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March 1998
Prospects of Greatness
The Mission of the Lunar Prospector
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Satellite Times

Cover Story

Cover Photo: Lunar Prospector in Orbit. This artist's conception of the Lunar Prospector shows the spacecraft in lunar orbit. Instrument masts are fully deployed. The spacecraft is expected to be in a 100 km polar mapping orbit for a year or more. NASA artist's rendition by Roger Arno.

Prospects of Greatness: The Lunar Prospector

An ST Satellite Profile
By Philip Chien, ST Staff

The first dedicated satellite since Apollo 17 over 25 years ago is now orbiting the moon. The Lunar Prospector is searching for water on the moon and satellite sleuths on Earth are chasing the Prospector's S-band downlink. Chien's story starts on page 10.

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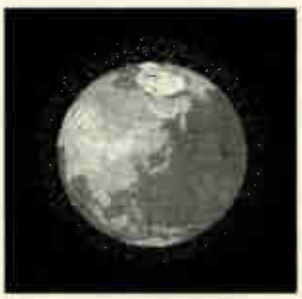


Loused in Space

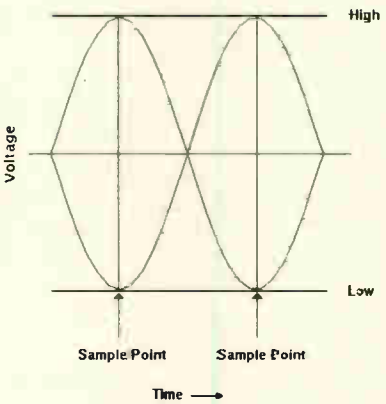
By Ken Reitz, ST Staff

While space debris has always been a concern to manned and unmanned space missions it doesn't pose nearly the problem of man-made orbiting objects known as "orbital debris." *ST* staffer Ken Reitz explores our forty year legacy of orbiting trash starting on page 15.

Under Construction: The KB2BD 9600 Baud Modem, Part II

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 19 for part two of this three part series.



New personal navigation systems (PNS) continue to flood the marketplace, but one device has set itself apart from the rest–the Garmin GPS III. *ST* staffer Steven Dye puts this graphic wonder through its paces starting on page 74.

DEPARTMENTS

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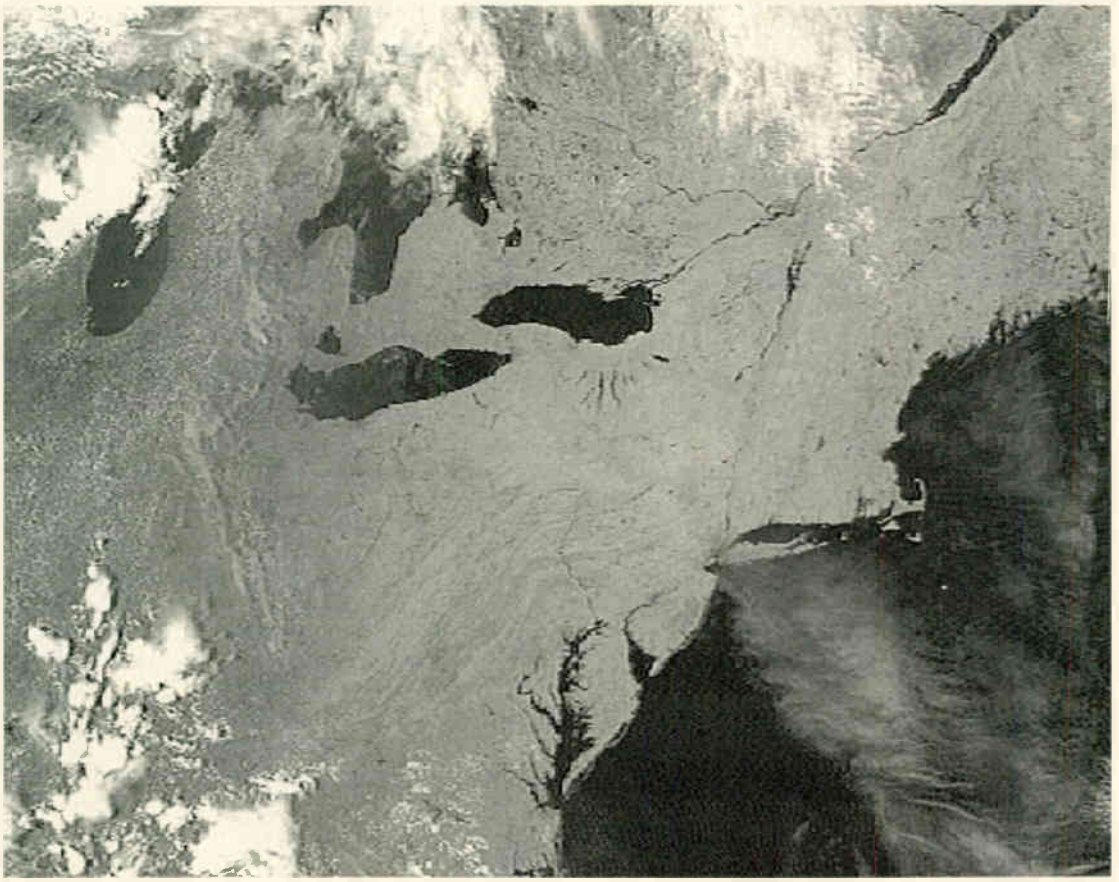

◄ **Section of magnified (zoomed 4x) NOAA 14 APT image of the northeast US. Unretouched image taken directly from saved image file.**

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By Larry Van Horn
Managing Editor
steditor@grove.net

Wants a Q&A column

Congratulations on a "GREAT" magazine. My wife pointed out that I read *Satellite Times* from cover to cover and it's true, I do. Do you plan on a Q&A column in the future? I think it would be an asset. On that line, I have a question. On page 34 of the November/December 1997 issue, Donald Dickerson refers to the "debris belt." What and where is it? In past articles have you covered layers, belts, and spheres surrounding the earth? This might be a good article for the future. Keep up the good work.

—Greg and Judi Kail <**gregjudi@blast.net**>

• *Instead of a separate Q&A column, for now I would prefer that readers direct their comments to our ST columnists. They are our resident experts in their fields and are happy to address questions from ST readers. As for your "debris fields" question, I have forwarded this on to Don Dickerson for his comments.*

Beginners versus Newcomers

I have been a subscriber to *ST* since the first issue ... and, while, it's quite fine for the beginners, but not really for the newcomers. I still have to learn how to receive digital satellites and no articles on *ST* explained me that. For a newbie it's important to know, how, when, where and why!

—Maurizio Bertolino <**i121171@amsat.org**>
Amsat-NA #30347/Huygens #20906

• *First of all, Maurizio, I hope you are enjoying the PACSAT modem project article by John Magliacane. It should help you get on amateur PACSATs. The best resource every reader has as a subscriber to Satellite Times is the editorial staff. These fellows are the world's best and a wealth of knowledge and talent. But they aren't mind readers. They patiently wait month after month for you to communicate with them about what you want to see in their columns or to answer your questions, but they never hear from you. As an old Navy friend of mine used to say, "The only dumb question is the one you didn't ask."*

Our columnists want and need your input. This is your magazine and we are here to serve you, but you have to communicate with us. If you don't have email, you can write to the columnist at the following address: P.O. Box 98, Brasstown, NC 28902. Be sure to include an SASE if you want a personal reply.

Correction to ST

I just recently found your publication and very much enjoy it. I enjoy the wealth of information presented on a variety of satellite related subjects that are in each of your issues. I have a correction for you for the November/December 1997 issue. The photos that accompany the article *The Death Of C-band* on page 70 and 73 are not of the DirecTV facility in Castle Rock, Colorado. I was one of the design engineers working on the baseband video system in that facility and spent five months on site.

—Alan Bourke–Sunnyvale, California

Digging a Deep Hole

What are the possibilities of actually digging a dish out of the Earth? I'm thinking something like the "Death Star" in *Star Wars*. Use a large amount of land (it wouldn't get knocked out of alignment) and aim it at a specific star or formation. You see, I am a little ignorant in the actual science of it. I just have ideas.

—Nicole Gibson <email address withheld>

• *Nicole, I think you would be throwing good money down a dry hole with this idea.*

Misses WRN Skeds

Congratulations on your first issue of *ST* monthly! One of the reasons I have subscribed to *ST* from its first issue is for the complete schedules of the audio information to be found on satellites. I particularly liked having the World Radio Network schedules. I am also a DX listener and although the new cycle has improved reception at night, daytime is still a vast glob of hash. With the WRN schedule I can take a shot at hearing some of my favorite stations coming off the satellite when I can't receive them live. I hope the exclusion of the WRN schedule from the Jan 98
issue of *ST* is a one-time thing and not a permanent policy. I also noticed WRN is now hyping a WRN Club (apparently for a fee that includes a schedule). Has that got anything to do with the above?

—John L. Maps <**maps@azstarnet.com**>

• *The decision to remove the WRN schedules was purely a matter of space constraints. When ST went monthly in order to keep subscription rates low and absorb a U.S. postal rate increase in January we had to cut our page count. Since WRN schedules are readily available online and we do not make other satellite schedules available for audio services, WRN skeds have been cut.*

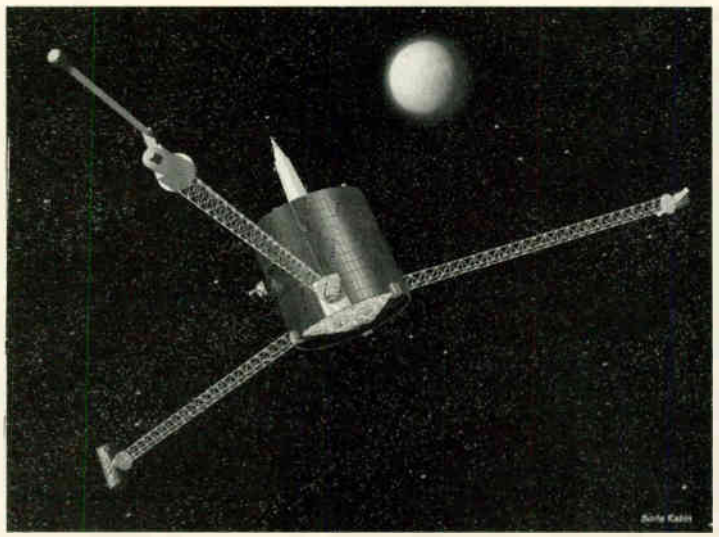
As advertising in ST increases and we increase our page count to compensate, we will certainly consider bringing them back into the magazine. In the meantime, since you have internet access, you can get WRN skeds free of charge at their internet website **http://www.wrn.org**. *As for the WRN club, according to their website, the WRN cost nothing other than sending your name and mailing address to them. Looks like you win either way!*

ST

SATELLITE MONITOR

By Wayne Mishler, KG5BI

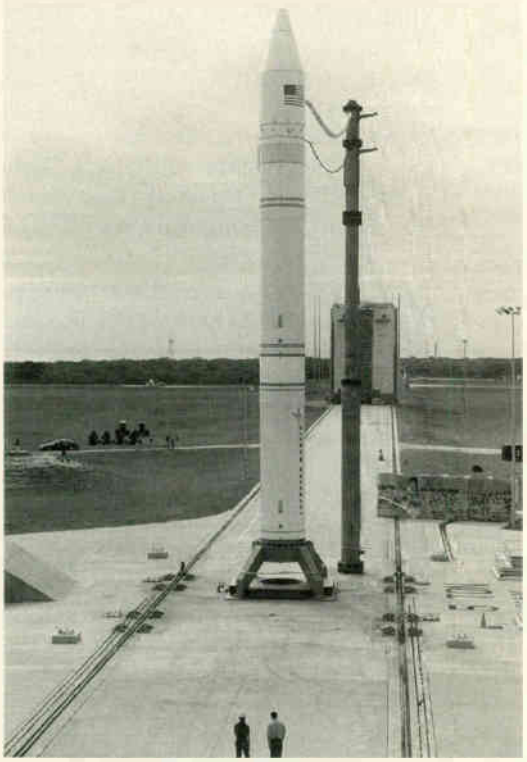
Lunar Prospector to study moon's secrets



The compact Lunar Prospector, perched atop a Lockheed Martin Athena II launch vehicle, roared off Spaceport Florida's pad 46 at the new, commercial launch complex at Cape Canaveral on schedule at 9:28:44 p.m. EST Tuesday, January 6, 1998, less than one second into the opening of the launch window.

The launch vehicle's three stages worked as planned, rocketing the spacecraft to an altitude of 62,500 feet after 88 seconds at stage 1 burnout. All additional milestones were achieved on schedule, culminating in attainment of a successful "parking orbit" around the Earth at an altitude of 125 statute miles.

After completing almost three-quarters of a revolution around the Earth, the vehicle's Trans Lunar Injection (TLI) stage completed a successful 64 second burn, blasting the small spacecraft out of Earth orbit and setting the spin-stabilized vehicle on its 105-hour "coasting" mission to the Moon.



Lockheed Martin Athena II launch vehicle, prior to the launch of the Lunar Prospector.

The spacecraft's science booms were successfully deployed and all science instruments turned on. The spacecraft was spinning at 11.2 rpm, as planned, at the nominal cruise attitude.

Lunar Prospector will conduct a one-year primary mission, mapping the surface composition and internal structure, volatile activity, and magnetic and gravity fields of the Moon from an altitude of about 63 miles. Additional mapping at altitudes as low as six miles above the lunar surface is planned over the following six months.

Lunar Prospector is expected to provide definitive evidence of the presence or absence of water ice in shaded lunar polar regions.

Cosmos believed to be expanding at constant speed

Peering halfway across the universe to analyze light from exploded stars which died long before our Sun existed, NASA's Hubble Space Telescope indicates to astronomers that the expansion of the cosmos has not slowed since the so-called Big Bang and should continue to balloon outward indefinitely.

Reporting their preliminary observations at the winter meeting of the American Astronomical Society, the team, led by Peter Garnavich of the Harvard-Smithsonian Center for Astrophysics (CfA) in Cambridge, Massachusetts, concludes there is insufficient matter in the cosmos to provide the gravity necessary to halt its infinite expansion.

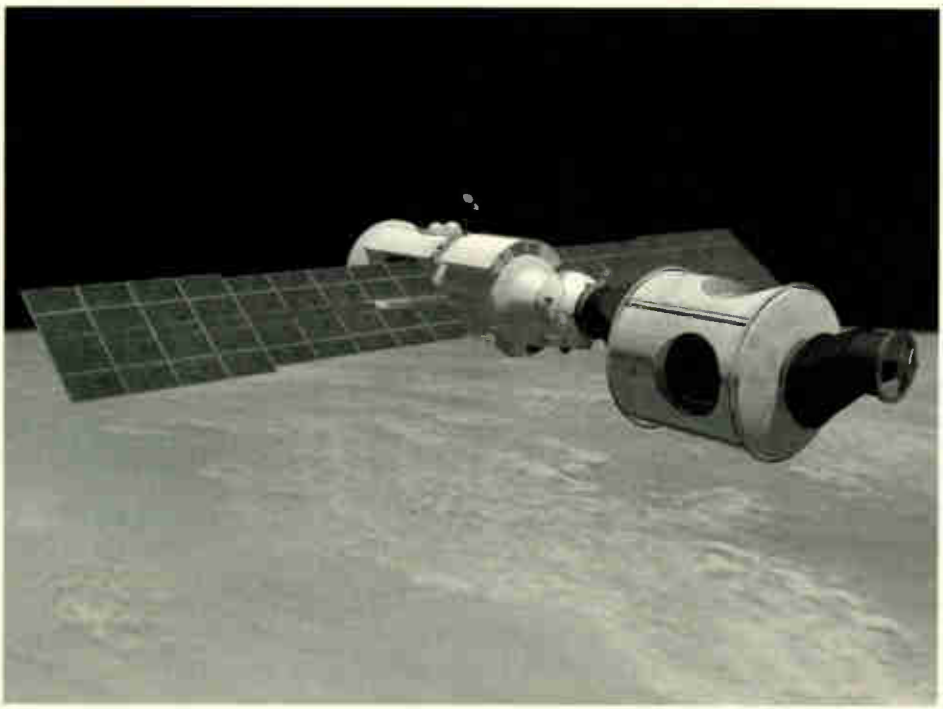
If these early conclusions are supported by additional observations, the lack of any significant deceleration since the initial conditions also means the universe could be as much as 15 billion years old. This would clearly establish the universe as truly older than the oldest stars, thus resolving the potential paradox caused by earlier estimates favoring a younger universe.

These results are based on unprecedented distance measurements to supernovae. The most distant supernova seen is approximately halfway back to the Big Bang, and thus existed about 7.7 billion years ago. The two others studied each exploded approximately 5 billion years ago, or just before our own solar system formed.

"We cannot make much of a conclusion from the single farthest supernova we've seen," says Garnavich. "But, when we average it with several others, we find, to a 95 percent level of confidence, that the density of matter is insufficient to halt the expansion of the universe."

"In other words, we'd bet US$100 against your US$5 that the universe isn't bound by dark matter, bright matter, matter that clusters, or matter that's spread out," says co-investigator Robert Kirshner, also of CfA.

Hubble made five observations of each of the three supernovae initially targeted. The observations were separated by about a week, to allow time for the supernovae



This digital artist's concept shows the first two elements of the International Space Station joined in orbit, the US-funded and Russian-built Functional Cargo Block (FGB) on the left and the US-built Node 1 connecting module on the right. (Courtesy of NASA)

to dim so astronomers could plot the required light curves.

Space Station element to be shipped to Russian launch site

A major piece of the International Space Station—a United States-funded and Russian-built control module—has been shipped from a Moscow factory to a Russian Space Agency launch site in Baikonur, Kazahkstan.

The 20-ton module is targeted for a June launch which will mark the beginning of the assembly of the new space station. The launch vehicle will be a Russian Proton rocket from the Baikonur Cosmodrome in Kazahkstan.

The module was built by the Khrunichev factory, under contract to The Boeing Company, the prime contractor to NASA for the International Space Station.

A special rail car will carry the module 1,200 miles in a five-day journey from Khrunichev to Baikonur, where it will begin five months of launch preparations and final testing.

"When the control module arrives at Baikonur, all of the elements for our first two launches will be undergoing final launch processing," International Space Station program manager Randy Brinkley said.

"The year of the International Space Station is 1998. This is something that all of us have looked forward to for a very long time. We have a lot of exciting and challenging activities ahead as we begin our assembly in orbit. The incredible efforts of a worldwide engineering and development team will be coming to fruition, and a new, unprecedented phase of space construction will begin."

Shortly after the control module is launched from Russia, *Endeavour* will launch on space shuttle mission STS-88 from the Kennedy Space Center, with the second piece of the station. This will be a connecting module, called Node-1, built by Boeing at NASA's Marshall Space Flight Center, Huntsville, Alabama.

Endeavour's crew will dock the control module to the node and perform three space walks to connect the two components during the 11-day flight. The station will then await the launch of the Russian-built Service Module, a component that will become the early living quarters, in December. The first crew of the new station is planned for launch on a mission in early 1999.

The 20-ton control module will provide early power and propulsion for the station as well as the capability to remotely rendezvous and dock with the Service Module.

New space shuttle tank readied for space station launch

The space shuttle is being outfitted with a new, super lightweight external fuel tank for use in launching the International Space Station.

