotation as viewed from the spacecraft's perspective, starting from the upper left image. The south pole is at the center of each image, and the continent of Antarctica is surrounded by sea ice and storm fronts. The smallest feature visible is approximately 8 miles (13 kilometers) in size.

CENTRAL SAUDI ARABIA

This black-and-white image of central Saudi Arabia was acquired from the Near Earth Asteroid Rendezvous Spacecraft (NEAR) on January 23, 1998.

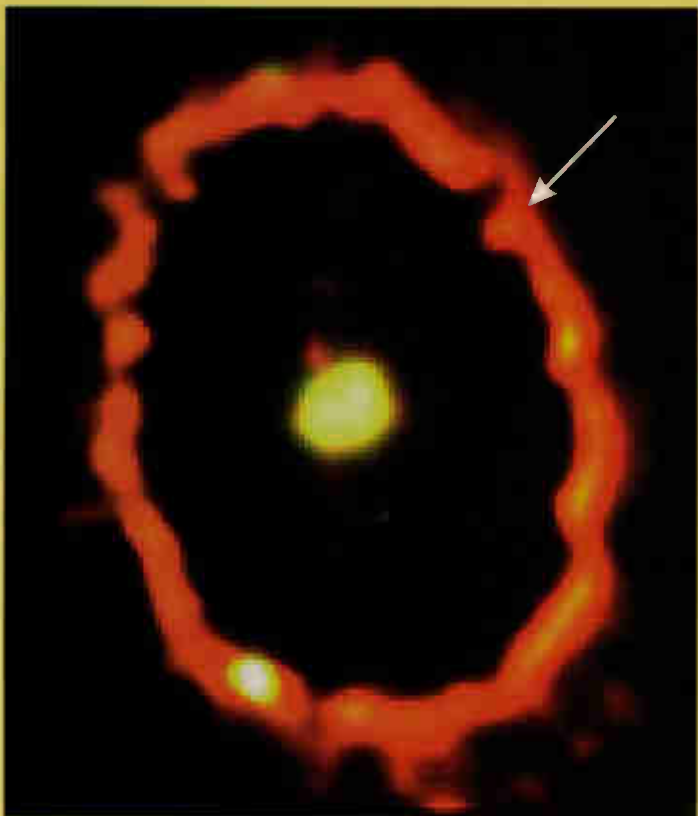
Radio signals indicating human civilization were detected by the Galileo spacecraft during its swingby of Earth in 1990, but this image shows the clearest visual evidence of intelligent life in the solar system yet detected by an interplanetary probe.

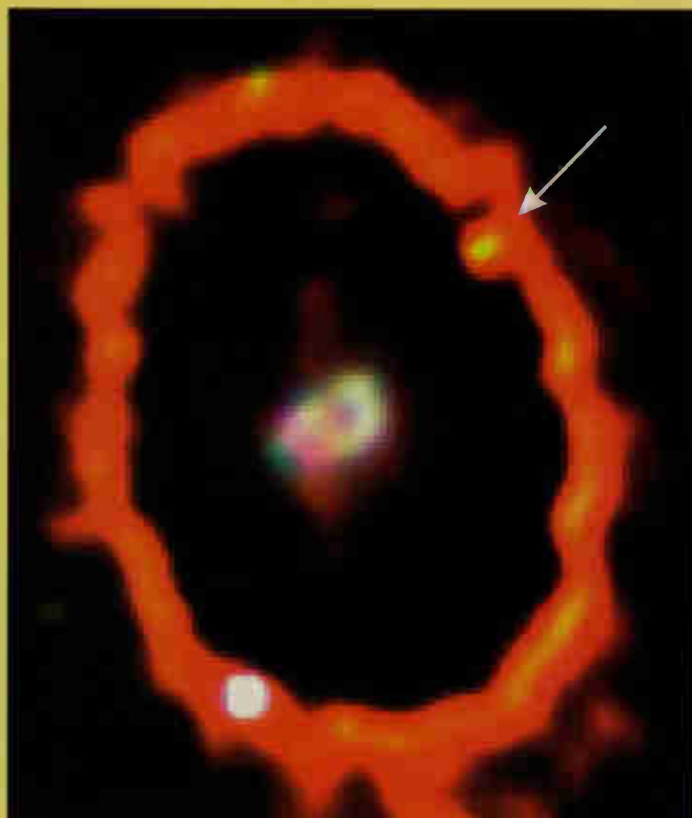
In the foreground, at the bottom of the image, the string of clouds appears to be the remnants of condensation trail (contrail) of a jet aircraft. In the background, the dark circular features appear to be irrigated agricultural fields whose darker surface stands out against brighter desert sands.

The image covers a region southwest of the Saudi capital of Riyadh, and was taken from a range of 430 miles (685 kilometers) when NEAR was over northeastern Saudi Arabia and the imager was looking to the southwest. The scene is 17 miles (27 kilometers) across, and the smallest feature visible is 220 feet (66 meters) across.

By Larry Van Horn

Bright Knot Appears in Supernova 1987A Ring





NASA's Hubble Space Telescope is giving astronomers a ringside seat to a never before seen titanic collision of an onrushing stellar shock wave with an eerie glowing gas ring encircling a nearby stellar explosion, called supernova 1987A.

Though the star's self-destruction was first seen nearly 11 years ago on Febraury 23, 1987, astronomers are just now beginning to witness its tidal wave of energy reaching the "shoreline" of the immense light-year wide ring.

Shocked by the 40-million mile per hour sledgehammer blow, a 100-billion mile diameter knot of gas in a piece of the ring has already begun to "light up", as its temperature surges from a few thousand degrees to a million degrees Fahrenheit.