"The space shuttle system needed additional performance either through more power or less weight," said Parker Counts, manager of the External Tank Project at NASA's Marshall Space Flight Center, Huntsville, Alabama. "Each pound removed from the external tank

equals a pound of payload that can be carried into space," Counts explained.

The new external tank is the same size as the one currently used on the space shuttle–but about 7,500 pounds lighter.

The 154-foot-long external tank stands taller than a 15-story building and is as wide as a silo with a diameter of about 27 feet. It holds the liquid hydrogen and liquid oxygen propellants in two separate compartments for the shuttle's three main engines.

The two major changes to the tank involved materials and design. Both the liquid hydrogen and liquid oxygen compartments of the new tank are constructed of aluminum lithium which is a lighter, stronger material than the metal alloy used for the shuttle's current tank.

The tank's structural design also has been improved. The walls of the redesigned hydrogen tank are machined in an orthogonal waffle-like pattern, providing more strength and stability than the previous design.

The tank will be shipped by barge from Louisiana to Kennedy Space Center, Florida, for its first launch scheduled in May on STS-91. The new design will not affect the assembly process when the orbiter is mated to the external tank and solid rocket boosters.

The shuttle's current external tank and the new, super lightweight tank are manufactured by Lockheed Martin at the Michoud Assembly Facility. Marshall provides the external tank, main engines and solid rocket boosters, including the reusable solid rocket motors, for every shuttle flight.

Kennedy Space Center offers tours of shuttle, space station

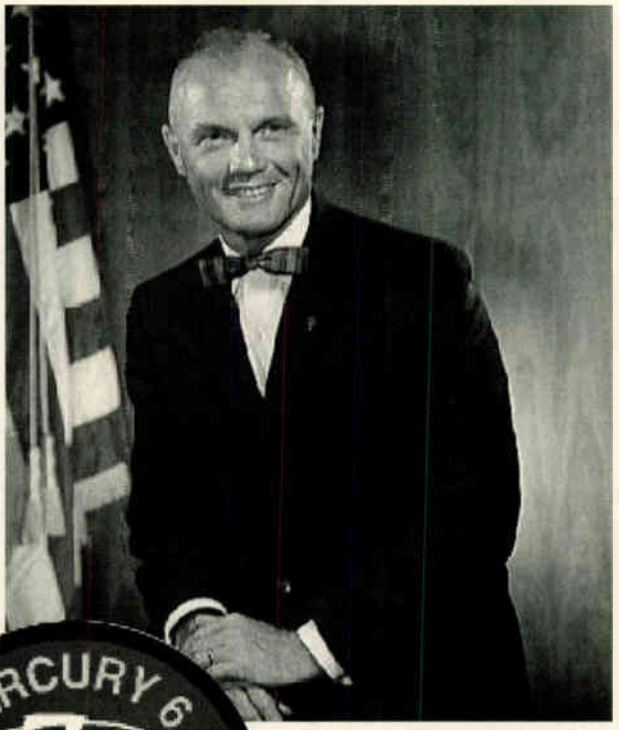
The Kennedy Space Center (KSC), home of the U.S. Space Shuttle, now offers tours of the facilities where the space shuttle is prepared and where the International Space Station is being constructed.

"This gives visitors unprecedented access to the U.S. space program," said James Ball, chief of the NASA Public Services Office at KSC. "Now, instead of a tour largely limited to driving around our facilities, the visitor can spend as much of their day as they wish in the heart of our operational sites, getting an up-close and personal view of both history and the future."

The 60-foot-tall LC 39 observation gantry features a top-level observation deck with a surrounding open-air walkway. From here, visitors have a 360-degree panoramic view of KSC's Launch Complex 39. The complex includes the two launch pads originally constructed to support the Apollo lunar landing program in the 1960s. It now serves as the springboard from which the space shuttle soars into space.

The International Space Station Center tours are designed to make visitors feel like participants rather than remote observers in America's space program. The ISSC experience begins with a film hosted by Robert Cabana, commander of the first U.S. assembly flight set to occur in July 1998. Cabana talks about the purpose of the station and the challenges of designing and constructing such a mammoth research laboratory. Full-scale mockups of station modules, through which visitors can walk, are on display. These include the Habitation Unit, where station crew members will live, sleep and work, a Laboratory Module, and the Pressurized Logistics Module, where racks and supplies will be transported back and forth from KSC to space.

Also on display is a mockup of Node 1, the first piece of U.S. hardware to be flown into space, which will serve as a connector between U.S. and Russian elements of the station. Guests can then take an elevated walkway to a gallery overlooking the work area where International Space Station hardware is being prepared for launch.



Astronaut John Glenn

Rather than having to take a preset tour that follows a specific program, visitors may choose which locations they would like to see and how long they wish to stay. Bus transportation to and from the stops and the KSC visitor complex is provided. Beverages and refreshments are available at each location.

Astronaut John Glenn returns to space

Astronaut John Glenn will be a payload specialist on the crew of the space shuttle *Discovery* when she launches in October, NASA announced.

Glenn made history 35 years ago when he strapped himself into a nine-by-seven foot capsule atop an experimental rocket and became the first American to orbit


Now and then: John Glenn as senator and as astronaut.

the Earth. Recently he asked NASA if he could fly again to conduct space-based research on aging. They agreed, provided that he meets the agency's physical and mental requirements.

"Not only is John Glenn a Marine test pilot, an astronaut, and the first American to orbit the Earth, he brings a unique blend of experience to NASA," said NASA Administrator Daniel S. Goldin. "He has flight, operational, and policy experience. Unlike most astronauts, he never got the opportunity for a second flight. He is part of the NASA family, an American hero, and he has the right stuff for this mission."

Glenn, who still flies his own plane, flew 149 missions as a Marine fighter pilot in World War II and Korea, and was hit by enemy fire 11 times.

As a test pilot, he set a transcontinental speed record and recently set a record for speed on a flight from Dayton, Ohio, to Washington.

Aging and space flight have similar physiological responses, and the study of space flight may provide a model system to help scientists understand aging. Some of these similarities include bone and muscle loss, balance disorders and sleep disturbances. Space biomedical researchers and gerontologists believe that more research in these areas could help older people live more productive and active lives, and could reduce the number of individuals requiring long-term medical care in their later years.

Senator Glenn has been a catalyst in promoting the use of space flight for the benefit of healthy and productive aging.

The human research on this mission will be conducted by NASA and the National Institute on Aging, part of the National Institutes of Health. The research was reviewed by independent scientists, and includes studies on sleep disorders, muscle atrophy, balance, and clinical evaluations of blood and heart function.

Dr. Michael DeBakey, Chancellor Emeritus of Baylor Medical College, who reviewed the medical data on Glenn, said he sees "no evidence to prevent Glenn from going into space. This is an opportunities to study the effects of the space environment on aging systems as has never been done in the past."

NASA has previously flown astronauts up to 61 years old. At least eight crew members over the age of 55 have flown multiple missions. Shannon Lucid was 54 when she spent six months aboard the Russian space station *Mir*.

Before NASA made the decision to fly Glenn, the senator underwent a battery of medical tests conducted by NASA physicians and by independent consultants. They all found him medically qualified for space flight. According to NASA flight surgeons, Glenn's fitness level is excellent.

NASA commits to second vehicle for X-34 program

NASA has modified its X-34 contract with Orbital Sciences Corporation, Dulles, Virginia, to produce a second flight vehicle for the X-34 Program. "The purpose of a second vehicle is to reduce risk to the X-34 program," said deputy program manager Mike Allen of NASA's Marshall Space Flight Center, Huntsville, Alabama. "One of the lessons we learned from the Clipper Graham program is that it is desirable to have a second flight vehicle available, especially if it can be acquired at a relatively low cost." Clipper Graham was a previous technology demonstrator that NASA flew four times in 1996, until it was destroyed during landing.

Under the new arrangement, X-34 test objectives are being expanded, adding, for example, unpowered tests to the flight profile. A second vehicle also will provide flexibility in demonstrating various technologies, Allen said, allowing testing that requires repetitive flights to continue at the same time as tests which require significant, time-consuming changes to the vehicle.

In August 1996 NASA entered into a US$50 million contract with Orbital Sciences Corp. to design, build and test-fly the X-34, a small, reusable technology demonstrator. An additional US$10 million was committed by NASA to be spent in direct support of X-34 by NASA Centers and other government agencies. Now the contract has been increased by US$7.7 million to purchase long lead-time hardware, including a new wing, fuselage, avionics set, hydraulic pump and actuator system, and more. NASA has committed US$2 million more for the government to provide wind tunnel testing, additional testing and analysis, and a second leading-edge thermal protection system.

A US$8.5 million option calls for purchase of shorter lead-time hardware, such as navigation systems, while a US$1.8 million option has been added for assembly of piece parts into subsystems, integration and final assembly. These options should be formally exercised shortly.

The X-34 is a single-engine rocket with short wings and a small tail surface. The vehicle is 58.3 feet long, 27.7 feet wide at wing tip and 11.5 feet tall from the bottom of the fuselage to the top of the tail. Capable of flying eight times the speed of sound and reaching an altitude of 250,000 feet, the X-34 will demonstrate low-cost reusability, autonomous landing, subsonic flights through inclement weather, safe abort conditions, and landing in 20-knot cross winds. ST

Satellite Monitor sources: NASA, European Space Agency, and the Kennedy Space Center

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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!

Order PHN05, only $4995.95
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PHN05A	same as above but with remote antenna connection	$5,145.00
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ST Satellite Profile

NASA's Lunar Prospector spacecraft launches successfully on its way to the moon (captured, incredibly, in the same shot) from Cape Canaveral Air Station on January 6. It was the inaugural launch of Lockheed Martin's Athena II launch vehicle (shown below).

Prospects of Greatness: The Lunar Prospector

By Philip Chien

NASA's Lunar Prospector is in orbit around the moon–25 years after Apollo 17. By the time you read this article the question about whether or not there is a vast cache of ice at the moon's poles should be solved–and with it, important questions about future lunar exploration.

Since the early 1960s a compelling scenario has been put together for how ice deposits could exist on the moon's surface. Here's how the logic goes.

We know that comets collide with the moon

on a regular basis, as they do with every other object in the solar system. Comets are primarily ice with a mixture of rock and other substances. Deep craters near the moon's poles are always be in shadow–never exposed to the sun's heat. Therefore, that lunar soil would be incredibly cold–several hundred degrees below zero.

In the almost perfect vacuum in space, any ice formed in these shadowy areas would not boil away. Comets which hit whatever portion of the moon is in daylight would quickly evaporate, and nighttime comet hits would only last until daylight. So comets

which happen to hit an appropriate, shaded crater would eventually form an ice deposit. Over four billion years enough comets should have hit to create a sizable amount of ice.

It's a compelling theory, but only remains a concept until the proof's on the table.

Since Clementine was a sensor platform, it didn't carry any remote chemical analysis instruments which could verify whether or not ice existed on the moon. However, scientists were able to come up with an indirect method. Clementine's radio transmitter was aimed towards polar craters with the angle calculated to reflect the signal towards the Earth. By analyzing how
the signal was changed by the reflection (similar to how aircraft weather radar works) information about the surface could be implied. A rocky surface would return one type of signal while an ice

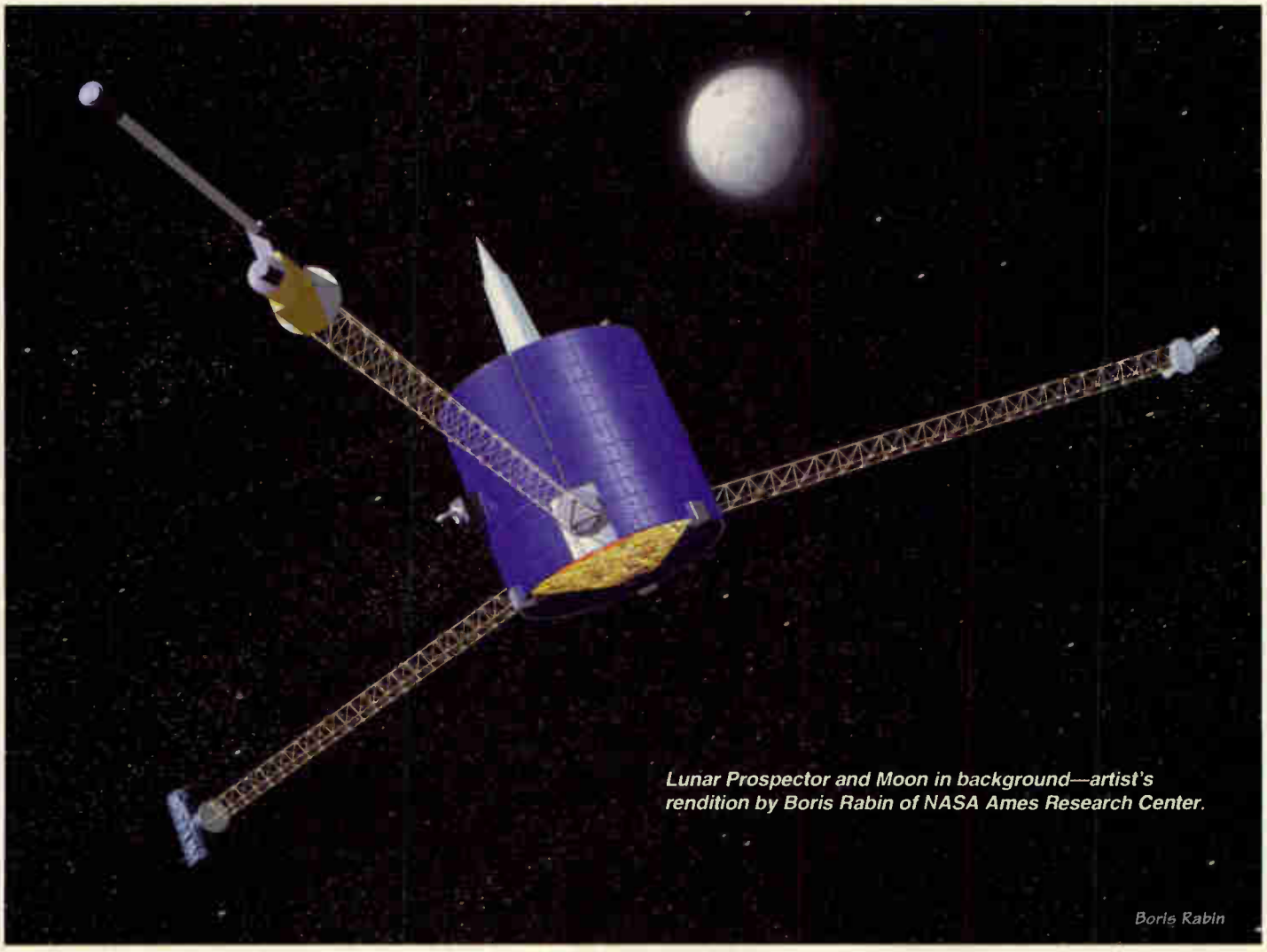
formation would give another. Using this technique the Clementine data appears to indicate that there's a large icy deposit in the Aitken basin which surrounds the South Pole.

Ground-based radio astronomers used the 1,000 foot Arecibo radio telescope in Puerto Rico for similar studies-transmitting a very high power signal at the moon and listening to its return. Their data didn't indicate any ice.

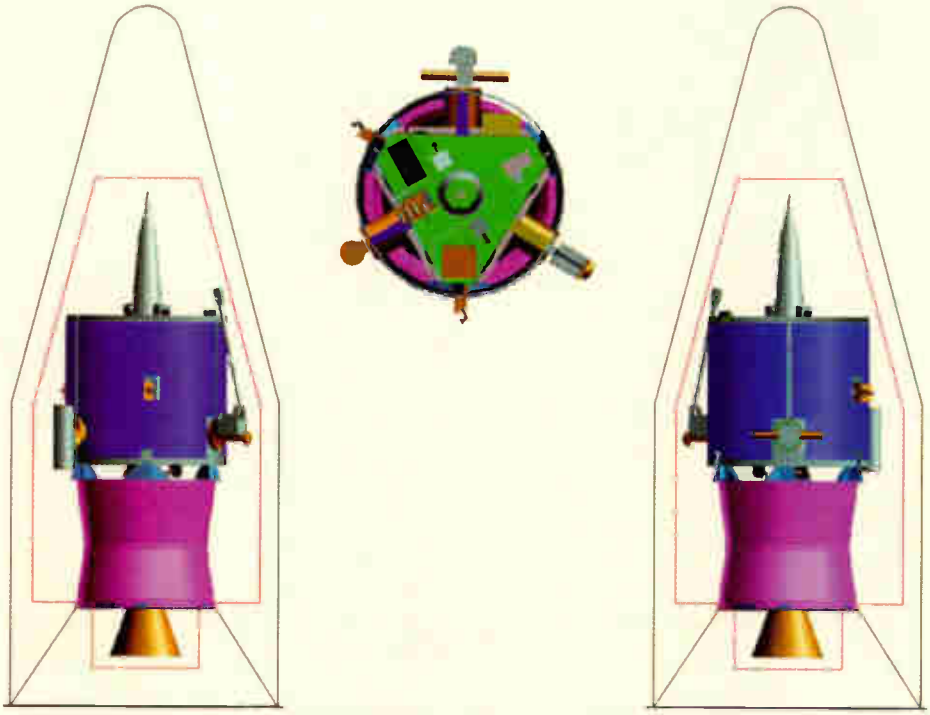
So why the discrepancy? Arecibo's data had greater resolution due to the size of the dish (you may remember it from the Jodie Foster movie *Contact*), but could only view the crater from one angle. In comparison, Clementine's much lower resolution signals came from the spacecraft in orbit around the moon, imaging the crater from different perspectives. So it's how the data is interpreted. Both groups of scientists agree that there's nothing wrong with the theory; they only disagree about interpretation of the data which has been collected.

But there's no need for fistcuffs, the controversy's going to be solved very soon–probably by the time you read this article. Lunar Prospector's Neutron Spectrometer is so sensitive it can directly measure the equivalent of a cup of water in a cubic yard of rock. NASA science manager Wes Huntress said, "What we're after is a binary answer–is there or is there not water at the South pole? Either answer is acceptable."

The Neutron Spectrometer uses proportional gas counters. Two chambers filled with Helium-3 gas are coated with



Lunar Prospector and Moon in background—artist's rendition by Boris Rabin of NASA Ames Research Center.



Lunar Prospector Spacecraft Configuration: This diagram of the Lunar Prospector shows the spacecraft with its instrument masts stowed. There are three sets of science instruments: 1) Gamma Ray Spectrometer (GRS), 2) Neutron Spectrometer (NS) with Alpha Particle Spectrometer (APS), and 3) Magnetometer with Electron Reflectometer (Mag/ER). The antenna which will facilitate the Doppler gravity experiment, as well as command and control is visible. The major electronics boxes are also seen. (NASA Ames Home Page)

Cadmium and Tin. The difference between the two chambers indicates the background neutron flux, and hydrogen should stick out like a sore thumb. While it's possible that the hydrogen could be in the form of methane, ammonia or some other compound, the most likely form for hydrogen is plain water. So if the neutron spectrometer detects large quantities of hydrogen near the moon's poles but not in other areas it's a good bet that the ice exists.

Don't Water Down the Importance

Ice can make the difference between a highly successful lunar base and one which can barely survive. Imagine if you were going on a camping trip and had to bring along all of your air and water! Now imagine you didn't have to bring the water or air–and could even get free fuel at your destination ... Apollo moon rocks show that there's plenty of oxygen on the moon. Conceivably, large tankers of liquid hydrogen could be sent to the moon and the hydrogen used to generate power and water using lunar soil.