Recent Hubble telescope observations show a brightening knot on the upper right side of the ring. This is the site of a powerful collision between an outward moving blast wave and the innermost parts of the circumstellar ring. The collision heats the gas and has caused it to brighten in recent months. This is likely to be the first sign of a dramatic and violent collision that will take place over the next few years, rejuvenating SN1987A as a powerful source of X-ray and radio emissions.

"We are beginning to see the signature of the collision, the hammer hitting the bell. This event will allow us to validate ideas we have built up over the past ten years of observation," says Robert Kirshner of the Harvard-Smithsonian Center for Astrophysics (CfA) in Cambridge, MA. "By lighting up the ring, the supernova is exposing its own past."

Astronomers predict it's only a matter of years before the complete ring becomes ablaze with light as it absorbs the full force of the crash.

Supernova 1987A is the brightest stellar explosion seen since Johannes Kepler observed a supernova in the year 1604. It is located about 167,000 light-years from Earth in the Large Magellanic Cloud. ST

THE SATELLITE SLEUTH

By Larry Van Horn

The Facts on Coax

In last month's *Satellite Sleuth* column we discussed what receiver we need to set up a satellite monitoring post. I hope you have that WinRadio or Icom R-8500 communications receiver on order at this point.

The next area on which we need to concentrate in setting up our listening post is the selection of the cable that we will use to connect our new receiver to the antenna. Here is where some of the most heated debate in the satellite listening world occurs. "What cable should I use in my satellite listening post?"

In the world of radio we use coaxial cable or ("coax") to connect our receiver to the antenna. The basic design of the coaxial cable consists of a center conducting wire surrounded by polyurethane or foam plastic. This is further surrounded by an outer connector of fine wire woven into a web or braid. All of this is protected by a thin plastic outer jacket.

Some coaxial cables have stranded wire center conductors while others use a solid copper conductor. Similiarly, the outer conductor (or shield) may be a single layer of copper braid, a double layer of braid (more effective shielding), solid aluminum (Hardline), aluminum foil, or a combination of these. The outer diameter of the various coax cables ranges from 0.06-inch to over 5-inches.

Coaxial cable exhibits some interesting characteristics that we need to be aware of in order to make a proper selection for our installation. As signals travel down the coax from the antenna, some of the signal is lost. How much is lost depends on the frequency band, the length, and type of cable. The higher the frequency (shorter wavelengths), the greater the signal loss. There is also a difference in signal loss between various types of cable. In general, losses decrease as cable diameter increases.

Table one examines some of the more common types of cable available and their losses at frequencies of interest to the satellite sleuth.

Some hobbyists urge the use of either Hardline (rigid) or Belden 9913 (semi-rigid) cable in order to have a suitable satellite receiving setup. If you're listening to frequencies above 1000 MHz, I would agree with that selection. But these super low loss cables are very expensive and difficult to work with. In addition, connectors for these cables are expensive and hard to find.

So what is the best recommendation?

Several years ago Bob Grove, publisher of *Satellite Times*, suggested an economical alternative to the relatively expensive RG-8 cables (look at that OD of nearly half an inch in table one). RG-6 is a 72-ohm coax designed for TV and TVRO installations. While it is not a perfect match for scanners and scanner antennas, its low-loss characteristics offset the mismatch to a great extent. It is also double-shielded: important if the cable must pass by sources of electrical interference.

RG-6 normally comes with F-connectors which makes it easy to convert to other types of connector options for receiver and antenna hookup. The outer diameter of RG-6 is .266-inch. RG-6 is much easier to work with than RG-8 when you are installing your antenna on the roof of the house or drilling that hole to run it in the shack. And the difference of .8 to 1.6 dB per 100-feet between RG-6 and RG-8 will not be noticeable in all but the most discerning of satellite setups.

TABLE ONE

Transmission Line Losses/Cable Diameters
(All values are dB per 100 feet/OD in inches)

Cable Type	Outside Diameter	100 MHz	200 MHz	400 MHz	1000 MHz
RG-58A/C	.195	4.9	7.4	12.0	24.0
RG-58	.195	4.6	6.9	10.5	17.5
RG-8X	.242	3.7	5.4	8.0	13.5
RG-59/59B	.242	3.4	4.9	7.0	12.0
RG-6	.266	2.7	4.1	5.9	9.8
RG-8/8A	.405	1.9	2.7	4.1	8.0
Belden 9913	.405	1.0	1.6	2.5	4.5

Yes, there are cheaper alternatives to even RG-6. But whatever you do–don't go cheap! RG-58 and RG-8X are not acceptable alternatives to RG-6/8 cable for VHF/UHF satellite work. The losses that these cables exhibit at even the lower satellite frequencies do not outweigh the cost savings.

Tip of the Month

Did you know that the WinRadio makes an excellent automatic picture transmission (APT) receiver for the polar orbiting weather satellites? Even though it doesn't have a 45 to 50 kHz wide filter in order to compensate for Doppler shift as the polar orbiting satellite travels across the sky, the automatic frequency control (AFC) does an excellent job of tracking the APT center frequency. This negates the need for the wider filter and improves the signal to noise ratio of the received signal.

The new WinRadio Digital Suite, which works hand in hand with your WinRadio, is now available. This suite of software modules has a facsimile module that enables the decoding and display of APT pictures in real time. You can also receive AX.25 standard packet signals from orbiting spacecraft such as the DOVE and *Mir* space station with the Digital Suite.

Some of the other neat features that the satellite sleuth might be interested in include a signal classifier, audio scope, and spectrum analyzer. And the best part is you don't need an external demodulator of any kind. Your computer and sound card handle that job for you. For more information on the WinRadio and the new Digital Suite, check out the Grove Buyers Guide in this issue of *ST*.

I will have more to say on the WinRadio and the Digital Suite in future editions of *Satellite Sleuth*, so stay tuned. Till next month, good hunting.

ST

ST Navigation Satellites

By Steve Dye, gpsyes@aol.com

OnStar

It's a cold, wet, dark night, you're doing 65 and suddenly you lose a tire. Your car leaves the road, heads nose-first down an embankment and comes to rest as the front bumper wraps around a tree. Your airbag deploys, saving your life–but you are unconscious and on that dark night, nobody saw it happen.

Luckily, as soon as the airbag deployed, a burst of data was sent from the modem connected to your car's GPS receiver and cellular phone. The information received at the monitoring station flashes an alert on the operator's screen–"airbag deployment at this GPS location." A communications channel is opened, and the operator tries to establish voice contact with you to no avail. Clearly an emergency situation. The operator then contacts the emergency services, and explains the predicament, and passes on the car's GPS-derived coordinates.

An ambulance and cutting crew rush along the highway, with your coordinates already entered in the GPS receiver as a waypoint. As the rescue vehicles close in on the position, they see skid marks on the road that finally lead to the scene. Thanks to GPS, you live to tell the tale, and are glad you subscribe to OnStar. (**http://www.onstar.com**)

The OnStar service is certainly one GPS application that will welcome us to a whole new way of driving. The OnStar service combines a host of safety and security features with a sophisticated communications system to give us a peace of mind while driving. The features of OnStar are both diverse and broad in application, and illustrate the effective convergence of Graphical Information Systems (GIS), wireless data communications, and GPS.

Auto theft is another arena in which the OnStar service assists us. When an OnStar-equipped vehicle is broken into and stolen, the security system will send a signal to the OnStar Center. An advisor will then call you at home or work to break the unfortunate news that someone else has taken possession of your pride and joy. The OnStar service center then gets your approval to track the vehicle and puts you in contact with the police.

Acura's system incorporates electrogyros as well as GPS for its navigation

As an OnStar subscriber, it may not be necessary to have the built-in security system; a simple phone call to let OnStar know your vehicle has been stolen will put them on the case. The GPS receiver will still send data to the monitoring facility via the cellular phone, allowing them to assist the police with its whereabouts.

Being stranded on the roadside due to a flat tire, an empty gas tank, or other malfunction can leave you very vulnerable or, at the least, very late. Simply pressing the OnStar button on your phone alerts OnStar that you need help. Roadside Assistance tells the advisor your vehicle's location, so he or she can send help from the nearest parts dealer, gas station, tire repair or towing service.

Have you ever locked yourself out of the car with the engine still running or with the keys staring up at you from the driver's seat? I remember witnessing a gentleman falling victim to this slip-of-the-mind: the locksmith very happily took his money for the call-out.

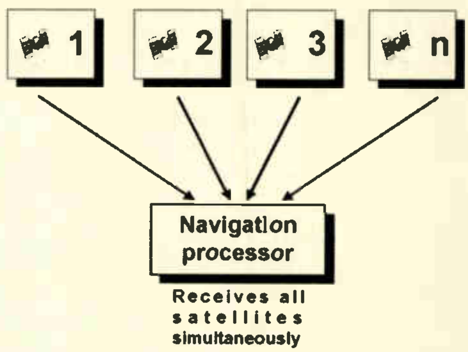
OnStar, as you may remember from previous columns, has the ability to help out in this situation. An OnStar-equipped vehicle hosts a central control management unit that takes inputs from the airbag deployment sensor, various engine sensors, theft alarm unit–and the GPS receiver, of course. These inputs enable the modem to transmit data over the cellular network pertaining to sensor's status and the GPS receiver's output. The control unit also provides outputs such as a control voltage to the electric window lifters, the power locks, etc

If an OnStar subscriber is locked out he simply calls the service, quotes his PIN and password. A signal from the OnStar center will then send a message to the vehicle's control unit that will open the doors for you. Much easier than calling your local friendly locksmith or roadside assistance.

Finding the way to your destination is sometimes not as obvious as you may expect. An unexpected fork in the road, a missing signpost or a diversion could take you off track, making you late, frustrated or lost. With a GPS receiver, you would know where you are, and as an OnStar subscriber, they would also know where you are. Should you become disoriented, simply tell OnStar your destination's address. Their up-to-date mapping service will allow the operator to explain to the best way of getting there, based on your current location which they, of course, know.

You are 250 miles away from Denver, hungry, and all you see is McDonalds, Texaco and a variety of inns (And I thought you could get spoilt for choice in the USA!). It seems an awfully long time since you saw an exit, and fuel is running low, the battery charge light is flickering and suddenly the journey is becoming a mission. As you have probably guessed, OnStar can help you out here as well. Press the OnStar button, and they will assist you with over 180 categories of conveniences such as restaurants, airports, ATMs, Dealers, repair workshops, gas stations, hospitals, hotels and more.

Though OnStar is well established in the industry, it is not alone. Oldsmobile, unlike the OnStar system, has a 4-inch LCD color display for their Guidstar system, available as a dealer-installed option. The user



simply enters a destination address, and the display marks out a route for you to follow with optional voice commands if you need them. This system does not use cellular phones and has no control center, so you are on your own if you need help.