However, every person at a lunar base will require 146 kg of water and 251 kg of oxygen each year–a substantial quantity to have to transport out of Earth's gravity. If the ice can be mined it could become the moon's most valuable resource. Even if lunar bases are located at the moon's equator a small sub-base or even robots could be stationed at the poles to mine the ice.

Certainly mining lunar ice would be an extremely long term goal for future permanent lunar bases. Early expeditions back to the moon would certainly have to carry all of their supplies with them, but future expeditions would benefit from the local resources. If ice is detected in large quantities it's likely that an early expedition to the polar regions will carry an experimental ice processing experiment to evaluate the feasibility of converting the ice into water and oxygen.

Unearthing More Moon Mysteries

Besides the Neutron Spectrometer, Lunar Prospector also carries three other instruments. The Gamma Ray Spectrometer is basically a radiation meter. Its bismuth germanate (BGO) detector is designed to measure naturally radioactive emissions from uranium, thorium, potassium, oxygen, silicon, manganese, iron, titanium, calcium and aluminum.

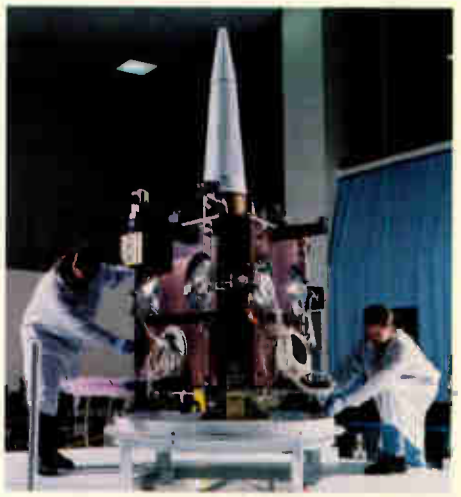
The Alpha Particle Spectrometer is aboard to answer a perplexing question–is the moon still active or is it dead? On rare occasions, changes have been observed on the lunar surface, possibly outgassings from the interior. The Alpha Particle Spectrometer will measure radioactive alpha particles to monitor when and where gas releases occur.

The Magnetometer/Reflectometer is a duplicate of the Mars Global Surveyor instrument which detected the telltale magnetic field around Mars. Similar instruments are on NEAR, ACE, and other planetary spacecraft.

Early spacecraft verified that the moon doesn't have an appreciable magnetic field. But Apollo lunar samples do show some residual magnetic fields, possibly from when the moon was formed. The Magnetometer/Reflectometer is much more sensitive than previous magnetometers. During the cruise to the moon it measured a magnetic field in the Earth-moon space of just one nanotelsa, the smallest measurement of any magnetic field in space.

Mapping Lunar Gravity

There's an additional science investigation which doesn't require any additional instrumentation aboard the spacecraft. Many deep space probes have used their radio transmitter for doppler gravity experiments. Spacecraft radios can be



The Lunar Prospector satellite under construction.

tuned to very precise frequencies. By monitoring the frequency of the radio as it's received on the Earth, the spacecraft's motion can be monitored.

The classic example of the doppler effect is a moving train. Its horn appears to change frequency as the train approaches and as it recedes. Using the frequency of the tone, the frequency of the horn when the train isn't moving, and the speed of sound you can calculate the train's velocity.

Anybody who's listened to a transmission from a low altitude satellite, especially at high frequencies (i.e. *Mir*'s 70 cm ham downlink), is quite aware of the requirement to carefully compensate for doppler.

The Lunar Prospector's radio signal can be used to track where the spacecraft is in its orbit around the moon and document unexpected changes due to mascons–large, high density areas underneath the moon's surface. The moon isn't as homogeneous as the Earth, and early Lunar Orbiter spacecraft in the 1960s first noticed the mascons. For example, if the frequency of the spacecraft suddenly shows an unexpected dip it would indicate that it had just passed over a mascon.

Ultimately, scientists hope to get a much higher resolution gravity map of the moon, which also has an impact on future lunar explorations. Lunar Prospector has to carry a very large fuel supply to be conservative about the moon's gravitational field. If the mascons are carefully mapped, a much better mathematical model of the moon can be created and future lunar missions will require less excess, "just in case" fuel. That mass can then be used to carry additional scientific instruments or other payloads.

This Dumb Satellite is a Winner

Clementine and Lunar Prospector are very complementary missions with little overlap. Lunar Prospector doesn't have any cameras because Clementine has already done a complete map of the moon's surface. Not carrying cameras enables Lunar Prospector to require a much less complicated spacecraft with much lower data rates. Consequently, Prospector only needs a very inexpensive radio and telemetry system.

Lunar Prospector doesn't even have a computer. The relatively simple "brain" has a microprocessor, but it's is just a command decoder capable of handling about 60 commands to reorient the spacecraft, fire thrusters, operate the transmitters and command the instruments. Principle Investigator Alan Binder said, "It just takes the commands and formats it. There's a microprocessor, and there are microprocessors in the instruments, but this is the dumbest thing I've seen in a long time. It is not a computer. Period."

Lunar Prospector spacecraft above Earth, with sun in background. Artist's rendition by Boris Rabin of NASA Ames Research Center

Because there is very little atmosphere on the moon, Lunar Prospector's 100 km (62 miles) high orbit is the lowest for any planetary spacecraft which isn't going in for a landing. In Earth terms, it's equivalent to a balloon orbiting 27 km (17 miles) high in the stratosphere. The lower lunar orbit will permit a higher resolution data taken by its instruments.

After a year of mapping the moon's resources Lunar Prospector will be lowered to an even lower altitude orbit, just 10 km (6.2 miles) above the lunar surface. Due to the lack of an atmosphere on the moon an equivalent "spacecraft" around the Earth would have an altitude of just 2.7 km. (1.7 miles). At one tenth of the height of the mapping orbit, the new orbit will permit a hundredfold increase in resolution. Data which was extremely noisy, or just seemed to indicate something interesting, will come in clearly.

Eventually Lunar Prospector will run out of fuel. And mascons will pull it lower and lower until it eventually crashes into the lunar surface. All previous lunar orbiting spacecraft have eventually crashed due to the moon's lumpy gravitational field.

Lunar Prospector was conceived as an extremely low cost mission, and it's succeeded. By NASA standards US$20 million is incredibly cheap for a spacecraft. However, at one point it looked like it could have been done privately for even less. A non-profit space advocacy group wanted to build the spacecraft using volunteer labor and donated components. The Soviet government was even willing to contribute a Proton launch vehicle, but there weren't enough donations and resources.

When the Discovery program–NASA's project to build low-cost planetary space-

TABLE 1

Lunar Prospector transmitter characteristics

Omni antenna:	0 dB gain using right hand circular polarization
Medium Gain antenna:	6.5 dB gain using right hand circular polarization
Uplink Frequency:	2093.0541 MHz
Downlink Frequency:	2273.000 MHz
Output Power:	5 watts
Subcarrier frequency:	1.024 MHz
Modulation type:	NRZ-L (Non Return to Zero-Level)
Telemetry subcarrier modulation index:	1.3 rads
Data Rate:	3600 bps (300 bps initial turn-on and emergency)

craft–came along Lunar, Prospector was the definitive choice. The Discovery program has a maximum cost of US$200 million for the spacecraft and launch vehicle. At US$53 million including the launch vehicle, Lunar Prospector could be built for a fraction of the maximum budget. Others in the Discovery competition have complained that the sole reason Lunar Prospector won was because of its low cost, not because of the quality of its science.

The Lunar Prospector team consisted of a small team of scientists who founded the Lunar Research Institute in Gilroy California, NASA's Ames research center, and spacecraft manufacturer Lockheed-Martin.

The Lunar Prospector project decided to include its own launch vehicle instead of requesting that NASA furnish one. It turns out that a different division of Lockheed was trying to sell small, relatively inexpensive launch vehicles. Lunar Prospector was an excellent candidate payload since it would provide the funding required to develop the two stage Lockheed Launch
Vehicle-2 (now Athena 2) and provide credibility when Lockheed tried to sell their launch vehicles to other potential customers.

Actually the Athena 2 is much too powerful for the Lunar Prospector mission, so an unusual "lofted" trajectory provided a less efficient trajectory to get rid of the excess performance.

Enter the state of Florida: Since 1989 the Spaceport Florida Authority had been trying to build its own launch pad. Originally the concept called for a universal pad which could accept Delta, Atlas, and Titan launch vehicles. For some reason the state thought that all of the commercial launch companies would prefer to abandon their existing launch pads and use a launch pad which they would have to share with each other. Nobody could see any logic in this plan besides Florida, and the idea quickly died.

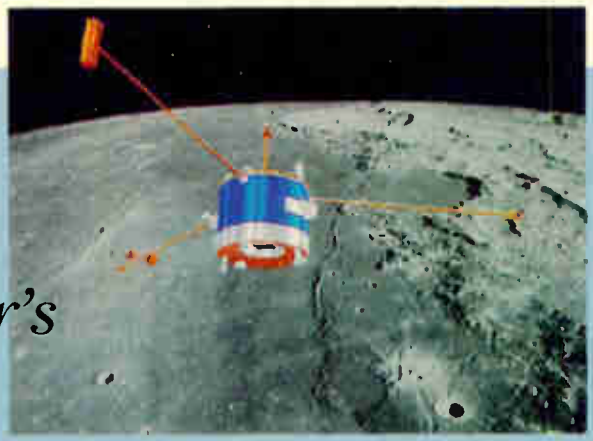
The Spaceport Florida Authority did find a niche, however, for new, smaller-class launch vehicles which didn't already have their own existing or adaptable launch pads. Instead of paying $8 million to build their own launch pads, companies like Lockheed and Orbital Sciences could join the state in a cooperative venture. Each of the launch companies contributed a relatively small amount of money; additional funds were provided by the other partners.

An existing Navy Trident launch pad was upgraded to support different types of launch vehicles. The key features which make this possible is an adaptable service structure. Instead of fixed platforms, the platform heights and diameters can be adjusted, similar to the way an airport jetway moves up and down to match up with different types of aircraft. When a company like Lockheed wants to use Spaceport Florida's Launch Complex 46 for an Athena launch, they book a reservation and pay US$250,000 to the state. Overall it's much less expensive for the launch vehicle company.

All of these different parties and objectives came together on January 6, 1998, at 9:28:44 p.m. EST. It was a spectacular launch for a new version of a launch vehicle off a newly upgraded launch pad, to begin a new age of exploring the moon.

ST

Receiving Lunar Prospector's Signals



During the Apollo-era some radio enthusiasts were able to monitor the Apollo spacecraft's signal-directly. Even before mission control got to receive the signal through NASA's worldwide tracking stations, a handful of amateurs were able to receive the signals from the Apollo spacecraft's radio transmitter.

Radio technology, low noise amplifiers, and other improvements have occurred over the 25 years since the last Apollo signals from the moon. So it isn't surprising that amateurs were once again listening for signals coming from the moon. Table 1 has the characteristics of Lunar Prospector's radio.

Al Ward, WB5LUA, and John Yurek, K3PGP, were two of the first to receive the signal, using 2.3 GHz antennas normally used for EME (Earth-Moon-Earth) experiments. EME involves sending a high-power, directed transmission towards the moon and listening for its reflection 2.5 seconds later. The moon is a fairly lousy radar reflector, but it is large, and with enough power from the EME transmitting station and enough sensitivity in the EME receiving station it is possible to communicate via Morse code.

Al said that with a 500 Hz bandwidth he measured the main carrier at 10 to 15 dB above the noise. John has posted his signals on his web page at:
http://www.qsl.net/k3pgp/!Start/prospect.htm

The official Lunar Prospector web site is at **http://lunarprospector.arc.nasa.gov**

Loused in Space

Listen my children and you shall gasp at our 40-year legacy of orbiting trash

By Ken Reitz

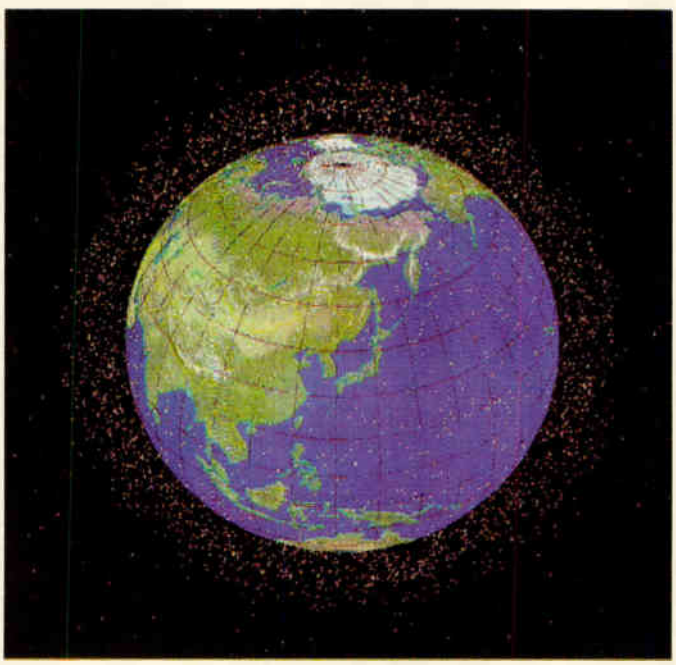
On any cloudless night there's nothing to match the inspiring view of our sky. The dizzying display of distant celestial light seems to bring out the poet in all of us. Who doesn't stand in awe of the great vastness of our universe?

These past four decades have seen the infant space programs of Earth develop from the era of Sputnik to missile gaps and the terrifying cold war space race. Now, the world's developing countries and their interlocked corporations are on the threshold of a new wave of space exploitation. On the one hand is the promise of world-wide global communications through simple, hand-held telephones, and on the other is the possible threat to those very same programs as well as to international scientific space exploration.

A Matter of Debris

For millions of years, before the first humans found themselves contemplating the swirl of lights we know as our Milky Way, all the planets of our solar system made their way around the sun just as they do today. They cruise through streams of natural space particles known as meteoroid flux or "space debris." The biggest of these objects bring us delightful meteor showers throughout the year. The population of space debris is relatively small. According to the Interagency Report on Orbital Debris, at any given moment within 2,000 km of Earth, the collective mass of space debris would weigh in at around 200 kg, the bulk of which is made up of tiny meteoroids .01 cm in size.

While space debris has always been a concern to manned and unmanned space missions it doesn't pose nearly the problem of man-made orbiting objects known as "orbital debris." Since the launch of Russia's first Sputnik satellite forty years ago, orbital debris has been a man-made consequence of space exploration. Thousands of successful and unsuccessful launches later, orbital debris outweighs space debris mass by 10,000 times. Much of orbital debris consists of spent rocket stages, payload shrouds, inactive satellites, and the results of unintended explosions. Orbital debris is broken down into four categories: operational debris (objects which are part of the operation of placing a satellite in orbit), fragmentation debris (exploding satellites or rocket bodies due to unspent fuel build up or battery explosions), deterioration debris (paint flaking off spacecraft), and rocket motor ejecta (thousands of kilograms of aluminum oxide dust which can be ejected into the orbital environment from unspent solid rocket motor [SRM] fuel long after the last burn is over). Only SRM ejecta, of which virtually all particles return to earth in just a few orbits, has a short life span. The rest of the orbital debris continuously falls to earth, some faster than others. But, we're throwing the stuff up there faster than it's coming down, hence, the growing debris population.



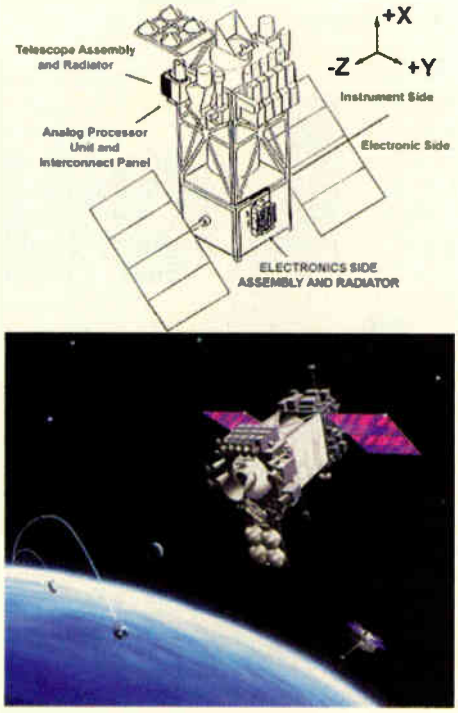
Early satellite launch procedures allowed all manner of ob-

jects to be jettisoned into space including empty propellant tanks, spin-up mechanisms, separation devices and clamps. Launch procedures have since been designed to curb such activities. Despite these precautions, according to the *Report on Orbital Debris*, there has been no change in the rate of fragmentation events. In fact there have been 19 such events from 1991 to 1995; four in LEO in 1996 and three in the first half of 1997. This rate might go up considerably with the expected increase in spacecraft building and launching over the next five years.

Eyes and Ears to the Skies

Isn't anyone keeping track of this mess? Yes; in fact, the Department of Defense has had an interest in tracking orbital activities since that first Sputnik caught America in a technological catnap. The United States Space Command's 21st Space Wing owns and operates the Space Surveillance Network (SSN) from its Space Control Center at Cheyenne Mountain Air Station in Colorado. The Space Control Center coordinates data gathered from 23 world wide sites which use a combination of radar and optical sensors to track a catalog of over 8,000 on-orbit objects. The catalog is comprised only of objects which can be identified and consistently tracked. According to USSPACECOM's Public Affairs office, "The SSN sensors provide over 60,000 satellite observations each day that are converted into Keplerian Element Sets (Predicted Orbit Location) and transmitted to each sensor site establishing a continuous command and control process."

At its inception the SSN was charged with maintaining a catalog of all known man-made space objects; predicting where and when a given man-made space object might re-enter the atmosphere; and notifying NASA of objects which may potentially interfere with an up-coming launch or on-orbit mission. Among the more memorable moments in USSPACECOM's history are the tracking of NASA's huge SpaceLab satellite which fell to earth in July of 1979 and last year's tracking the demise of a large Chinese spy satellite. This past September the Russian Space Station *Mir* was said to have come within 500 to 1,000 yards of colliding with a U.S. military satellite. According to press reports USSPACECOM advised *Mir* crew members that the 220 pound military reconnaissance satellite, MSTI-2, was on a collision course with *Mir*. The crew took no chances and sealed themselves into the Soyuz escape capsule attached to *Mir* and hunkered down.



Miidcourse Space Experiment.

Layers and Layers of Debris

Governments and businesses are interested in orbital debris in three specific layers of near earth space: low earth orbit (LEO) seen as less than 5,500 km above earth; middle earth orbit (MEO) around 10,000 km; and geostationary orbit (GEO) 36,000 km above earth. There are two other orbits which are of importance as well: transfer orbits, the space between MEO and GEO which is where geostationary satellites are transferred from launch vehicle to final orbital slot; and Molnya orbits, so named for the Molnya series of satellites operated by the former Soviet Union, which have characteristically high elliptical orbits ranging from a perigee of several hundred kilometers to an apogee of more than 36,000 km. AMSAT, the Amateur Radio Satellite organization also operates several satellites in elliptical orbit.