Acura has a similar system with a 6-inch display, shown on previous page. This system, however, incorporates electrogyros as well as GPS for its navigation. This raises a point–GPS alone should not be seen as the ultimate in-car navigation system since some limitations do apply. Should the vehicle find itself in urban or natural canyons, tunnels, or heavily treed routes which block visibility to the constellation, then tracking will be lost. If a gyroscopic navigation system could operate in parallel, then it would act as a back-up to the GPS system during such times.

Other systems are available for BMW, Lincoln and other manufacturers, but what if you drive a Ford or a Chevrolet? Alpine Electronics offers a GPS receiver that can be installed in just about any dash, or could be free mounted on nearly any car. The system allows a user to select an address, intersection or type of place, and the unit will guide you there. Phillips, Magnavox and other name brands are in the market as well. It won't be too long before you are installing your new CD player one day that just happens to have a built-in GPS receiver, alarm, cell phone ...

The Year 2000 Update

As promised, I said I would keep you up to date regarding the GPS Year 2000 problem. So far Trimble and Motorola have told me the good news that, come August 1999, all will be well and your investment will continue to work.

Tomorrow Never Dies

I have received a few emails queries recently regarding 007's recent adventures in the South China Sea, with Her Majesty's Royal Navy drifting off course due to some rapscallion individual spoofing the GPS signal. The latest James Bond film suggests it is possible to send an uplink signal to the constellation that would send users–military users–way-off course.

The emails I have received basically ask, is this possible? My answer to this seemingly rhetorical question is more than likely not. The U.S. military has exclusive access to the GPS Secondary L2 (1227.6 MHz) frequency, that uses the P-code. The P-Code is an extremely complex code that exhibits a code cycle or repetition rate of 38 weeks compared to the civilian access code's rate of 1-ms. This means that to actually try and work out the code that not only has this duty cycle but is further encrypted, would be a task beyond comprehension for most......

The encryption process is what the military terms "anti-spoofing encryption," so designed to prevent outside forces' signals from providing our forces with incorrect location information. It would be far easier to just broadcast a wide-band signal centered on the L2 frequency and hope for the best. This transmitted signal may affect local reception to a degree, but GPS signals are CDMA in format and are less vulnerable to noise. So, spoofing a GPS signal would be as difficult as trying to build a GPS guided missile in your garage. The US government, like Q, is well equipped to counter such items as clandestine transmissions, so don't try this at home or in the desert!

Multi-Channel Receivers

A regular reader from Mainz in Germany, Bernd Rademacher, asked about multi-channel and sequencing receivers. Why do GPS receivers come in a variety of types? To answer that, let's look at various types of GPS receivers. There are many types of receivers available–all suited for a particular application or range of applications. There are two major groups of GPS receivers :

- Those that can track four or more satellites simultaneously
- Those that can scan/sequence between all visible satellites.

Sequencing receivers can be divided into five more types :

- Starved Power
- Single Channel
- Fast Multiplexing Single Channel
- Two Channel
- Multi channel

Starved Power

The starved power, single channel receiver is the cheapest to manufacture and doesn't require the amount of circuitry reached to simultaneously receive the necessary four satellites. The smaller circuits in the sequencing receiver consume less power but are also less accurate and are therefore ideal for hiking and casual use. The fact that each individual satellite is sampled in turn interrupts the positioning readout, affecting the accuracy, but it does add to the portability and compactness of the receiver.

Single Channel Receivers

The single channel receiver uses its only channel to receive satellite messages as well as the ranging, pseudo random code. This means that a continuous position update is not possible. The price of these receivers is held down by employing lower cost clocks. This in turn affects the accuracy of velocity measurements.

Fast Multiplexing Single Channel

The fast multiplex receivers are similar in structure to the above, but perform measurements a lot more quickly between satellites. This allows a ranging measurement to be performed while the satellite's data is being read, thus providing continuous position readout. These receivers are probably no longer manufactured, since their complexity and cost equals those of the mon-accurate two-channel receiver.

Two Channel

In adding a second channel to a receiver, its capabilities can be significantly increased. The design of such a receiver allows the receiver to work in noisier conditions, offering a better chance of acquiring the four satellites required, by allowing satellites closer to the horizon to be sampled. While one channel is measuring the range from one satellite, the other can be used to acquire another satellite, thus providing an uninterrupted position readout. Velocity measurements are greatly improved thereby. The cost of such receivers is much higher than their single channel counterpart.

Multi channel

A multi-channel receiver (see figure 2) can have up to 12 receive channels, as does the Garmin GPS III, reviewed last month. One of the many advantages of a multi channel receiver is that it virtually eliminates Geometric Dilution of Precision (GDOP). The receiver can track as many satellites as its channels will allow, enabling the receiver to choose the most appropriate satellites to obtain the lowest GDOP figure, hence the better accuracy.

That wraps it up for this month. Please keep your emails coming in; you can reach me at **gpsyes@aol.com.** ST

Satellite Technical Forum

Philip Chien

Listening to the *Mir*

In the glory days of the Soviet Union there was a worldwide network of tracking stations, including ships stationed in the Pacific and Atlantic oceans and ground stations in friendly Socialist countries.

Many radio hobbyists around the world have enthusiastically listened to *Mir*'s transmissions for many years. *Mir* uses conventional VHF radios with unencrypted voice communications. One of the most enthusiastic listeners is Chris van Berg in the Netherlands. His *Mir News*, summaries of the communications, offers a fascinating insight into *Mir*'s inner details. Chris posts *Mir News* to his web page at **http://infothuis.nl/muurkrant/mirmain.html.**

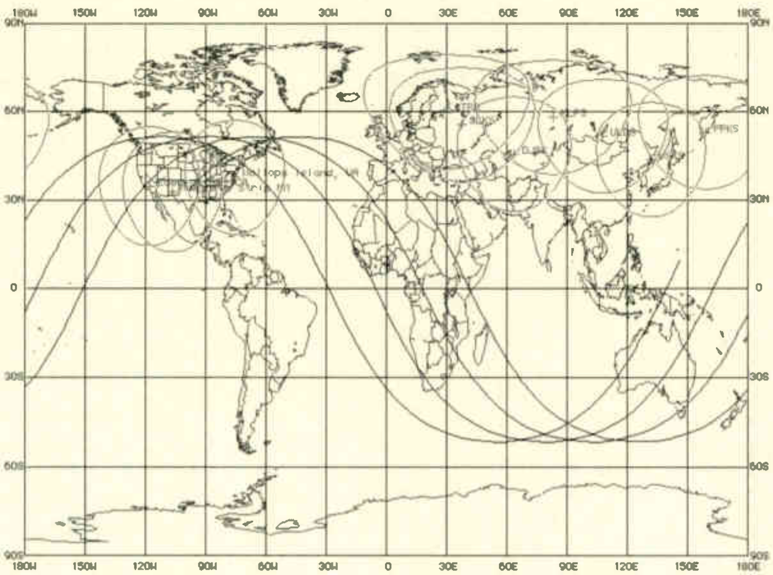
As the Soviet Union fell apart, the non-Russian resources started to disappear. A Ukrainian ground station even went on strike during a spacewalk. In January 1991 the tracking ships were called home, eventually to be scrapped. By 1995 the Russian ground station network was reduced to seven locations, all on Russian soil.

The *Mir*-to-ground station frequency is 143.625 MHz. It's a wideband signal with a bandwidth of 20 kHz. You can get fairly decent quality sound in a normal scanner if you keep the frequency centered in the passband. Many two-meter amateur radios have extended receive capabilities from 137 to 174 MHz; however *Mir*'s velocity and Doppler shift will result in distorted signals on narrowband radios.

The Russian Soyuz spacecraft uses 121.75 MHz and *Mir*-to-Soyuz communications occurs on 130.1625 MHz. The backup frequency is 121.75 MHz simplex. The Soyuz frequencies are used by the shuttle during the joint shuttle-*Mir* activities. The FCC has granted NASA a Class 3 waiver through 1999 for the use of these frequencies on a shared basis with existing air force and commercial communications.

Besides ground stations, Russia has two Luch relay satellites, similar to NASA's Tracking Data and Relay Satellites (TDRS). The operational satellite (USSPACECOM 23426 International ID 1994-82A) is located at 16.2° west, but it's only used for major activities due to its high operating costs. The satellite is shared with Russian military users.

The lack of continuous communications is in stark contrast to the shuttle which is almost always in contact with mission control, consequently, *Mir*'s crews operate much more autonomously.



This track represents a typical six hour period as Mir travels around the Earth. Note that there is coverage through the U.S. ground stations, but none over any of the Russian stations. Before the U.S. stations were activated the Mir crews were on their own without any way of contacting their control center for this period.

Orbital mechanics results in several relatively short passes over Russia in a row, then long periods where *Mir* doesn't pass over Russia. The time of day for the passes gradually changes as *Mir*'s orbital plane precesses to the west. *Mir*'s crew keeps a Moscow timetable, consequently there are periods where there is a fairly large number of decent communications passes, followed by periods when most of the passes occur while the crew's sleeping.

It's desirable to start the spacewalk shortly before the first Russian communications pass takes place. *Mir* previously supported two person crews and during spacewalks the station had nobody aboard. Currently *Mir* is supported by three-person crews, so during spacewalks there's one person inside to operate *Mir*'s systems while the spacewalkers complete their tasks. There are desirable times for spacewalks when the good *Mir* communications passes coincide with the crew's wake-sleep schedule. When spacewalks are scheduled for other times, the crew's schedule has to be adjusted to match the communications passes.

Soyuz and shuttle dockings and undockings are always scheduled to occur over Russian ground stations to permit ground controllers to monitor *Mir*'s systems.

It has taken a long time for NASA to adapt to *Mir*'s operations. NASA engineers are amazed at the casual attitude towards operations on *Mir*. The cosmonauts get their daily timetables in "radiograms," but have a lot of flexibility in scheduling tasks to fit whatever they think will work out best instead of the minute-to-minute flight plans which are used on shuttle flights. *Mir*'s long periods out of communications and long crew shifts necessitate this mode of operation.

During astronaut Norm Thagard's three month stay aboard *Mir* there was a desire for additional communications and a "no cost" experiment was planned. A Yagi antenna was mounted on an existing, large parabolic dish used for satellite tracking at Wallops Island, Virginia. Rus-

sian air-to-ground communications uses full duplex mode; when *Mir* comes within range, the
cosmonauts and ground station personnel turn on their radios.

After his 3.5 month spaceflight, which set a new record for the duration for an American space traveler, Norm's recommendations stressed the lack of communications. Norm could pick up *Mir*'s ham radio and talk to any ham around the world, but his communications through *Mir*'s network was much more limited!

The comparison between *Mir*'s ham radio and operational communications is very appropriate. Both use similar frequencies, hardware, and techniques, so it isn't surprising that experienced ham radio operators were called in to help set up additional *Mir* communications stations.

Dr. Ron Parise is best known as a professional astronomer who had the opportunity to fly in space twice with the ASTRO payload. He's also well known as WA4SIR, an active ham radio operator for many years, including both of his shuttle flights.