Of the three main orbit layers, LEO represents the main population of orbital activity. There are currently about 1,300 spacecraft, 700 rocket bodies, and 4,000 debris fragments for a total of roughly 6,000 objects in LEO, making it the most congested layer of orbit. MEO has the least activity with a total of only 134 objects. GEO, transfer and Molnya orbits make up the rest of the debris action with just over 2,000 objects.

These layers of debris are of great concern to everyone. Governments are concerned for the safety of astronauts and cosmonauts whose lives and work in the Space Shuttle, Mir, and the future International Space Station are at risk. Businesses are concerned because billions of dollars are being invested in complex LEO satellite systems for the future of telephone, paging, and Internet activities. And, if we thought the LEO environment was crowded before, check in again at the turn of the century when the figures mentioned above could be almost doubled.

Current and Future LEO Players

Over the past several years U.S. businesses have been lining up to take a crack at a new world market: international telephone, paging, data, and Internet services. For many in developed countries, such services are taken for granted. But, in the rest of the world, these services are largely unavailable. The lack of a reliable terrestrial-based infrastructure keeps most world citizens from participating in the communications revolution currently being experienced by the richest countries. That's all about to change. Now, cellular-style phones will provide global, multi-mode communications access to areas of the world which don't even have basic phone or power service. Here are some of the current hopefuls:

Globalstar

By the time you read this, Globalstar should have launched the first four of a scheduled 56 satellites in its LEO constellation. Flying six satellites in eight orbital planes, Globalstar will cover the planet from 70 degrees north to 70 degrees south. Globalstar is a partnership of well known international telecommunications companies involved in service and manufacturing. The Globalstar system is designed to allow local service providers to offer satellite based digital wireless voice telephony and data services.

Iridium

May 5, 1997, was the official launch of the Iridium system when a Delta II rocket lifted the first five of an anticipated 66 satellites into Low Earth Orbit. A division

of Motorola, Iridium plans to offer global satellite and local cellular service including a global alphanumeric service. Iridium hand held telephones will feature dual-mode compatibility for seamless satellite and wireless service and offer digital voice, fax and data at 2.4 kilobits per second using FDMA/TDMA (Frequency Division/Time Division Multiple Access) transmissions. The 66 satellites will fly in a constellation of 11 satellites in six orbital planes with one on-orbit spare per plane. That's a total of 72 satellites in Iridium's constellation.

Motorola is enthusiastically planning even more LEO projects. In October of 1997 Motorola announced plans to have 300 to 400 new satellites constructed for several additional projects. In addition to building replacements for the original Iridium system, Motorola has created the Celestri project, a data communications system for business, and MStar, a support network for LEO satellites.

Orbcomm

A partnership owned by Orbital Sciences Corp., Teleglobe Inc. of Canada, and Technology Resources Industries of Malaysia, Orbcomm began limited service with the launch of two satellites nearly three years ago. In the next two years Orbcomm hopes to have in orbit 36 small LEO satellites offering, as their press release says,"...real-time person-to-person or machine to machine communications, remote industrial asset and environmental monitoring, stolen vehicle recovery and two-way Internet e-mail communications for lap-top and palm-top computers."

Taking a page out of the thirty year history of AMSAT success, Orbcomm will use lower VHF frequencies (137-150 MHz) to provide its services. They hope to take advantage of existing off-the-shelf hardware and software technology. Another big advantage in this strategy is much lower cost to both the service provider and the service user. The biggest disadvantage will be the more narrow focus of services as opposed to the broadband services of Iridium or Teledesic.

Teledesic

Teledesic is the brain-child of Craig McCaw, pioneering cellular phone entrepreneur, and backed by Microsoft Chairman Bill Gates, who needs no introduction. An international team is being assembled to manufacture and launch the Teledesic system, led by the Seattle-based Boeing Company. Teledesic Network's constellation will consist of 288 operational satellites flying 24 satellites in 12 planes. Carrying a price tag of $9 billion, service is slated for 2002.

In late November of 1997 the World Radio Conference allocated the radio spectrum Teledesic had sought for its service to provide two-way telecommunications services through its global, broadband "Internet-in-the-Sky," videoconferencing, high-quality voice and other digital data needs. Operating in the Ka-band (28.6-29.1 GHz uplink and 18.8-19.3 GHz downlink) the Teledesic Network hopes to support millions of simultaneous users at speeds 2,000 times faster than today's standard analog modems. To show the usefulness of such increased speed, Teledesic touts the example of X-rays taking four hours over today's modems, a time which would be reduced to seven seconds over the Teledesic Network.

TRW

TRW has spent years planning its Odyssey satellite telecommunications service. The service is unique because it is the only one planning to use Middle Earth Orbit. Flying a constellation of 12 satellites at about 10,000 km, Odyssey services will include fax, digital data transfer, and short message service. Originally, Odyssey had planed to begin service by the year 2000, but, according to spokesman Jay McCaffry at Odyssey, "Attracting investors has gone much more slowly than anticipated...It's a highly competitive world out there."

Haystack radar dome.

Indeed, it is. And it's bound to get even more competitive with the addition of new companies not yet announced. With the combination of existing LEO satellites, planned business ventures and many national government projects (weather, spy, and military communications satellites), it should be clear that opportunities to continue to pollute near space will increase. If Teledesic, Motorola and all the others are successful we can look for an additional 1,000 satellites jamming the LEO orbits with possibly countless bits and pieces of operational, fragmentation and deterioration debris spewing into our already crowded vision.

One LEO Case Study

Succeeding in the marketplace is not easy. The world of commerce is a tough enough venue in which to play without having to factor in the possibility that your business venture could blow up on a launch pad during ascent or in-orbit. That's why companies seeking their fortune in the sky pay close attention to the subject of space debris. "The Teledesic Network," explains Teledesic President Russell Daggatt, "is designed to both minimize the introduction of orbital debris and maximize the survival of our satellites."

As an example of this Daggatt cites the "...low drop-off altitude from our launch service providers, rather than a direct injection with a rocket upper stage that would pose a continuing risk of spent booster explosion and fragmentation..." "After deployment," Daggatt says, "Teledesic satellites will fly up to their operational orbit under their own power..."

Once in orbit, Teledesic has taken design precautions to increase their chances of success.

Daggatt says confidently, "...we've designed our spacecraft with enough fuel so we can de-orbit the satellites at the end of their useful lives, which will help keep the space environment both clean and safe for future spacecraft operations." Is he concerned about plans of other companies to launch hundreds more satellites in the LEO environment? "No," says Daggatt, "space is a big place...We expect eventually to have competition from other satellite sources, but it's too soon to tell definitively who and what the competition will be...Our challenges now are largely a matter of execution. We can't base our

plans on the press releases and regulatory filing of others."

Indeed, his point is well taken. In the DBS satellite TV world, competition has been fierce. DBS hopeful Alphastar, despite its technical expertise, proved less than able in the marketplace. In the LEO satellite business talk is cheap and a war of press releases rages. Which company or companies are actually in operation five years from now remains to be seen. Teledesic's own plans have changed dramatically from an original constellation of 840 satellites to the present plan for 288.

An Unclear Future

The impact of all this space and orbital debris has been felt since the early days of the space race. Space debris, traveling roughly 44,000 miles per hour and orbital debris traveling at half that rate, no matter how small, becomes a threat to manned and unmanned space vehicles. And, while it's impossible to determine for certain if there has been a confirmed collision attributed to orbital debris impact, suspicions have been raised. NASA's *Report on Orbital Debris* states that the breakup of Russia's Kosmos 1275 satellite in 1981* may have been the result of just such a collision. Study of the size and velocity distribution of objects which resulted from the breakup indicate a possible collision.

The most notable evidence of orbital debris is found on all of the space shuttle vehicles. NASA reports that exterior surfaces of each vehicle show tell-tale pitting to such an extent that an orbiter window is replaced every other mission. While such pitting evidence is removed from the orbiter's surface tiles on re-entry, other such evidence is preserved on parts of the orbiter exposed to the space environment and then covered for re-entry, such as the radiator panels inside the payload bay doors. Russia's *Mir* space station is said to suffer similar damage on its windows and exterior light bulbs.

NASA projects specifically designed to measure space and orbital debris have been launched and studied. Most notable was the Long Duration Exposure Facility (LDEF) which was in orbit for nearly six years. According to NASA, "... [LDEF's] surface was covered with tens of thousands of impact pits, the largest being about 0.63 cm in diameter. Laboratory studies of the pitted surfaces confirm that about half the large impacts where the source could be identified were caused by debris, while practically all of the smallest impacts were man-made aluminum oxide debris."

Liquid mirror telescope.

The Astronomical Angle

Are earth based astronomers concerned about the effects of all this near-space activity? Yes, and no. A spokeswoman I talked with at the McDonald Observatory in Austin, Texas, says no. She agrees with Teledesic's Daggatt that space is a big place. From the standpoint of Earth based observations, the debris doesn't hamper astronomer's work. But, Samuel Goldstein, astronomy professor at the University of Virginia, is worried. He co-authored, with his brother R. M. Goldstein at Jet Propulsion Laboratory, a study on orbital debris which appeared in the *Astronomical Journal* in January 1994. Samuel Goldstein's concern is that there is a tendency in humans to overlook the consequences of pollution both on earth and above in the short-sightedness often found in the enthusiasm of enterprise.

Nicholas Johnson is Project Director for NASA's Orbital Debris Management Program. In an article which appeared in the January-March 1997 issue of *Orbital Debris Quarterly News*, Johnson writes of a fragmentation event in 1996. "...Preliminary analyses suggest that the number of such small debris from this one event equals the previous background population of this size [3-5 mm in diameter] near 600 km. Hence, the risk to spacecraft like the Hubble Space Telescope from objects with approximately 3 mm or greater diameter has doubled." The Hubble Space Telescope, which had enough trouble just becoming operational and which has become an invaluable tool for hundreds of astronomers the world over, is at risk. The International Space Station, which is still on the drawing board, will stand the same risk.

NASA Reacts

The original findings of the *Report on Orbital Debris*, which was released in 1989, were updated in 1995 with the following recommendations:

1. Continue and Enhance Debris Measurement, Modeling and Monitoring Capabilities
2. Conduct a Focused Study on Debris and Emerging LEO Systems
3. Develop Government/Industry Design Guidelines on Orbital Debris
4. Develop a Strategy for International Discussions
5. Review and Update U.S. Government Policy on Debris."

To this end NASA has been quite active. NASA scientists have developed a modeling program called Orbital Debris Engineering Model 96 (ORDEM96). This model can, according to NASA, "...be used to predict the future effects of various methods proposed to slow the growth of the debris environment..." The model is specifically created for spacecraft design and observation in LEO.

In addition, week long international meetings among government, industry and academic representatives take place on a regular basis at venues all over the world. Results of these, and other efforts, are published in NASA's *Orbital Debris Quarterly News* and may be accessed by the public through NASA websites.

Coping with earth based pollution has grown into a billion dollar industry. Our experience with oil products, nuclear waste and chemical production has made us acutely aware of the importance of maintaining a clean environment. Now, that same awareness is required for our continued activity in space. The problem in space is that Earth-style solutions don't work. What's required is forethought, careful planning, and a lot of luck.

*Kosmos 1275 was launched June 4, 1981 and broke up July 24 just weeks later. 306 fragments were cataloged on breakup, of which 275 are currently tracked at an altitude just over 1,000 km.

ST

UNDER CONSTRUCTION:
The KD2BD 9600 Baud Modem, Part II

By John A. Magliacane, KD2BD
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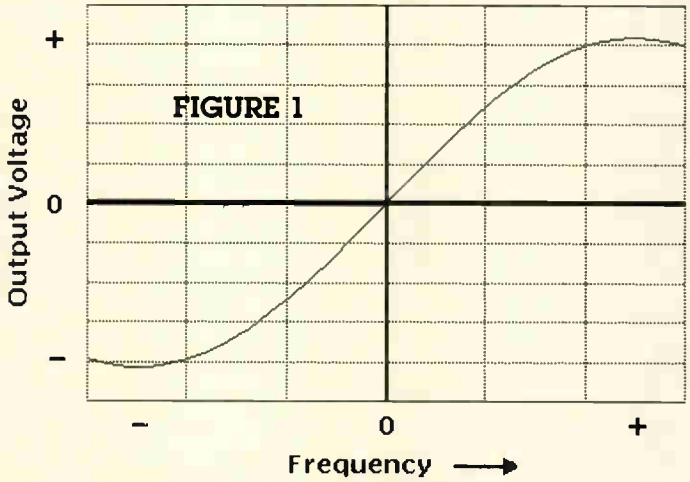
9600 baud Frequency Shift Keying (FSK) modems are typically used in conjunction with communications quality FM receivers and transmitters. In actuality, 9600 baud modems are signal processors more than they are modems (Modulator/Demodulators) since the actual signal modulation and demodulation processes occur in the groundstation radio equipment rather than in the electronics that is typically referred to as a "modem."

One of the radical features of the KD2BD 9600 Baud Modem design is that it uses full DC coupling to the the receiver's detector and the transmitter's modulator. This direct coupling provides a frequency response that extends for the full spectrum of the FSK signal. DC coupling to an FM receiver's discriminator and transmitter's varactor diode requires some careful design considerations. First, we'll tackle the receive end of things.

FM Detectors

Demodulators used in receivers for FM detection exhibit an "S Shaped" response curve. Figure 1 shows the response of a typical FM demodulator. The demodulator's linear curve extends for several kilohertz above and below the center of the receiver's final IF frequency. As can be seen in the figure, an unmodulated carrier applied to an FM demodulator at its center frequency will produce an output voltage of exactly zero volts, while a carrier either above or below the center frequency will produce either a positive or negative output voltage. Modulation applied to the frequency of the carrier produces an AC output voltage from the demodulator.

Provided the modulation waveform is symmetrical and the carrier frequency is properly centered, the AC output voltage from the discriminator is centered about the zero volt level. If the received carrier is tuned to one side of the response curve rather than the center, the audio output from the detector will not be centered about the zero level, but instead be centered about a small positive or negative voltage. This voltage is known as an offset voltage, and in some receivers is used for automatic frequency control (AFC) purposes or to drive a zero-center tuning meter.



Response characteristics of a linear FM demodulator are plotted as a function of frequency. Quadrature detectors have similar characteristics except the center of their response is elevated to such that their output voltage is always positive.

DC Offsets and Level Correction

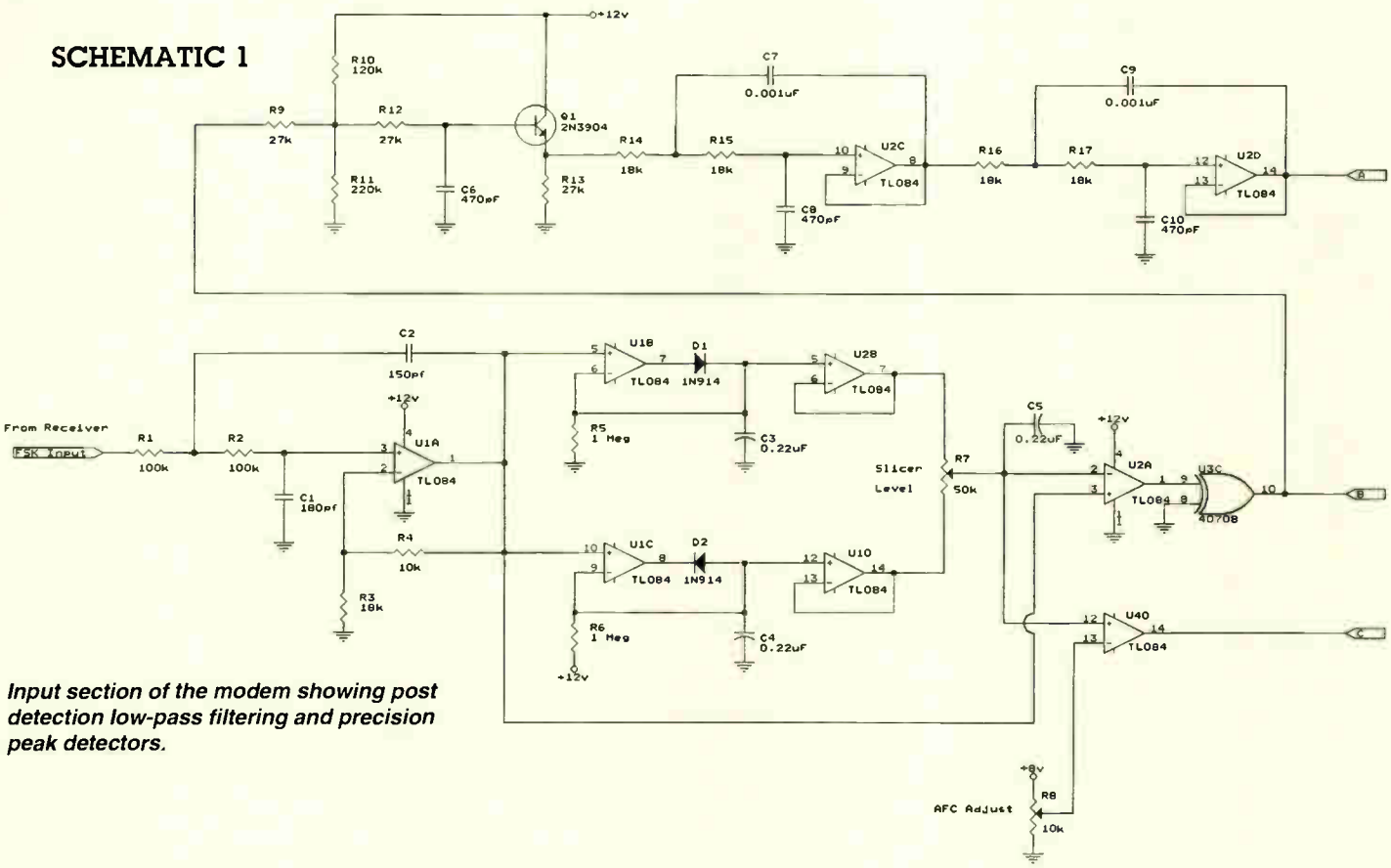
Modern FM communications receivers typically use a quadrature detector chip for FM signal demodulation. Quadrature detectors posses the same "S Shaped" response curve as do classic discriminators, but because they are designed using active components powered by a single-ended power supply, quadrature detector output voltages are typically centered about a voltage level that is several volts above ground. A positive DC offset voltage is always present, even with properly tuned signals, and this voltage and varies linearly with receiver tuning.

Even some older transceivers such as the Yaesu FT-726R that use a ceramic discriminator for FM detection elevate the reference of the discriminator several volts above ground so that the output voltage is always positive. With this in mind, we are pretty well guaranteed that the detector output of an FM receiver tuned to an FSK data transmission will consist of an FSK waveform riding on top of a positive DC offset voltage (FSK+DC).

Since the position of the FSK carrier within the passband of the FM detector will vary the offset voltage, the offset will continuously vary over time when receiving transmissions from communication satellites due to the effects of doppler shift. Therefore, if a frequency response down to DC is required and direct coupling is used between the FM receiver detector and the data demodulator portion of an FSK modem, adequate measures must be taken to properly handle the DC offset voltage present on the output of the detector so that it does not interfere with post detection signal processing of the received FSK data.