Ron is employed by Computer Sciences Corporation (CSC), a government contractor which supplies scientific personnel at Goddard Space Flight Center. CSC is also one of NASA's contractors for its ground station operations, so Ron was a logical choice as a point of contact. It was originally supposed to be just a small portion of his job, but it's turned out to be one of his major activities. Ron told friends that he's got the best of both worlds. He was an amateur astronomer, and then paid as a professional astronomer; and his hobby is amateur radio, and now he's paid to do similar activities as part of his work, too!

NASA agreed to provide additional support for *Mir* communications and eventually three sites at existing NASA facilities in the continental U.S. were added: Wallops Island, Virginia, White Sands, New Mexico; and Edwards Air Force Base, California. NASA's Dryden Research Center at Edwards had already done similar activities, and White Sands and Wallops already have existing satellite tracking facilities.

At one point the EROS data center in South Dakota was considered for support due to its more northern location, but it wasn't considered worth the additional effort. Santiago, Chile, was considered, but also deemed unnecessary since most of the orbits which pass over Chile would also pass over U.S. or Russian sites.

It turns out that the three continental U.S. sites cover much of North America and give significant improvements to *Mir*'s communications situation. *Mir*'s maximum period, where it's outside of communications range, has been reduced from over seven hours to about 80 minutes.

The Wallops site now consists of four 22-element M^2 Yagis on a motorized azmith-elevation mount, controlled by an M^2 serial controller. Two Icom 820 transceivers, modified for wider bandwidths, are used as separate transmitters/receivers. The antenna pointing is controlled by a Pentium computer running FODTrack.

FODTrack, by Manfred Mornhinweg, XQ2FOD, is a shareware satellite tracking program. It doesn't have fancy color maps since it's designed specifically to control motorized antennas. FODTrack is available at the AMSAT software archive: **http://www.amsat.org/ftpsoft.html.**

The latest Keplerian elements for *Mir* are automatically emailed to the tracking computer each time they're received. The computer's clock is also automatically synchronized with an atomic clock at Goddard. Before each pass FODTrack automatically updates the latest tracking information for *Mir*.

Communications technicians at the ground stations perform communications checks before each pass. The communications are routed to the Russian "Tsup," or mission control, in Korelov using normal telephone circuits.

Although the system has a 100 watt amplifier, the controllers would prefer more power to minimize interference from others using the same frequencies. When *Mir* is over the Midwest, it's only a couple hundred miles over major cities, but thousands of miles from the ground stations; consequently, the RF power from pagers, aircraft radios, and others using the same frequencies, is often more powerful than the ground stations.

While the ground stations were set up to support the U.S. portion of the Phase 1 *Mir* operations, it's expected that they'll continue to operate to support the Russian communications requirements for the International Space Station, both normal day-to-day operations and emergencies. The Russian Service Module, including the living quarters for the early joint U.S. Russian crews, will use VHF radios similar to the ones on *Mir*. If a crew ever has to abandon *Mir* or the International Space Station it will use the Soyuz vehicle.

When *Mir* was launched in 1986 the concept of using U.S. government facilities as part of the Soviet tracking and communications network was unthinkable. Americans living aboard long-term Russian spacecraft as integral parts of the crews? Preposterous! The Soviet Union breaking up? Unfathomable. Russia and the U.S. working together to build an international space station? Only in science fiction stories. But now, it's just normal day-to-day operations.

ST

Mir's Ground Stations

Mir's seven ground stations. In richer times the Russian space agency used several tracking ships and international tracking stations. Currently ground controllers keep in contact with *Mir* through seven ground stations on Russian soil, supplemented by three U.S. locations. Note that *Mir* is only in contact with a ground station for a short period for several orbits of each day, but spends most of its time out of range.

Abbreviation	Name	North	East
DJSS	Dzhusali	45.7	63.5
KLPS	Kolpashevo	58.2	82.9
PPKS	Petropavlosk-Kamchatski	53.0	158.7
SLKS	Tshelkovo	55.7	37.6
STPS	St. Petersburg	60.0	30.0
ULDS	Ulan-Ude	51.8	107.6
USKS	Ussurisk	43.9	131.6
	Dryden, CA	34.9	-117.9
	White Sands, NM	32.9	-76.3
	Wallops Island, VA	37.9	-75.5

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SATELLITE TIMES ADVERTISERS' INDEX

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SPACE GLOSSARY

The following are some terms used in the satellite business and are described in layman's terms.

ALTITUDE (ALT): The distance between a satellite and the point on the earth directly below it, same as height.

AQUISITION OF SIGNAL (AoS): The time at which a particular ground station begins to receive radio signals from a satellite.

APOGEE: The point in a satellite's orbit farthest from the Earth's center.

ARGUMENT OF PERIGEE: This value is the number of degrees from the ascending node the perigee point occurs. The perigee point is the point where the satellite is the closest to the earth (assuming an orbit which is elliptical to some degree). This number may be entered as a real value between 0.0 and 360.0.

ASCENDING NODE: Point at which the satellite crosses the equatorial plane from the southern hemisphere to the northern hemisphere. (See RIGHT ASCENSION OF THE ASCENDING NODE.)

AZIMUTH (AZ): The angle measured in the plane of the horizon from true North clockwise to the vertical plane through the satellite.

CATALOG NUMBER: A 5-digit number assigned to a cataloged orbiting object. This number may be found in the NASA Satellite Situation Report and on the NASA Two Line Element (TLE) sets.

COORDINATED UNIVERSAL TIME (UTC): Also known as Greenwich Mean Time (GMT). Local time at zero degrees longitude at the Greenwich Observatory, England. Uses 24 hour clock, ie. 3:00 pm is 1500 hrs.

CULMINATION: The point at which a satellite reaches its highest position or elevation in the sky relative to an observer. (Known as the Closest Point of Approach)

DECAY RATE: This is the rate of decay of the orbital period (time it takes to complete one revolution) due to atmospheric friction and other factors. It is a real number measured in terms of Revolutions per Day (REV/DAY).

DECLINATION (DEC): The angular distance from the equator to the satellite measured positive north and negative south.

DIRECT BROADCAST SATELLITE (DBS): Commerical satellite designed to transmit TV programming directly to the home.

DOPPLER SHIFT: The observed frequency difference between the transmitted signal and the received signal on a satellite downlink where the transmitter and receiver are in relative motion.

DOWNLINK: A radio link originating at a spacecraft and terminating at one or more ground stations.

DRAG: The force exerted on a satellite by its passage through the atmosphere of the Earth, acting to slow the satellite down.

EARTH-MOON-EARTH (EMR): Communications mode that involves bouncing signals off the moon.

ECCENTRICITY (ECC): This is a unitless number which describes the shape of the orbit in terms of how close to a perfect circle it is. This number is given in the range of 0.0 to less than 1.0. An perfectly circular orbit would have an eccentricity of 0.0. A number greater than 0.0 would represent an elliptical orbit with an increasingly flattened shape as the value approaches 1.0.

ELEMENT SET: (See ORBITAL ELEMENTS.)

ELEVATION (EL): Angle above the horizontal plane.

EPHEMERIS: A tabulation of a series of points which define the position and motion of a satellite.

EPOCH: A specific time and date which is used as a point of reference; the time at which an element set for a satellite was last updated.

EPOCH DAY: This is the day and fraction of day for the specific time the data is effective. This number defines both the julian day (the whole number part of the value) and the time of day (fractional part of the value) of the data set.
The julian day figure is simply the count of the number of days thatparticular date is from the beginning of the year. (January 1 would have a julian day of 1. Feb 28 would be 59.) This number may range from 1.0 to 366.999999999 (taking into account leap years).

EPOCH YEAR: This is the year of the specific time the rest of the data about the object is effective.

EQUATORIAL PLANE: An imaginary plane running through the center of the earth and the Earth's equator.

EUROPEAN SPACE AGENCY (ESA): A consortium of European governmental groups polling resources for space exploration and development.

FOOTPRINT: A set of signal-level contours, drawn on a map or globe, showing the performance of a high-gain satellite antenna. Usually applied to geostationary satellites.

GROUND STATION: A radio station, on or near the surface of the earth, designed to receive signals from, or transmit signals to, a spacecraft.

INCLINATION (INC): The angle between the orbit plane and the Earth's equatorial plane, measured counter-clockwise. 0 (zero) degrees inclination would describe a satellite orbiting in the same direction as the Earth's rotation directly above the equator (orbit plane = equatorial plane). 90 degrees inclination would have the satellite orbiting directly over both poles of the earth (orbit plane displaced 90 degrees from the equatorial plane). An inclination of 180 degrees would have the satellite orbiting again directly over the equator, but in the opposite direction of the Earth's rotation. Inclination is given as a real number of degrees between 0.0 and 180.0 degrees.

INTERNATIONAL DESIGNATOR: An internationally agreed upon naming convention for satellites. Contains the last two digits of the launch year, the launch number of the year and the piece of the launch, ie. A-indicates payload, B-the rocket booster, or second payload, etc.

LATITUDE (LAT): Also called the geodetic latitude. the angle between the perpendicular to the Earth's surface (plane of the horizon) at a location and the equatorial plane of the earth.

LONGITUDE (LONG): The angular distance from the Greenwich (zero degree) meridian, along the equator. This can is measured either east or west to the 180th meridian (180 degrees) or 0 to 360 degrees west. For example, Ohio includes 85 degrees west longitude, while India includes 85 degrees east longitude. But 85 degrees east longitude could also be measured as 275 degrees west longitude.

LOSS OF SIGNAL (LoS): The time at which a particular ground station loses radio signals from a satellite.

MEAN ANOMALY (MA): This number represents the angular distance from the perigee point (closest point) to the satellite's mean position. This is measured in degrees along the orbital plane in the direction of motion. This number is entered like the argument of perigee, as a value between 0.0 and 360.0.

MEAN MOTION (MM): This is the number of complete revolutions the satellite makes in one day. This number may be entered as a value greater than 0.0 and less than 20.0 (See DECAY)

NASA: U.S. National Aeronautics and Space Administration.

ORBITAL ELEMENTS: Also called Classical Elements, Satellite Elements, Element Set, etc. Includes the catalog Number; epoch year, day, and fraction of day; period decay rate; argument of perigee, inclination, eccentricity; right ascension of ascending node; mean anomaly; mean motion; revolution number at epoch; and element set number. This data is contained in the TWO LINE ORBITAL ELEMENTS provided by NASA.

OSCAR: Orbiting Satellite Carrying Amateur Radio.

PERIOD DECAY RATE: Also known as Decay. This is the tendency of a satellite to lose orbital velocity due to the influence of atmospheric drag and gravitational forces. A decaying object eventually impacts with the surface of the Earth or burns up in the atmosphere. This parameter directly affects the satellite's MEAN MOTION. This is measured in various ways. The NASA Two Line Orbital Elements use revolutions per day.

PERIGEE: The point in the satellite's orbit where it is closest to the surface of the earth.