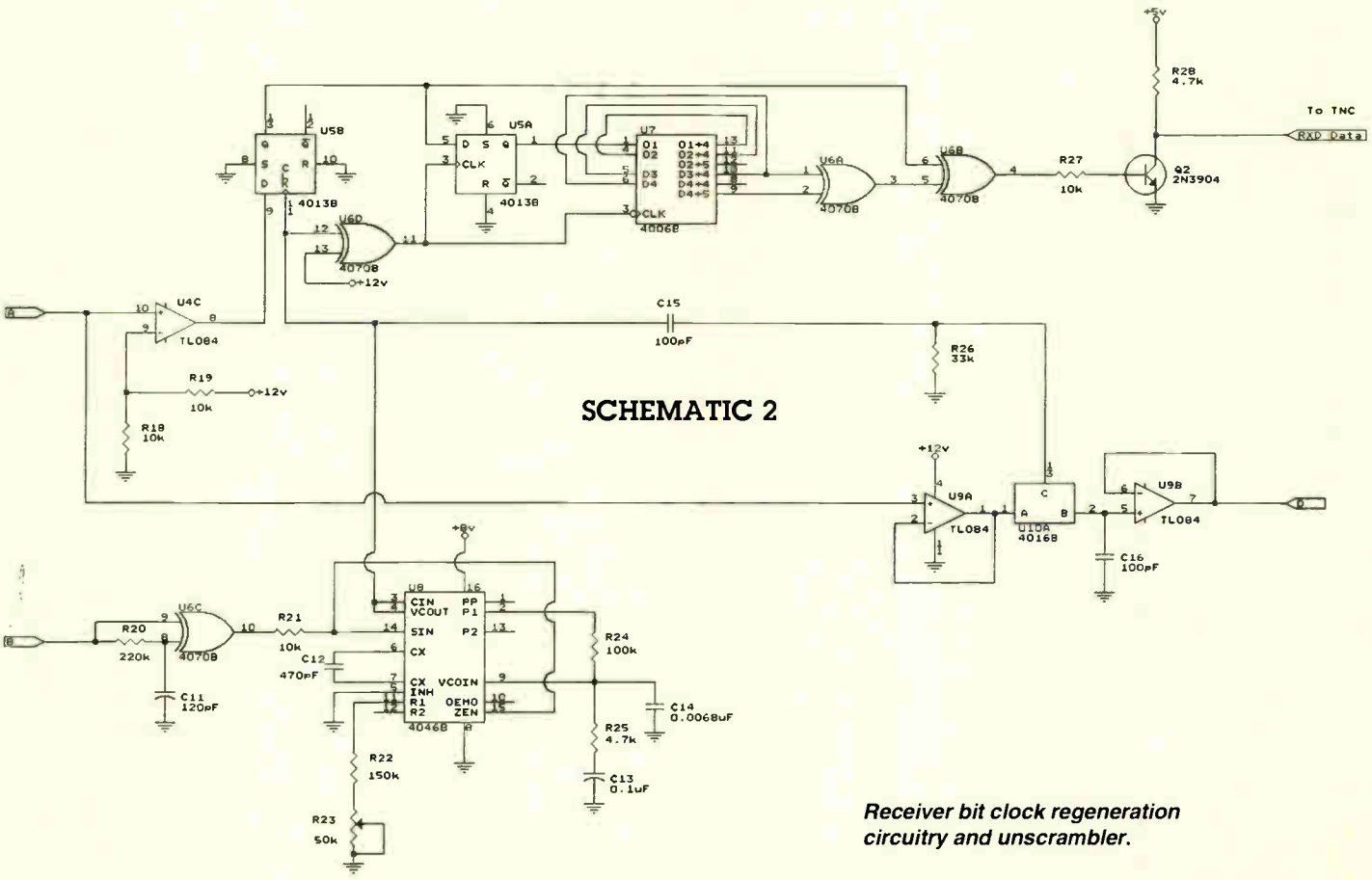
Figure 2 is a schematic showing the circuitry used to initially process FSK signals received by a narrowband FM receiver. Received signals consisting of a demodulated FSK signal plus a DC offset voltage (FSK+DC) are first processed through a second-order low-pass filter designed around operational amplifier U1A. The purpose of the filter is to attenuate any intermediate frequency (IF) noise that may be present on the output of the

SCHEMATIC 1



Input section of the modem showing post detection low-pass filtering and precision peak detectors.

SCHEMATIC 2



Receiver bit clock regeneration circuitry and unscrambler.

receiver's FM detector. A small voltage gain is also provided by this filter, and a positive DC offset voltage from the host FM receiver is required for its proper operation.

The output of the low-pass filter is then applied to two precision peak detectors and a data slicer. The purpose of this circuitry is to convert the sinusoidal FSK waveform delivered by the receiver to a binary waveform compatible with digital logic circuitry without being affected by the DC offset voltage riding along with the FSK waveform.

A positive peak detector is formed around U1B, D1, and U2B, while a negative peak detector is formed around U1C, D2, and U1D. In operation, the positive peak detector provides an output voltage equal to the maximum voltage excursion of the filtered FSK voltage waveform, while the negative peak detector provides an output voltage equal to the minimum voltage excursion.

Potentiometer R7 allows the average of the two peak voltages ((positive peak + negative peak) / 2), which is a voltage level equal to the exact center of the filtered FSK voltage waveform, to be accurately set and used as a threshold voltage for the data slicer. The beauty of this arrangement is that if the FSK's DC offset voltage should rise or fall due to receiver mistuning or the effects of doppler shift, the average voltage produced by the peak averaging circuit will rise or fall accordingly and always remain exactly at a level equal to the precise midpoint of the filtered FSK voltage waveform and insure proper operation of the data slicer. Essentially, what this circuitry does is subtract the DC offset voltage from the incoming signal (FSK+DC), and yield a clean FSK signal that can then be further processed by the modem.

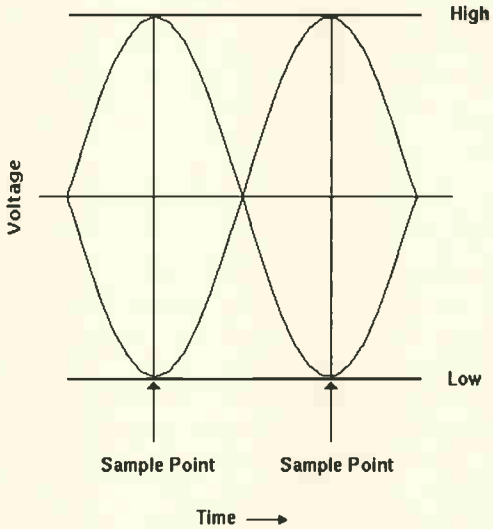
The data slicer is simply a voltage comparator designed around operational amplifier U2A that provides a binary output voltage that is a function of the peak FSK input voltage. The comparator's output voltage goes high if the received FSK peak positive voltage is above the threshold voltage, or goes low if the received FSK peak negative is below the threshold voltage.

The output of the data slicer is then fed through exclusive-OR (XOR) gate U3C which acts as a buffer to produce a high amplitude 12-volt peak-to-peak voltage waveform with sharp rise times and fall times. The waveform at this point is essentially a level-converted binary representation of the received FSK transmission, and could be applied directly to a packet radio terminal node controller for decoding if it were not for the fact that the 9600 baud data received was randomized prior to transmission and must first be unscrambled before processing can take place by the host TNC.

Bit Clock Detection and Regeneration

Linear feedback shift register (LFSR) unscrambling circuitry must be driven by clock pulses that match the frequency and phase of the clock in the transmitting TNC. Since a 9600 baud clock signal is not directly available from the FSK transmitter, it must be regenerated locally from the received FSK data itself using additional circuitry in the modem.

FIGURE 2



A plot of several filtered bits over time yields an "eye diagram" pattern. Sampling the "eye" at its center provides proper signal detection with the highest signal-to-noise ratio possible.

In order to accomplish this, level converted FSK data available from U3C is applied to an edge detector consisting of an exclusive-OR gate (U6C) and an RC timing network. The edge detector produces an output pulse for every FSK logic level transition received. This waveform is known as a protoclock, and is in phase with the transmitting station's bit clock. It is, however, non-continuous, and so is used to drive a phase locked loop (PLL) to produce a continuous clock signal. The phase locked loop is designed around a micropower 4046B CMOS PLL (U8), and operates at 9600 Hz. The regenerated clock, which is available on pin 4 of U8, is used to drive the LFSR unscrambler as well as a sample and hold circuit that is part of a unique FSK data carrier detection (DCD) circuit.

The center frequency of the phase locked loop's VCO is set to 9600 Hz by R23. Resistors R24, R25, and capacitors C13 and C14 form a loop filter that allows the phase lock loop to acquire and maintain lock with the received FSK signal despite small amounts of noise that may be present with the incoming signal.

Low-Pass Filtering

The level converted FSK data available from U3C is further processed through a fifth-order low-pass filter to match the modem's detector bandwidth to that of the transmitted signal. The filter also delays the FSK waveform in time so that by the time the signal reaches the output of the filter, the bit centers of the filtered FSK waveform are synchronous with the rising edges of the regenerated clock pulses and can be sampled at the optimum moment by D-Latch U5B prior to final processing by the unscrambler. The filter is designed around transistor Q1, operational amplifiers U2C and U2D, and their associated RC passive components.

The output of the filter is available on pin 14 of U2D, and if the waveform present at this point were viewed on an oscilloscope whose horizontal sweep were triggered on the regenerated FSK clock waveform, an "eye diagram" would be observed. The "eye," or filtered bit center, is widest at the modem's sampling point (see Figure 2). The filtered waveform is converted back to a digital logic compatible square waveshape through comparator U4C, and applied to an unscrambler consisting of a 4013B D-Latch (U5), a 4006B shift register, and three exclusive-OR gates. The output of the unscrambler is converted to 0 to 5 volt TTL-levels by Q2, and is made available for final processing by the host TNC.

Data Carrier Detection

Filtered FSK data is also processed through a sample-and-hold circuit consisting of operational amplifiers U9A, U9B, and a 4016B CMOS bilateral switch

(U10A). The switch is triggered for a very brief instant at the center of the filtered FSK waveform by a differentiation network consisting of capacitor C15 and R26. 9600 samples of the voltages taken at the filteredwaveform bit centers are taken and stored in capacitor C16 every second. The voltage present across C16 is buffered through voltage follower U9B.

The output of the sample-and-hold circuit feeds an LM3914 LED dot/bar display driver, which forms the basis of the modem's data carrier detection circuitry. The LM3914 has 10 outputs, each of which represent a discrete voltage level of the sampled FSK sampled bit center. The presence and quality of an FSK signal can be determined by examining the filtered bit center. A bit center that is wide and noise-free is an indication of reception of a valid, high quality FSK signal. Noise and other distortion narrows the gap within the opening of the bit center. A signal that is pure noise will display no opening at all.

The LM3914's four center outputs represent voltages corresponding to the central region of the filtered FSK bit centers. These outputs are logically "ORed" together and converted to a ground-referenced voltage through transistor Q3. The upper three and lower three outputs of the LM3914 are also combined together through transistor Q4 to produce a reference voltage against which the center outputs can be compared. The upper and lower outputs remain fairly constant regardless of whether noise or a clean FSK signal are being received. The difference between the two transistor output voltages is an indication of the signal-to-noise ratio of the received FSK signal. This voltage ratio is used to drive signal quality meter, M1, as well as a voltage comparator designed around operational amplifier U9C.

The voltage comparator generates an FSK Data Carrier Detect (DCD) output signal for use by the host TNC. Hysteresis and some low-pass filtering is used around the comparator to bolster its immunity against noise or false signals. The DCD output voltage logic is active low to match the requirements of most terminal node controllers. A DCD connection to the TNC is required for half-duplex communications, and not full-duplex satellite communications. LED D4 provides the user with a visual indication of FSK data carrier detection.

Automatic Frequency Control

The slicer threshold voltage available at the center of potentiometer R7 is applied to a second voltage comparator designed around operational amplifier U4D. This comparator compares the FSK DC offset voltage with that of a regulated reference voltage adjustable through potentiometer R8. Since the offset voltage present at R7 drifts slowly with time due to doppler shift, the comparator output can be used to tune the downlink receiver lower in frequency to compensate for the effects of doppler shift.

The AFC system used in the KD2BD 9600 Baud Modem is designed to connect to transceivers that allow UP/DOWN tuning through the front panel microphone connector. The modem sends a series of pulses generated by operational amplifier U9D to the groundstation receiver to tune it lower in frequency during a satellite pass in compensation for doppler shift. Since the direction the FSK DC offset voltage changes with receiver tuning may differ between receivers of different makes and models, an AFC polarity inverter circuit consisting of CMOS switches U10B, U10C, and U10D is installed between the output of U4D and the gated pulse generator, U9D. The inverter may be bypassed through switch SW1.

A selection of positive or negative tuning polarities is provided by the modem as well. Yaesu transceivers require a 5 volt pulse on the frequency control line to tune the receiver from the microphone connector, while others require a switch to ground. Potentiometer R8 is adjusted so that the AFC circuit properly adjusts the downlink receiver when it is incorrectly tuned, and becomes inactive after proper compensation is applied by the modem and the receiver is properly tuned. Since doppler shift causes the signal received from an earth orbiting satellite to drift lower in frequency and never higher, the automatic frequency control system used in the KD2BD 9600 Baud Modem tunes the downlink receiver in one direction only.

LED D3 provides a visual indication of when the automatic frequency control circuitry in the modem is active. The LED flashes as frequency corrections are made to the downlink receiver during a satellite pass.

FSK Generation

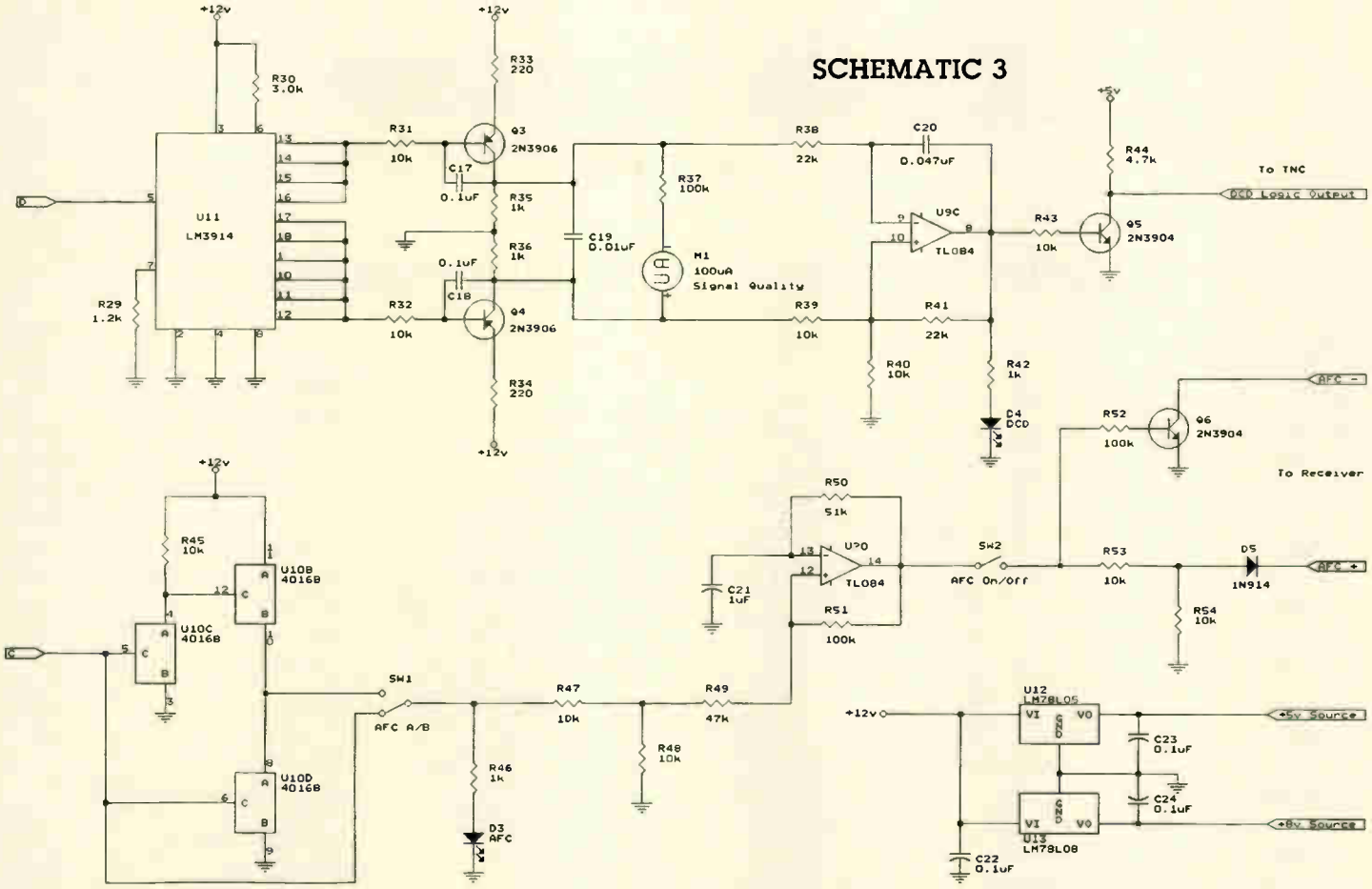
As stated earlier, 9600 baud FSK data is randomized or "scrambled" prior to transmission. As in the case of the LFSR unscrambler used in the receive section of this modem, a clock at 9600 Hz is required for proper operation of the LFSR scrambler circuitry. However, the TX Clock available from many TNC modem disconnect headers is at 16 times the transmitted data rate (153,600 Hz). The x16 clock frequency must therefore be divided by 16 to yield a proper signal for operating the scrambler.

U14, a CMOS 4040B binary counter, is used to divide the x16 TX Clock down to 9,600 Hz. The counter is synchronized to the TX Data waveform through a differentiation network consisting of capacitor C26 and resistor R59. The TTL digital logic levels from the TNC are also converted to the 0 to +12 volt CMOS logic levels required by the modem through transistor Q7, DC blocking capacitor C25, and resistors R57 and R58.

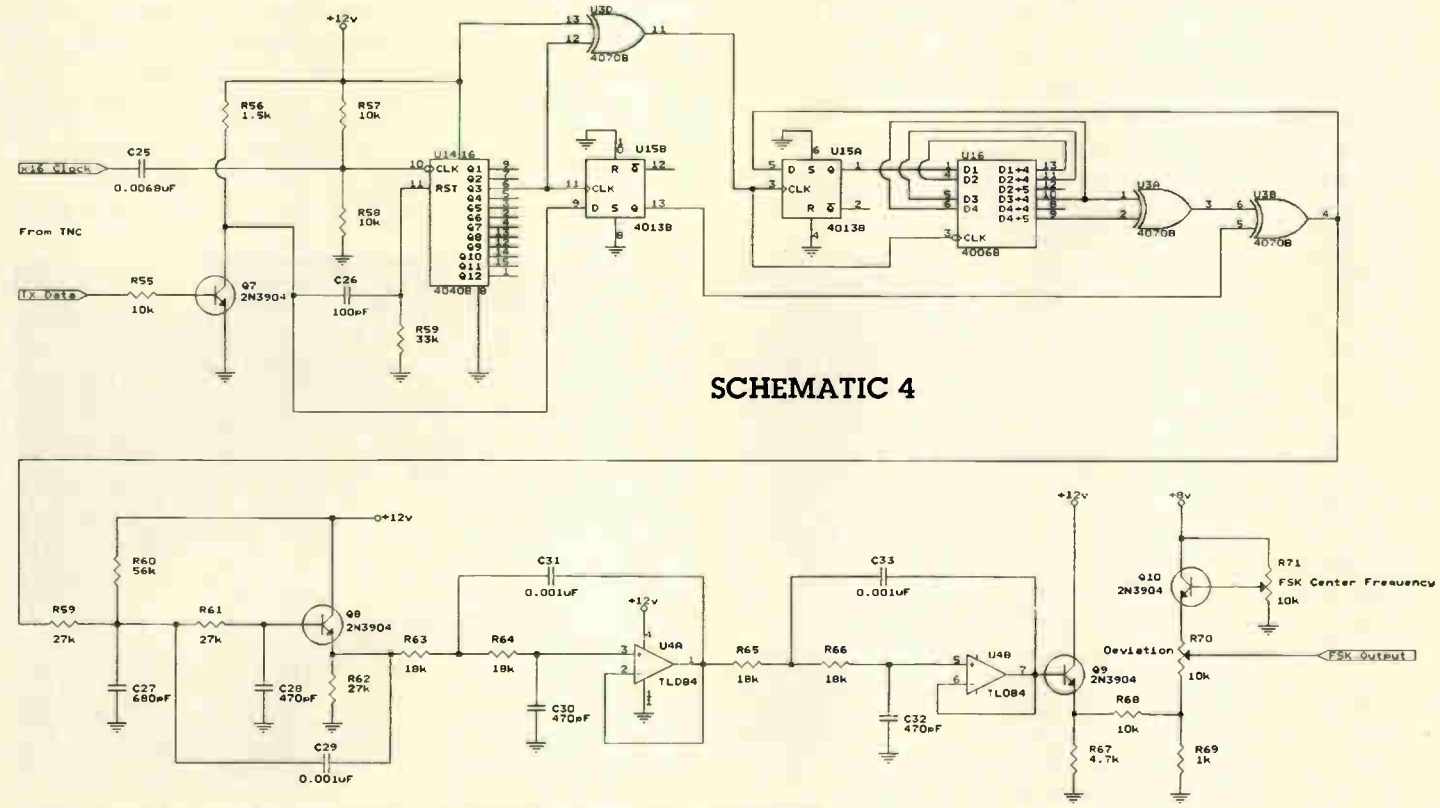
The LFSR scrambler is similar in design and construction to the unscrambler used in the receive section of this modem. Scrambled transmit data is available on pin 4 of U3B, and is processed through a six pole low-pass filter designed around transistor Q8, operational amplifiers U4A, U4B, and their associated passive RC components. The output of the filter available on U4B pin 7 is a pure raised-cosine voltage waveform. The waveform is then attenuated and level converted to match and amplitude and DC bias level required by the varactor diode in the transmitter's FM modulator to produce a peak carrier deviation of 3.5 kHz.

Since a direct connection is used between the modem the transmitter's varactor diode, the modem output voltage levels control both the FSK modulation level as well as the FSK transmitter's center frequency. Potentiometer R71 adjusts the DC bias voltage level added to the modem's FSK output waveform and sets the transmitter's center frequency. R70 sets both the center frequency and the peak FM deviation level of the FSK transmitter. These adjustments are not mutually exclusive, so some skill and patience are required to set each one properly.

To Be Continued: In Part 3, topics such as testing and alignment of the KD2BD 9600 Baud Modem will be covered, and interfacing issues will be discussed in further detail.



FSK data carrier detection (DCD) and digital automatic frequency control (AFC) circuitry.



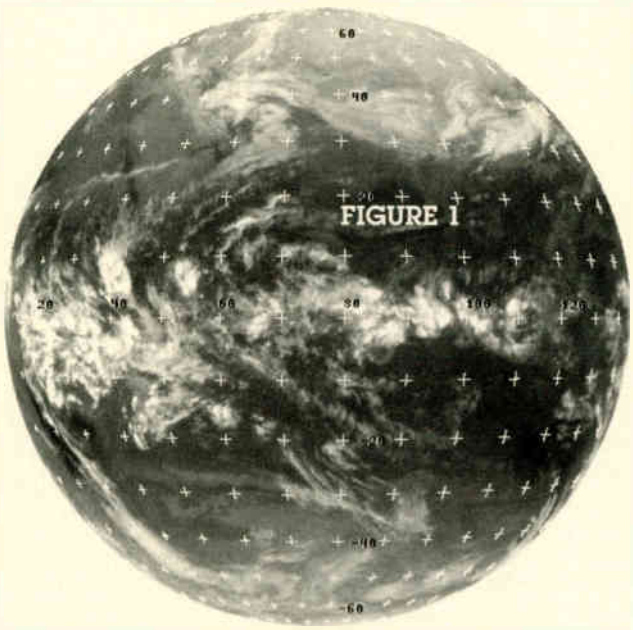
FSK generation circuitry consisting of an LFSR scrambler and low-pass filter.

By Lawrence Harris
lawrenceh@ndirect.co.uk

Even England Gets Hurricanes

Plymouth, on the southwest coast of Britian, gets its weather straight off the Atlantic. Up until ten years ago we had never experienced a hurricane. They were novelties to be watched across the big pond on weather satellite images. The European meteorological satellite Meteosat disseminates a few GOES-E images every three hours, and this gives us our "fix" of American images.

One evening in 1987 a well-known UK weather forecaster (they are all employees of the Meteorological Office) told his audience that (despite a nearby storm) there was no chance of a hurricane hitting Britain. A few hours later he regretted those words when Plymouth got its first recorded hurricane, and the roof of my house became a statistic among the many that vanished that day.



GOMS infrared image on January 13 at 1459 UTC (retransmitted from Meteosat-6)

Wind speeds of 120 mph were recorded. Businesses closed for the day when it became obvious that there was an emergency. I made no attempt to bicycle home. The roar of the wind was frightening and my concern was to ensure the safety of my family–so I battled against the storm to stagger the two miles home. All around me, tiles were coming straight off roofs, and from a great height–a lethal bombardment. I struggled against the wind, then found myself stranded along a road where a building met a wall and an eddy current had been generated. I was pulled, rotated, and pushed; it took me several minutes to cross a region of about two meters.

When I eventually got back home, apart from a missing section of the roof, the main damage was to my Meteosat dish which had blown over, but had at least not flown away! It still bares the scars. The house, however, had to be re-roofed.

I have larger dishes now, and my monitoring of the weather is far more comprehensive. I was therefore somewhat alarmed when, once more, there was a forecast of high winds for Plymouth. The forecast stated they would likely reach to 100 mph. This time I brought my vulnerable dish indoors and no significant damage was done. I now have a first-hand appreciation of the meaning of the term "hurricane season!"

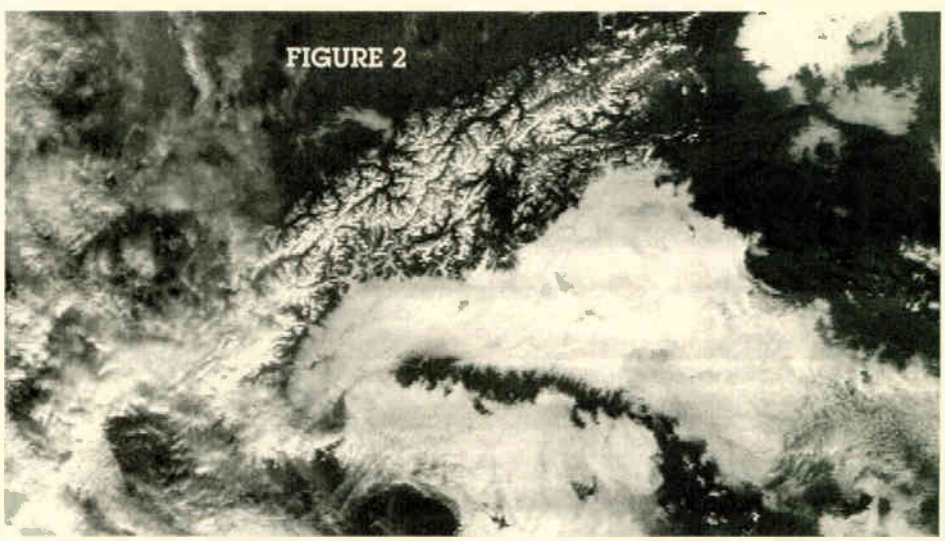
Current Weather Satellites

Apart from a few apparent problems with GOMS during the Christmas and New Year period (I noticed several images were missed from the schedule), the geostationary weather satellite constellation has been operating normally (see Fig. 1 left). And some good news from the NASA staff is that regular images from Fengyun-2B should soon be available (see next page).

METEOR and NOAA Visible Images Compared

Unlike the U.S. NOAA weather satellites, which transmit two side-by-side images continuously, the Russian Meteors normally transmit just one image, with a consequent increase in spacial resolution. Figure 2 shows the Swiss Alps at full APT resolution, and is taken from a section of the image which I received during a UK pass at 1102 UTC on January 12.

Take a look at figures 3 and 4. One is

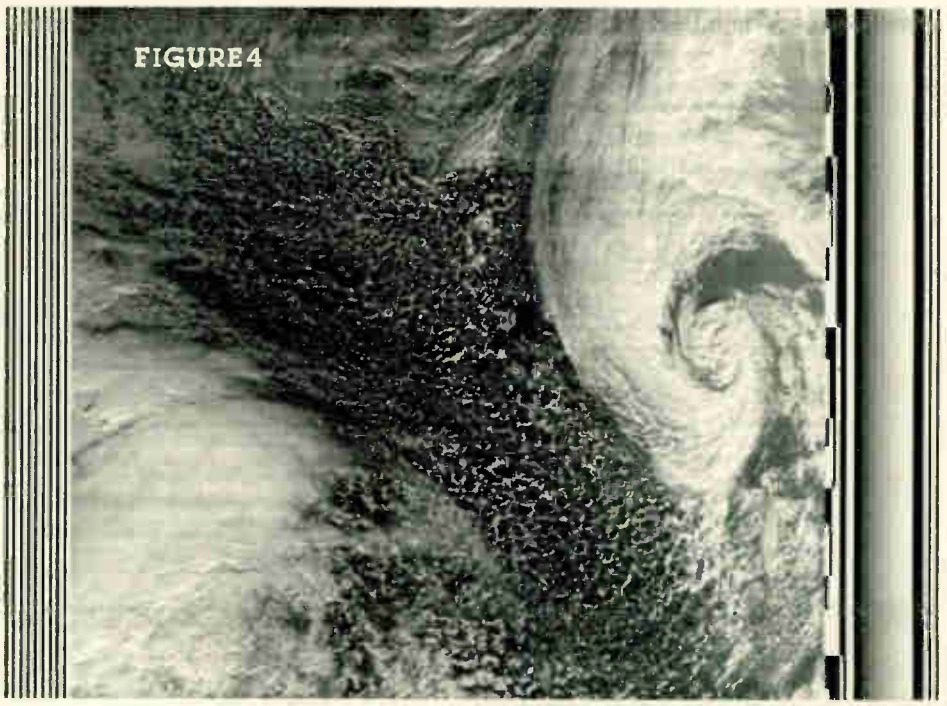


Meteor 3-5 close-up at 1102 UTC on January 12

Unlike the U.S. NOAA weather satellites, which transmit two side-by-side images continuously, the Russian Meteors normally transmit just one image, with a consequent increase in spacial resolution.

Figures 3 and 4 were received 20 minutes apart on January 13. The solar illumination of these images was similar yet the difference between the visible image from NOAA-14 (the right-hand section of Fig. 3) and that from Meteor 3-5 (Fig. 4) is considerable.

from Meteor 3-5 and the other from NOAA-14. These were received 20 minutes apart on January 13. The solar illumination of these images was similar yet the difference between the visible image from NOAA-14 (the right-hand section) and that from Meteor 3-5 is considerable. A vigorous depression can be seen in both images, confirming the time. Sensors for the visible-light (channel 2) cover the region 0.725 to 1.0 micrometers; Meteor sensors cover a slightly different region–0.5 to 0.8 micrometers. This is part of the reason why images of the same area scanned by Meteor and NOAA weather satellites show differing levels of land and cloud detail.



FengYun-2

The Chinese geostationary weather satellite Fengyun-2 is providing much needed coverage of the central Asian region and is doing so on an hourly basis. NASA has obtained permission to receive and share its data. The downlink is being received by NASA in Adelaide, Australia, at the University of Southern Australia. Some full-resolution data, as well as calculated real-time products and localized sectors, are transmitted over the internet through Hawaii to NASA's Ames Research Center and Goddard Space Flight Center. There, the data will join similar data already being provided for GOES-8/9 and GMS-5. A short-term archive of infrared images will be available online for perhaps a week. Long-term archiving of FengYug 2 images will only be available from volunteers willing to download the images using anonymous FTP from the NASA sites. My thanks to Dennis Chesters for providing this information.

In China, reception of Fengyun-2 telemetry is performed by the command and data acquisition (CDA) station in Beijing.

FIGURE 5

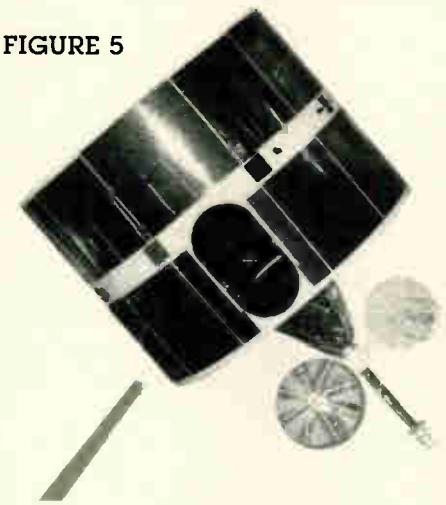


FIGURE 6

Fig. 5 shows the FY-2 geostationary weather satellite. Fig 6 is the FY-2 receiving station.

From any location on Earth most of us can usually receive telemetry/imagery from more than one geostationary weather satellite. In the UK, it is possible to receive Meteosat-6 and GOES-8. In North America GOES-8 and 9 (and occasionally 10) can be received. In Australia, GMS-5 and Fengyun-2 are routinely monitored.

This station's main tasks are:

- Receiving the raw (high resolution) data (at 14-mbps) using an antenna 20 meters in diameter.
- Creating and broadcasting the stretched digital image with a data speed of 0.6-mbps.
- Relaying the low resolution cloud image and synoptic map.
- Receiving and processing telemetry and space environmental monitoring data.
- Receiving data from data collection platforms (DCP).
- Exchanging data with data processing center and satellite operational control center.
- Making up a turn-around ranging (TAR) system for the satellite locating together with three other stations (Urumqi, Guangzhou and Melbourne in Australian).

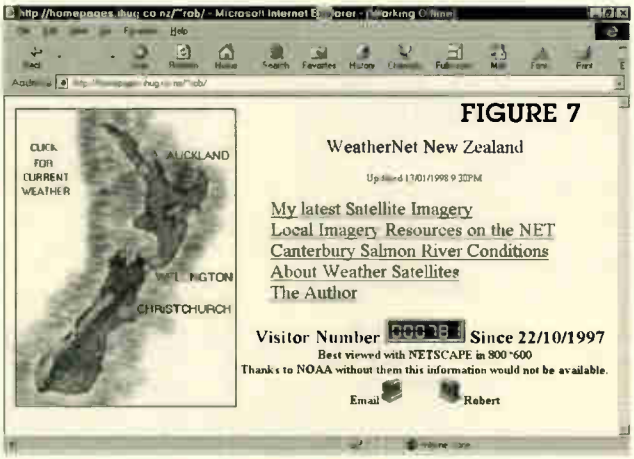
This information was provided by the U.S. Geological Survey (USGS) which hosts a web page as a courtesy to the Peoples' Republic of China's National Satellite Meteorological Center, both organizations being members of the international Committee on Earth Observation satellites.

For more information on the Chinese weather satellite program visit the USGS site at:
http://edcwww.cr.usgs.gov/china/china.htm

Meanwhile, I have received an email from Patrick L. Coronado of NASA's Goddard Space Flight Center, which indicates that his group will shortly be setting up an FTP site on the internet were Fengyun-2 images will soon be available. Details will be given in a future *View from Above* column.

Update on Internet Weather Satellite Sites

From any location on Earth most of us can usually receive telemetry/imagery from more than one geostationary weather satellite. In the UK, it is possible to receive Meteosat-6 and GOES-8. In North America GOES-8 and 9 (and occasionally 10) can be received. In Australia, GMS-5 and Fengyun-2 are routinely monitored.



Robert Read's homepage.

As mentioned above, images from all the geostationary weather satellites are gradually becoming available via the Internet. Additionally, some personal internet web sites have been set up by amateurs who are making available NOAA images of areas not otherwise seen by those of us living half-way around the globe from them.

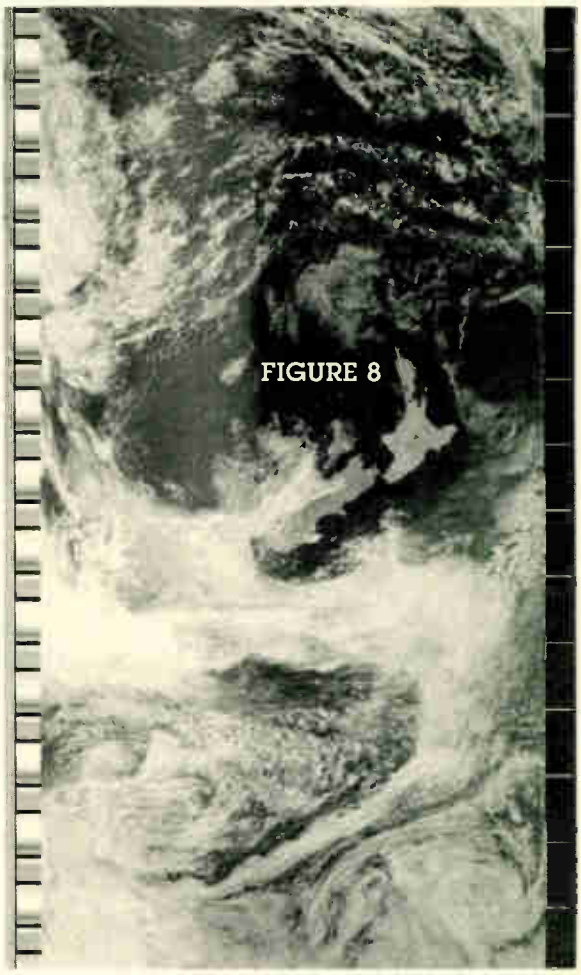
Robert Read is an enthusiast who lives in Christchurch, New Zealand, and works in the computer operations department of a large grocery wholesaler. He works with IBM AS/400 midrange computer systems, and has set up a web page on the Internet with the latest images received from NOAA-14 at his station.

Robert uses NOAA-14 because it provides better daytime images from its visible-light sensor. NOAA-12 passes over New Zealand occur near local twilight, and therefore provide visible-light images of limited clarity. You will find more at Robert's homepage by pointing your web browser to URL: **http://homepages.ihug.co.nz/~rob/**

Robert's web site carries a variety of links to basic information on all types of weather satellites, some local net resources on the geostationary weather satellites, and the latest NOAA-14 daytime images received at his station. Robert adds color to each of the displayed images–a fact which is appreciated by newcomers to the weather satellite monitoring.