POSIGRADE ORBIT: Satellite motion which is in the same direction as the rotation of the Earth.

RETROGRADE ORBIT: Satellite motion which is opposite in direction to the rotation of the Earth.

REVOLUTION NUMBER: This represents the number of revolutions the satellite has completed at the epoch time and date. This number is entered as an integer value between 1 and 99999.

REVOLUTION NUMBER AT EPOCH: The number of revolutions or ascending node passages that a satellite has completed at the time (epoch) of the element set since it was launched. The orbit number from launch to the first ascending node is designated zero, thereafter the number increases by one at each ascending node.

RIGHT ASCENSION OF THE ASCENDING NODE (RAAN): The angular distance from the vernal equinox measured eastward in the equatorial plane to the point of intersection of the orbit plane where the satellite crosses the equatorial plane from south to north (asecending node). It is given and entered as a real number of degrees from 0.0 to 360.0 degrees.

SATELLITE SITUATION REPORT: A report published by NASA Goddard Space Flight Center listing all known man-made Earth orbiting objects. This report lists the Catalog Number, International Designator, Name, Country of origin, launch date, orbital period. inclination, beacon frequency, and status (orbiting or decayed).

TLM: Short for telemetry.

TRANSPONDER: A device aboard a spacecraft that receives radio signals in one segment of the radio spectrum, amplifies them, translates (shifts) their freuency to another segment and retransmits them.

TELEVISION RECEIVE ONLY (TVRO): A TVRO terminal is a ground station set up to receive downlink signals from 4-GHZ or 12-GHZ commerical satellites carrying TV programming.

TWO LINE ORBITAL ELEMENTS (TLE): See ORBITAL ELEMENTS.

UPLINK: A radio link originating at a ground station and directed to a spacecraft.

VERNAL EQUINOX: Also known as the first point of Aries, being the point where the Sun crosses the Earth's equator going from south to north in the spring. This point in space is essentially fixed and represents the reference axis of a coordinate system used extensively in Astronomy and Astrodynamics.

UPLINK

By Bob Grove, Publisher
E-mail address: st@grove.net

The Paper Satellite Glut

In our February column we discussed the growing problem of satellite speculation, groups of profiteers applying capriciously for International Telecommunications Union (ITU) orbital frequency awards, never intending a launch, but planning instead to retail their coveted prizes at a profit later to hungry PCS contractors.

If the ruse sounds all too familiar, it should. For years, frequency merchants have been doing the same thing at FCC auctions, vying for spectrum, selling it later at huge turn-over profits. It got so bad that a proposal was made to rescind the award if the winning bidder didn't actually implement the assignment within a reasonable period of time.

In the case of the ITU, satellite salesmen are submitting applications by the thousands every year, creating an unrealistic–and unmanageable–backup of paperwork. Emerging and developed countries alike are grasping for their piece of the space spectrum just in case, without any current need or even realistic vision.

As a stopgap measure, a proposal was to be proffered at last year's World Radio Conference (WRC) to establish filing fees to slow down the stampede, but it was so vigorously opposed by many countries, including the United States, that it never even came up for discussion.

One problem is that the ITU is a voluntary consortium of member countries; to give regulatory authority to their collective nucleus would be to give up the independence of its members.

But the ITU did pick up on one of the hints from the FCC debacle–they reduced the amount of time an award was available, from nine to seven years if no substantial progress is being made on its implementation into space.

Perhaps ORBCOMM should be used as a role model. At press time, Orbital Sciences Corporation launched numbers 11 and 12 of their proposed 28-satellite constellation, complementing the world's first global satellite messaging system. Already deployed for transportation, industrial, and marine data communications, ORBCOMM expects rapid development of PCS applications as well.

But the idea of a mandatory filing fee for all ITU space-slot applicants definitely is not dead. A proposal to charge $1 million per application, non-refundable if the applicant does not build the system for which he applied for spectrum, might discourage a significant number of flighty speculators and their rapacious investors.

But all these good intentions don't help the current glut. With the accelerative speed of technological evolution, by the time an award is made, dependent systems may be obsolete, or at least obsolescent. And what about legitimate investors? They don't want to plunk down their money until they know that an award of spectrum is forthcoming.

It's a dilemma. Too much, too soon. Our techno-society is demanding PCS products faster than they can be produced, and they can't be produced until there is spectrum available. Perhaps this inertia will act as a built-in governor, self-regulating the industry without interference from the ITU. And with the ITU's own inertia, it may have to.

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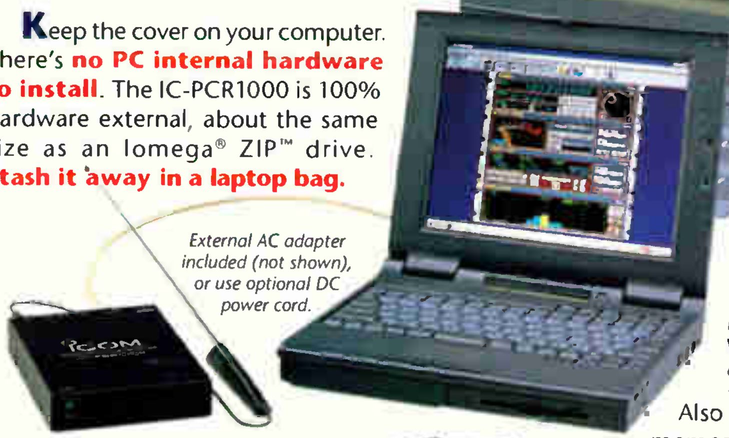

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