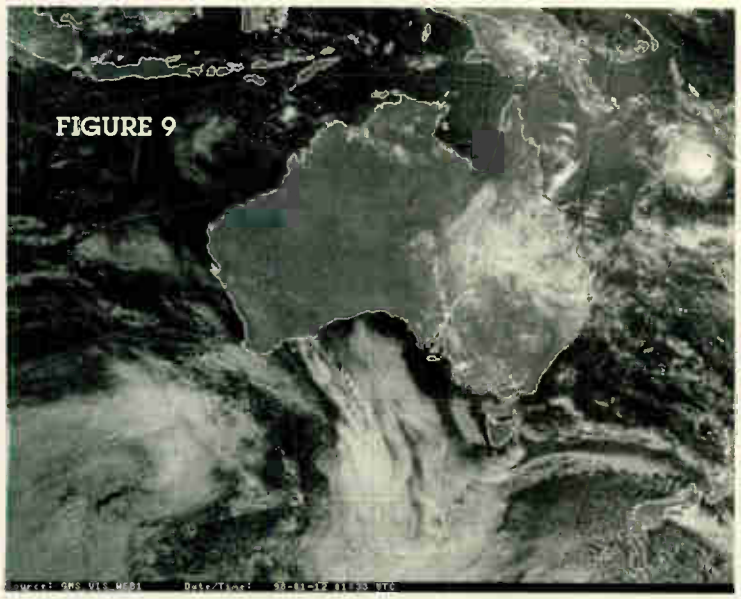
None of the orbiting weather satellites transmit any color information/imagery, so any such enhancement you see on a picture is a matter of local image processing by ground stations. Robert adds the description "false color," time of the pass, and its maximum elevation to each of his images.

Higher resolution images are available by clicking on an image. To receive these images Robert has modified his Uniden Bearcat 142XLT scanner from Software Systems Consulting



NOAA-14 the western pass on January 14 from Christchurch, New Zealand.

Those who monitor satellite downlinks might not be aware of frequency spectrum allocations conferences which take place regularly at the International Telecommunications Union (ITU) in Geneva, Switzerland.



Australia (visible light image) on January 12 at 0133 UTC (Courtesy of BOM and JMA)

(in the United States) feeding the 137 MHz APT signals to his PC soundcard. The freeware computer program *WXSAT*, written by Christian H. Bock, is used to decode the image data from the APT analog signal.

Robert and Donna (his wife) use a homemade, half-turn, quadrifilar helix antenna, and a preamp is connected directly to the antenna to overcome cable losses down to the receiver. Roberts receiving system (excluding the cost of the computer) runs around NZ$400. He enjoys watching the various weather patterns develop and pass. The Read's also use their system to see in detail how the countryside changes with the seasons–snow showing up especially well on the Alps in winter on a good visible pass in the afternoon from NOAA-14.

Finally, Robert has provided links to sites carrying Kepler elements, image decoding software and a satellite tracking program.

Australian Bureau of Meteorology

The web site of the Australian Bureau of Meteorology has an archive of images received directly from the Japanese Geostationary Meteorological Satellite (GMS-5), which is located at longitude 140 degrees east. The URL of the site is: **http://www.bom.gov.au/weather/national/satellite/**

This Australian archive holds both infrared and visible light images from GMS-5 and, on the day that I studied the site, had the last seven days worth of both sets of images. These images are made available with the permission of the Japan Meteorological Agency (JMA). The Bureau of Meteorology of the Commonwealth of Australia receives and processes the GMS-5 images, and the site also carries a number of service and educational links, including sections on meteorology and information on the Antarctic weather.

International Telecommunication Union

Those who monitor satellite downlinks might not be aware of frequency spectrum allocations conferences which take place regularly at the International Telecommunications Union (ITU) in Geneva, Switzerland. A visit to their web page at **http://www.itu.ch/index.html** will give the hobbyst an opportunity to read about the latest news on meetings, conferences and decisions. The ITU is an international organization in which governments and the private sector coordinate global telecom networks and services.

Current Weather Satellite Frequencies

NOAA-12 transmits APT on 137.500 MHz
NOAA-14 transmits APT on 137.620 MHz
Both NOAA spacecraft transmit beacon data on 137.770 or 136.770 MHz
METEOR 3-5 transmits APT on 137.850 MHz
OKEAN-4 and SICH-1 (rarely operating) use 137.400 MHz
GOES-8 and GOES-9 use 1691.0 MHz for WEFAX transmissions
Mir voice communications can be heard on 143.625 MHz ST

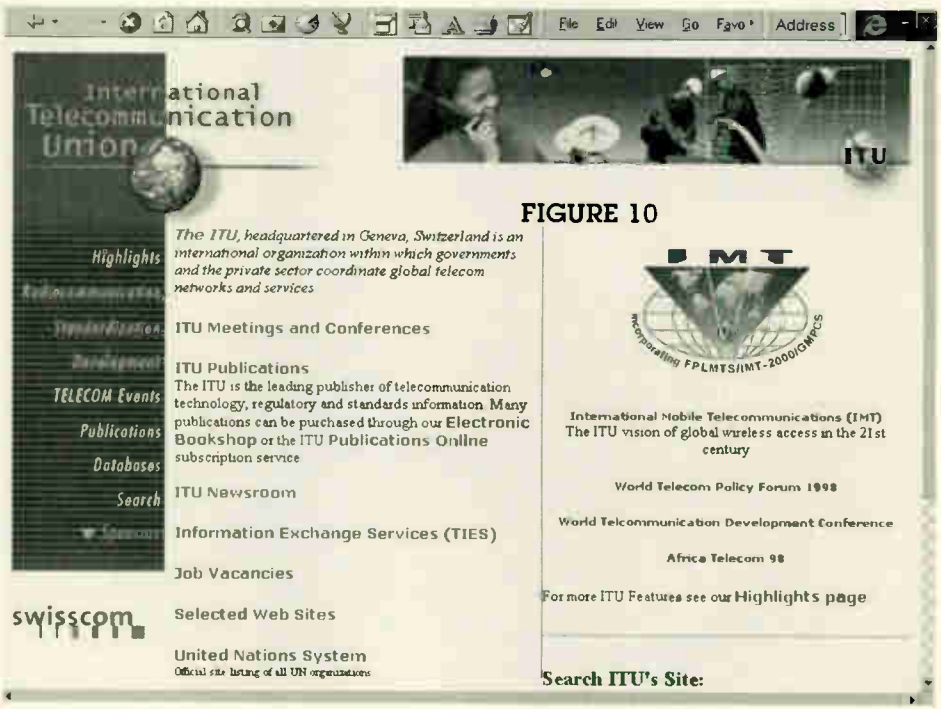


FIGURE 10

ITU homepage.

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

Antarctic Expeditions Followed Via OSCARs

Late last year, Ronald Ross, KE6JAB, traveled to Antarctica with a portable PACSAT station, and used his radio equipment to share his experiences with friends via the UoSAT OSCAR 22 amateur radio communication satellite.

Ron and his wife Sheryl departed from San Francisco, California, and arrived in Punta Arenas, Chile, on December 21, 1997. From Punta Arenas, they traveled to Patriot Hills, Antarctica, on Christmas Day 1997 on a Hercules transport plane operated by South African Airways.

Ron, KE6JAB, poses alongside one of the eggbeater antennas he used at the south pole to communicate with friends via the UoSAT OSCAR 22 PACSAT satellite. (Photo via www.thistle.org)

KE6JAB at the south pole. This image was relayed from his base in Antarctica via the UoSAT OSCAR 22 communications satellite. (Photo via www.thistle.org)

Ron's portable PACSAT station station consisted of an Icom IC-821 transceiver, a 70-cm low-noise receive preamplifier, a pair of eggbeater antennas mounted on seven foot bamboo poles 20 feet apart on either side of Ron's tent, a KPC9612 packet radio terminal node controller, a laptop computer, and a 12 volt, 18 amp/hr storage battery that was recharged using a solar panel borrowed from a Cessna pilot.

During his stay in Antarctica, Ron was able to relay not only text messages to friends via UoSAT OSCAR 22, but color images (JPEGs) well. A total of 70 messages were uploaded to the satellite, 16 of which were JPEG images.

Since UoSAT OSCAR 22 is in a high inclination polar orbit, and Ron was situated very close to the South Pole (80S, 81W), he was in an ideal location to enjoy satellite access every 100 minutes, 24 hours a day. Ron also tried accessing other PACSAT satellites, but had his best luck with UO-22.

Ron reported that his portable PACSAT station generated a lot of interest among other people at the basecamp. Many were amazed by the ability of an amateur network to provide such communications on a voluntary basis, especially considering the official communications at the camp were hampered due to problems experienced with Inmarsat.

Ron and Sheryl departed from Antarctica and arrived back in Chile on January 12, 1998, after a very successful expedition. OSCAR satellites clearly proved their value in keeping Ron in touch with the rest of the world using a minimum of radio equipment.

Several days prior to Ron and Sheryl's departure from Antarctica, Andre Phillips (ex VP8MAP) arrived at the South Pole and was waiting for his portable PACSAT communications equipment to arrive at press time. Like Ron, Andre expects to share his experience with others through the UoSAT OSCAR 22 and KITSAT OSCAR 25 PACSAT communication satellites.

During his stay in Antarctica, Ron was able to relay not only text messages to friends via UoSAT OSCAR 22, but color images (JPEGs) well. A total of 70 messages were uploaded to the satellite, 16 of which were JPEG images.

TABLE 1

A message sent to Roy Welch, W0SL, from Ron Ross, KE6JAB, via the UoSAT OSCAR 22 satellite during his trek to the South Pole late last year:

To : W0SL
From: KE6JAB
Time: 062159UTC
Date: 30 Dec 1997

Saturday, 12/27/97, Patriot Hills.

All the satellite passes good for me start after 1:30am now and continue till 9.30am. Therefore, I'm going without much sleep for now. But the bonus today, was 4 messages back from Roy and Jerry confirming the reception of my outgoing messages. We also had hoped to go to the South Pole today, but slightly bad weather had been forecasted at the refueling depot. The rule of thumb regarding weather down here is to err on the very cautious side.

On the flight down we traveled with a Polishman, Marek Kaminski, he had man-hauled from the coast to the Pole on his own last year. This year he intended to man-haul to the Mt Vinson basecamp then climb Mt. Vinson. He had been practicing with a parasail for the last few days to use as an aid. We watched him take leave this morning on his trip, it was quite inspiring to watch him set off into the vast expanse, alone, with just his skis and sled. Later in the day, Steve the Canadian Pilot who would take us to the Pole gave a short talk on how to navigate in Antarctica, without all the trappings that pilots are used to in the US, air traffic control etc. In the evening we took a couple of skidoos and went 5 miles from the basecamp to where a crashed DC-6 was half buried in the snow. The plane had crashed in 1990 when the pilot had misjudged the ground height in a bad blizzard. Only the tail section and the top of the fuselage were visible, snowfall will eventually cover the entire craft. The trip to the DC-6 was a good reality check for us, as the wind was blowing fairly hard, my hands got really cold when using my camcorder. Luckily we were close to camp and could re-warm ourselves quickly. But it was windless at basecamp but blowing hard at the crash-site. The windchill factor took the temp down to -30F, at the crash-site, the cutting wind make such a difference, and the sun was shining in a clear blue sky!

Tomorrow we expect to leave for the South Pole Station, temps there are expected to be -25F, when no wind

New Student Satellite under Construction

A team of over 300 students at Arizona State University (ASU) have been working on a new amateur radio communication satellite called ASUSAT-1. Weighing in at only 10 pounds (4.5 kilograms), ASUSAT-1 is considered to be a "nanosatellite," capable of being launched from a Pegasus (high altitude aircraft) launch vehicle. ASUSAT-1 will operate with an uplink in the 2-meter band, a downlink in the 70-cm band, and will carry a transponder capable of 9600 band digital operation in addition to a "bent pipe" voice repeater similar to the AMRAD OSCAR 27 satellite. The satellite will also carry two Dycam digital cameras, a Trimble GPS receiver, and a collection of experimental earth, sun, temperature, and attitude determination sensors.

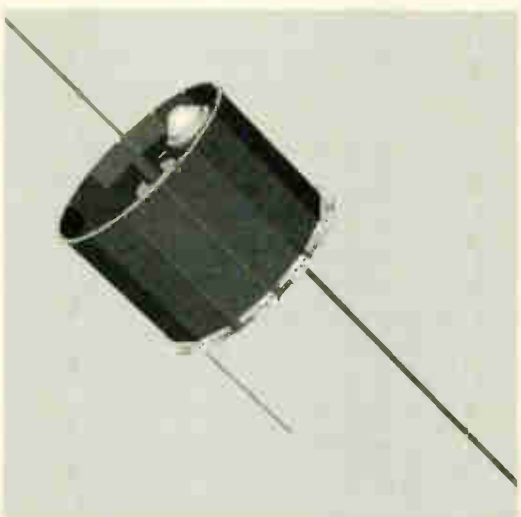


Image of the ASUSAT satellite currently under construction. Its ride into space is expected via a Taurus or Pegasus launch vehicle. (Photo via the ASUSAT Web Page)

ASUSAT-1 was conceptualized back in 1993 and was originally to be launched by an Orbital Science Corporation (OSC) Pegasus launcher in past years, but ASUSAT's 10 pound mass allocation was used up due to changes made to the launcher at previous launch opportunities. There is hope, however, that launch of ASUSAT-1 may occur sometime this year on an OSC Taurus or Pegasus launcher.

Two versions of the ASUSAT satellite have been built so far. The developmental model was used for developing procedures for manufacturing the flight satellite, and has gone through shock, vibration, and functional testing. The second (qualification) satellite was completed in June 1997. The conditions for testing the second satellite are dependent upon the launch environments and final orbital parameters, so testing will commence once the new launch vehicle is confirmed. The third and final flight structure will then be assembled in two months' time after qualification testing.

Mir Frequency Test Canceled

The latest *Mir* frequency experiment that was supposed to have started in December 1997 was canceled due to difficulties experienced with one of the amateur radio antennas mounted on the exterior of

TABLE 2

Listing of user commands for Mir's new Kantronics dual-port packet radio terminal node controller.

B(ye)	PBBS WILL DISCONNECT
J(heard)	CALLSIGNS WITH DAYSTAMP
J S(hort)	HEARD CALLSIGNS ONLY
J L(ong)	CALLSIGNS WITH DAYSTAMP AND VIAS
L [x [y]] [;]	LIST MESSAGES x THRU y YOU CAN READ
L <|> call	LIST MESSAGES FROM OR TO CALL
LB	LIST BULLETINS
LC [cat]	LIST CATEGORIES
LL n	LIST LAST n MESSAGES
LM(ine)	LIST UNREAD MESSAGES ADDRESSED TO YOU
LO [+|-]	LISTING ORDER
LT	LIST TRAFFIC
LTn	DISPLAY LOCATION TEXT n=1-4
K(ill) n	DELETE MESSAGE NUMBER n
KM(ine)	DELETE ALL READ MESSAGES ADDRESSED TO YOU
R(ead) n	DISPLAY MESSAGE NUMBER n
RH n	DISPLAY MESSAGE n WITH HEADERS
RM(ine)	READ ALL MESSAGES ADORESSED TO YOU
S(end) call	SEND MESSAGE TO callsign
S[B|P|T] call	SEND BULLETIN, PRIVATE, or TRAFFIC

After operating for 55 days under lithium battery power, the Sputnik-40/RS-17 satellite went silent around December 29, 1997. Sputnik-40/RS-17 was hand deployed by Russian cosmonauts from the space station

Above, Alfonso, IK4HLV, shows off his shack in an image he uploaded to the KITSAT OSCAR 25 satellite in celebration of the New Year.

the *Mir* space station. Computer problems and increased workload for the *Mir* cosmonauts delayed the reconfiguration of the new TNC placed on *Mir* late last year, and prevented astronaut David Wolf, KC5VPF, from getting much air time during his stay on the Russian space station.

Sputnik-40/RS-17 Mission Ends

After operating for 55 days under lithium battery power, the Sputnik-40/RS-17 satellite went silent around December 29, 1997. Sputnik-40/RS-17 was hand deployed by Russian cosmonauts from the space station *Mir* on November 4, 1997, and transmitted a low-power VHF-FM beacon signal on 145.820 MHz similar to the original Sputnik satellite. The satellite was built by Russian and French students, and was launched to help celebrate the 40th anniversary of the launch of the original Sputnik satellite and the dawn of the space age. Sputnik-40/RS-17 operated almost four weeks longer than designers had originally anticipated.

RS-12 In Mode KA

The RS-12 satellite was recently placed in Mode KA (2-meters plus 15-meters up, 10-meters down). As a result of this change, look for increased activity on RS-12, particularly among ground stations without VHF radio equipment.

Pat Gowen, G3IOR, reported that RS-12's ROBOT (autotransponder) 15-meter uplink suffers from an unexplained deep signal fade that has a period of about four seconds. This phenomenon is seen only when communicating through the ROBOT, and not when operating through the analog transponder.

AMSAT-OSCAR-10 Wobbling In Orbit

Observations made over the last several months suggest that the AMSAT-OSCAR-10 satellite is no longer stable in its Z-axis (the normal axis of spin), and is slowly tumbling or "wobbling" in orbit. The satellite is currently going through several deep periods of signal fading with a measured cycle of 15 to 20 minutes, and this condition will make it difficult, if not impossible, for spacecraft controllers to accurately predict AO-10's functional status over long periods of time. If the present trend continues, AMSAT-OSCAR-10 will simply continue to show periods of slow signal fading followed by periods of rather strong signals over a cycle of multiple minutes as a result of the Z-axis wobble.

TMSAT-1 Launch Delayed

The launch of the TMSAT-1 amateur radio communications satellite has been delayed. TMSAT-1 was originally expected to be launched before the end of 1997, but as often occurs in the amateur satellite program, the launch of the satellite has been pushed back until a suitable launch opportunity becomes available.

TMSAT-1 will feature a digital communications transponder utilizing a 9600-bps (bit per second) uplink and a 38.4-kbps (kilobit per second) high-speed downlink. The delay in its launch will allow experimenter's more time to develop and build receivers and data modems suitable for communicating with this new satellite once it makes it into orbit. The TMSAT-1 satellite will also include an advanced multispectral imaging system that should yield spectacular views of the earth. ST

Below, View of northern Italy as captured by the earth imaging camera carried onboard the KITSAT-OSCAR-25 satellite.

TABLE 3

UoSAT-OSCAR-11 operating schedule. Downlink transmissions are made on 145.825 MHz FM at 1200 bits per second using AFSK modulation. The schedule is under the control of the spacecraft's Forth Applied Diary (FAD), and the sequence repeats continuously. Additional status blocks are also transmitted after each news bulletin between the ASCII telemetry and whole orbit data transmissions.

ASCII OBC Status (210 seconds)
ASCII News Bulletin (60 seconds)
Binary Single Event Upset Data (SEU) (30 seconds)
ASCII Telemetry (90 seconds)
ASCII Whole Orbit Data (WOD) (120 seconds)
ASCII News Bulletin (60 seconds)
Binary Engineering Data (30 seconds)

By Keith Stein
kstein@erols.com

Monitoring a Pegasus Launch

I recently had a chance to observe, first hand, a Pegasus launch from Wallops Island, Virginia, and it was truly a monitor's dream. I had a chance to attend the December 23, 1997, launch of a Pegasus XL rocket carrying eight Orbcomm Little LEO satellites into orbit.

Info on the Pegasus

Pegasus launch vehicles are carried under the belly of a L-1011 aircraft to about 40,000 feet and are dropped at the appropriate launch time. Five seconds after drop, the first stage ignites and the rocket begins the climb into low earth orbit.

The launch countdown began about six hours and thirty minutes before the scheduled drop time from the L-1011. The first order of business was to link voice and data circuits between the Wallops flight facility, Bermuda tracking station, and the Goddard Space Flight Center to support the launch.

The L-1011, using the callsign *Orbital 1* (tail number N140SC), starts its engines about three hours before the drop time and then receives a weather briefing. All pre-taxi checks and preliminary telemetry and communications checks between the Wallops Range Control Center (RCC) and the aircraft are conducted on 311.200 MHz which is designated "ground operations."

Once Orbital 1 was ready to taxi, they switched to 121.950 MHz which is designated the "primary" mission frequency (back-up was 326.300 MHz).

After rolling onto runway 22 at Wallops, *NASA 846* (a F-18 chase aircraft, tail number N846NA) brought up the rear behind *Orbital 1*.

With a final "clear for take-off and release" from Wallops Tower (126.5 MHz), the L-1011 and the F-18 rolled down the runway and climbed into the low clouds and disappeared.

Since there wasn't much to see at that point, we moved into the Wallops public affairs office to watch the live video feed from the L-1011 during the launch. Table one shows the launch sequence of events.

A network of tracking stations located in Bermuda (BDA), Antigua (ANT), Guam (GTS) and Carnarvan, Australia (CRN) supported the launch phase of the mission.

Satellite and Rocket Stats

Orbcomm satellites are 15.367 cm in length and 103.886 cm in diameter weighing 40.725 kg each (dry mass). Projected lifetime for each spacecraft is five years.

The Pegasus XL launch vehicle is a three stage solid rocket motor vehicle with a optional fourth stage hydrazine auxiliary propulsion system (HAPS) with a total mass of 22,583 kg. The third stage dimensions are 133.858 cm by 96.52 cm and the fourth stage is 71.12 cm by 96.52 cm.

The launcher was carried aloft to about 12.9 km and dropped of the L-1011 at approximately 100 km off the coast of Wallops Island, Virginia. Pegasus has a total length of 16.895 meters and diameter of 1.27 meters.

The Orbcomm satellites launched in December will ultimately provide low-cost data communications, emergency position determination assistance, data acquisition and messaging services using portable pocket and mobile subscriber terminals. When complete later this year, the constellation will consist of twenty eight 43-kg satellites orbiting at an altitude of 775 km using inclinations of 45 and 70 degrees. Orbcomm communications frequencies are listed in Table Two.

Orbcomm A1-A8 aren't the first Orbcomms in orbit. Orbcomm FM1 (catalog number 23545 137.7075 MHz downlink) and FM2 (catalog number 23546 137.6075 MHz downlink) were launched on April 3, 1995, on board a smaller version of the Pegasus booster.

TABLE ONE: PEGASUS LAUNCH SEQUENCE OF EVENTS

Event	HH:MM:SS
Drop of Pegasus from L-1011	00:00:00
Stage 1 ignition	00:00:05
Stage 1 burnout	00:01:16
Stage 1 separation	00:01:36
Stage 2 ignition	00:01:37
Fairing ejection	00:02:16
Stage 2 burnout	00:02:47
Stage 2 separation	00:06:20
Stage 3 ignition	00:06:31
Stage 3 burnout	00:07:38
HAPS 1 ignition	00:08:38
HAPS 1 cutoff	00:09:04
HAPS 2 ignition	00:52:46
HAPS 2 cutoff	00:56:11
Payload separation (FM5)	00:56:51
Payload separation (FM6)	00:58:51
Payload separation (FM7)	01:00:51
Payload separation (FM8)	01:02:51
Payload separation (FM9)	01:04:51
Payload separation (FM10)	01:06:51
Payload separation (FM11)	01:08:51
Payload separation (FM12)	01:10:51
Deploy solar arrays	Separation + 30 sec
Deploy antenna	Separation + 90 sec
Transmission begins	Separation + 120 sec

TABLE TWO: ORBCOMM COMMUNICATIONS FREQUENCIES

Downlink Frequency	Power	Remarks
137.560 MHz	5 watts	Orbcomm telemetry
400.100 MHz	5 watts	Orbcomm doppler beacon
412.000 MHz		FTS uplink
2269.50 MHz	5 watts	Pegasus instrumentation system
2288.50 MHz	5 watts	Pegasus telemetry
5765.00 MHz	400 watts	Pegasus tracking transponder

Intl Desig	Spacecom Cat. Number	Spacecom Name (OrbComm Name)	Downlink Frequency
97-84A	25112	Orbcomm FM 8 (A4)	137.460
97-84B	25113	Orbcomm FM 10 (A6)	137.7375
97-84C	25114	Orbcomm FM 11 (A7)	137.800
97-84D	25115	Orbcomm FM 12 (A8)	137.2875
97-84E	25116	Orbcomm FM 9 (A5)	137.3125 (on 137.6875 for 3 days)
97-84F	25117	Orbcomm FM 5 (A1)	137.200
97-84G	25118	Orbcomm FM 6 (A2)	137.225
97-84H	25119	Orbcomm FM 7 (A3)	137.435
97-84J		25120	Pegasus rocket 3rd stage
97-84K	25121	HAPS Hydrazine 4th stage	

The Orbcomm satellites launched in December will ultimately provide low-cost data communications, emergency position determination assistance, data acquisition and messaging services using portable pocket and mobile subscriber terminals.

All of the Orbcomm satellites can be heard with a very simple radio and antenna setup.

Orbcomm Launch History and Schedule

Here is a complete list of past and scheduled Orbcomm launches.

Date	Vehicle	Payload	Launch Site
April 1995	Pegasus	2 satellites	Cape Canaveral AFS, FL
December 1997	Pegasus XL	8 satellites	Wallops Island, VA
January 1998	Taurus	2 satellites	Vandenberg AFB, CA
February 1998	Pegasus XL	8 satellites	Wallops Island , VA
May 1998	Pegasus XL	8 satellites	Wallops Island, V

TABLE THREE: WALLOPS FLIGHT FACILITY FREQUENCY LIST

Note: All frequencies are in MHz unless otherwise indicated.

760 kHz	Wallops Information Station (AM)
121.700	Ground Control (AM)
121.950	Radar Surveillance Aircraft (AM)
123.450	NASA Aircraft Operations (AM)
126.500	Wallops Tower (AM)
139.208	Mir Space Station Uplink (Russian) (NFM)
156.800	U.S Coast Guard (NFM)
170.350	Administration (NFM)
170.400	Voice Paging (NFM)
171.000	Security (NFM)
171.150	Fire Channel (NFM)
171.3875	Maintenance (NFM)
311.200	Ground Operations (AM)
314.600	NASA Aircraft Operations (AM)
326.300	Pegasus Primary Mission Frequency (AM)
394.300	Wallops Tower (AM)

Boeing Prepares for Delta III and Sea Launch Operations

In early September the Boeing Company in Huntington Beach, California, submitted a request for NASA tracking support during missions that will use their new Delta III launch vehicle now under development (designated Delta 8930). The vehicle will provide services to medium-class payloads. The first mission, Galaxy X, is currently scheduled for June 9, 1998, from the Cape Canaveral Air Station in Florida.

Tracking support may also include some of the U.S. Navy's P-3 tracking aircraft based at Point Mugu, California and NASA's Tracking and Data Relay Satellite System (TDRSS).

Support from NASA's Bermuda Tracking Station (BDA) in the Atlantic Ocean will only be available until September 1998, after which BDA is scheduled to close. However, BDA S-band service may be terminated as early as March 1998.

Delta III downlink frequency assignments

S-band	2241.5 MHz (first and second stage telemetry)
S-band	2252.5 MHz (spacecraft telemetry)
S-band	2272.5 MHz (special post mission telemetry)

Boeing and NPO Yuzhnoe of the Ukraine plan to conduct the first launch of their new Sea Launch Zenit 3SL booster on October 30, 1998. The Zenit 3SL will use a Block DM-SL upper stage to place payloads into orbit, similar to the one that failed in December 1997

TABLE FOUR: RAW/PROCESSED DOVE TELEMETRY DOWNLINK (145.825 MHZ NFM/PACKET)

```
SWITCH*>SWITCH <DM>
DOVE-1*>TIME-1:
PHT: uptime is 075/08:02:08.  Time is Sun Dec 28 02:46:22 1997
SWITCH*>SWITCH <DM>
DOVE-1*>TLM:
00:58 01:57 02:86 03:32 04:58 05:57 06:6C 07:52 08:6B 09:70 0A:A0
0B:E8 0C:E8 0D:D6 0E:00 0F:26 10:CD 11:9C 12:00 13:02 14:AA 15:92
16:93 17:94 18:94 19:93 1A:94 1B:8D 1C:98 1D:94 1E:24 1F:5A 20:91
DOVE-1*>TLM:
21:86 22:1A 23:19 24:12 25:41 26:00 27:00 28:00 29:00 2A:00 2B:00
2C:00 2D:31 2E:00 2F:9B 30:C8 31:9C 32:00 33:00 34:C6 35:A5 36:AC
37:AA 38:B5
DOVE-1*>STATUS:
 80 00 00 1E 09 18 99 02 00 50 00 00 0A 0C 3C 05 1C 00 0F 04 01
DOVE-1*>BRAMST:
12/20/97
Peace on Earth, goodwill to all.
Seasons' greetings from the DOVE team.
Jim, Richard, Russ, Bob and Harold
2401.22 MHz is .8W, 2 meters is 1W

For a QSL send SASE:

Dianne White, N0IZO
45777 Rampart Rd.
Parker, CO 80138
USA

DOVE-1*>LSTAT:
I P:0x3000 o:0 I:14140 f:14140, d:0 st:0

—— DOVE-1 Satellite Telemetry Analysis By KD2BD——
DOVE-1/OSCAR-17 Decoded Telemetry:
```

[00] Rx E/F Audio (W)	2.16V(p-p)		
[01] Rx E/F Audio (N)	2.14V(p-p)	[29] Battery 8V	1.28 Volts
[02] Mixer Bias V	1.37 Volts	[30] Array Voltage	9.80 Volts
[03] Osc. Bias V	0.51 Volts	[31] +5V Bus	4.74 Volts
[04] Rx A Audio (W)	2.16 V(p-p)	[32] +8.5V Bus	7.77 Volts
[05] Rx A Audio (N)	2.14 V(p-p)	[33] +10V Bus	10.39 Volts
[06] Rx A DISC	0.41 kHz	[34] BCR Set Point	21.37 Counts
[07] Rx A S Meter	82.00 Counts	[35] BCR Load Curr	87.40 mA
[08] Rx E/F DISC	-0.98 kHz	[36] 8.5V Bus Curr	24.98 mA
[09] Rx E/F S Meter	112.00 Counts	[37] +5V Bus Curr	285.17 mA
[10] +5 Volt Bus	4.88 Volts	[38] -X Array Curr	-10.75 mA
[11] +5V Rx Current	23.20 mA	[39] +X Array Curr	-13.49 mA
[12] +2.5V VREF	2.51 Volts	[40] -Y Array Curr	-11.96 mA
[13] +8.5V Bus	8.37 Volts	[41] +Y Array Curr	-11.41 mA
[14] IR Detector	0.00 Counts	[42] -Z Array Curr	-16.53 mA
[15] LO Monitor I	1.41 mA	[43] +Z Array Curr	-11.37 mA
[16] +10V Bus	10.40 Volts	[44] Ext Power Curr	-20.00 mA
[17] GaAs FET Bias I	4.06 mA	[45] BCR Input Curr	216.55 mA
[18] Ground REF	0.00 Volts	[46] BCR Output Curr	-17.24 mA
[19] +Z Array V	0.20 Volts	[47] Bat 1 Temp	7.26 Deg. C
[20] Rx Temp	-1.82 Deg. C	[48] Bat 2 Temp	-19.97 Deg. C
[21] +X (RX) Temp	12.71 Deg. C	[49] Baseplate Temp	6.65 Deg. C
[22] Battery 1V	1.29 Volts	[50] FM TX#1 RF Out	0.03 Watts
[23] Battery 2V	1.28 Volts	[51] FM TX#2 RF Out	-0.00 Watts
[24] Battery 3V	1.28 Volts	[52] PSK TX HPA Temp	-18.76 Deg. C
[25] Battery 4V	1.27 Volts	[53] +Y Array Temp	1.21 Deg. C
[26] Battery 5V	1.27 Volts	[54] RC PSK HPA Temp	-3.03 Deg. C
[27] Battery 6V	1.30 Volts	[55] RC PSK BP Temp	-1.82 Deg. C
[28] Battery 7V	1.28 Volts	[56] +Z Array Temp	-8.47 Deg. C

Table four illustrates the raw DOVE downlink signal as captured by Dale in December and the telemetry analysis courtesy of STs John Magliacane. The message on the previous page was repeated every thirty seconds. An interesting side note to all this was that DOVE's on board clock appeared to be about 90 seconds fast compared to National Bureau of Standards time station WWV.

on board a Proton booster. Launch operations will be conducted from a sea barge platform position as 154 degrees West longitude on the Earth's equator, approximately 240 miles east of Christmas Island in the Pacific Ocean.

The Sea Launch Zenit 3SL will have the capability to place payloads into geosynchronous transfer orbit (GTO) and medium earth orbit (MEO).

Sea Launch has also requested tracking support from NASA's Tracking and Data Relay Satellite System (TDRSS) using the following frequencies:

Zenit 3SL	Downlink Frequency Assignments
S-band	2211.0 MHz
S-band	2272.5 MHz

DOVE Telemetry Report

Dale Lamm has monitored the amateur radio DOVE satellite (catalog number 20440) on December 28, 1997, at 0245 UTC making a south-to-north pass over his location in northeast Ohio.

DOVE's packet signals were decoded using Dale's DSP-232 multi-mode decoder attached to the external speaker jack of an AR-3000 receiver. The packet signals were intercepted on DOVE's 145.825 MHz downlink in the narrowband FM mode. Table four illustrates the raw DOVE downlink signal as captured by Dale in December and the telemetry analysis courtesy of *ST*s John Magliacane.

The message on the previous page was repeated every thirty seconds. An interesting side note to all this was that DOVE's on board clock appeared to be about 90 seconds fast compared to National Bureau of Standards time station WWV.

Till next month, good listening from the *Satellite Listening Post*.

Satellite Listening Post Intercepts

All times in UTC (Universal Coordinated Time).

AM	Anplitude Modulation
ARIA	Advanced Range Instrumentation Aircraft
FM	Frequency Modulation
FSK	Frequency Shift Keying
K	kHz
M	MHz
NASA	National Aeronautics and Space Administration
NFM	Narrowband FM
USB	Upper Side Band

K760.0	NASA Wallops Information Station at NASA's Wallops Flight Facility using AM at 1615. (Keith Stein-Wallops Island, VA)
K4486.4	ARIA Control heard calling ARIA 1 and ARIA 2 for tracking support for Delta/Iridium launch at 1131 using USB mode. (Keith Stein-Woodbridge, VA)
M121.700	Wallops Ground Control working several aircraft supporting launch of Pegasus/Orbcomm launch using AM at 1815. (Stein, Wallops Island, VA)
M121.950	Primary mission frequency used by Orbital 1 (L-1011 aircraft, tail number N140SC) and NASA 846 (F-18, tail number N846NA) during launch of Pegasus/Orbcomm mission at 1915 in AM. (David Stein-Springfield, VA)
M123.450	NASA 511 conducting weather observations and pre-flight patterns for launch of Pegasus/Orbcomm mission using AM at 1615. (Stein-Wallops Island, VA)
M126.500	Wallops tower working Orbital 1, NASA 846 and NASA 511 (T-38, tail number N511NA) at Wallops Flight Facility during Pegasus/Orbcomm launch at 1915 in AM mode. (Stein-Wallops Island, VA)
M137.225	Orbcomm-2 heard at 1749 using NFM mode. (Stein-Woodbridge, VA)
M137.2875	Orbcomm-8 heard at 1747 using NFM mode. (Stein-Woodbridge, VA)
M137.435	Orbcomm-3 heard at 1749 using NFM mode. (Stein-Woodbridge, VA)
M137.620	U.S. weather satellite NOAA 14 downlink heard at 0730 using NFM mode. (Stein-Woodbridge, VA)
M137.680	Orbcomm-FM2 downlink heard at 0515 using NFM mode. (Stein-Woodbridge, VA)
M137.710	Orbcomm-FM1 downlink heard at 0608 using NFM mode. (Stein-Woodbridge, VA)
M137.7375	Orbcomm-6 heard at 1746 using NFM mode. (Stein-Woodbridge, VA)
M137.7075	Orbcomm FM1 heard at 1814 using NFM mode. This satellite was moved to this frequency from its orginal M137.710 frequency after the new eight Orbcomms 1-8 were launched (Stein-Woodbridge, VA)
M137.800	Orbcomm-7 heard at 1747 using NFM mode. (Stein-Woodbridge, VA)
M137.850	Russian polar orbiting weather satellite Meteor 3-5 noted at 1305 with APT downlink. (Larry Van Horn-Brasstown, NC)
M139.208	Voice uplink to *Mir* heard while at NASA's Wallops Flight Facility. Russian language using the NFM mode. Nothing heard on the M143.625 downlink. (Stein-Wallops Island, VA)
M143.625	Russian voice heard from *Mir* space station at 1626 using NFM. (Stein-Woodbridge, VA)
M145.825	Amateur radio satellite DO-17 heard at 0329 with a packet downlink. (Stein-Woodbridge, VA)
M145.985	Russian *Mir* space statikn with a 2-meter packet downlink at 1855. (Van Horn-NC)
M149.910	Russian military navigation satellite Cosmos 2341 heard at 0135 with a FSK downlink. (Stein-Woodbridge, VA) Noted same at 1440. Coherent unmodulated carrier on 399.760 MHz not heard during pass
M149.940	Russian military navigation satellite Cosmos 2218 heard at 0336 with a FSK downlink. (Stein-Woodbridge, VA)
M149.970	Russian military navigation satellite Cosmos 2336 heard at 0545 with a FSK downlink. (Stein-Woodbridge, VA)
M150.000	Russian civilian navigation satellite Tsikada heard at 0720 with a FSK downlink. (Stein-Woodbridge, VA). Russian civilian navigation satellite Cosmos 2315 (23603) heard at 1440 using a FSK downlink. Coherent unmodulated carrier on 400.000 MHz also monitored during pass. (Van Horn-NC)
M150.030	Russian military navigation satellite Cosmos 2346 (24953) heard at 1400 with a FSK downlink. No coherent 400.080 MHz signals heard. (Van Horn-NC)
M166.000	Progress M-37 heard between 1320-1323, Also heard on 922.750, and 926.050 MHz. (Sven Grahn, Stockholm, Sweden)
M311.200	Wallops ground operations used by Orbital 1, NASA 846 and NASA 511 during a recent Pegasus/Orbcomm launch at 1615 using AM. (Stein-Wallops Island, VA)
M314.600	NASA 511 calling Wallops Flight Facility, no joy. Using AM mode at 1630. (Stein-Wallops Island, VA)
M326.300	Backup frequency to M121.950 (see above). (Stein-Wallops Island, VA)
M389.100	Monitored a very interesting burst signal here that appears to be of non-terrestrial origins. Will have more as information becomes available. (Van Horn-NC) ST

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 service	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/Spanish)	G5,17	7.56
KAZN-AM (1300) Pasadena, CA—Asian Radio	GE1, 22 (Ku-band)	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-band)	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 (Present as audio for Hero Teleport slate)	S4, 12	6.20/6.80

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 Service/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 Corporation (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 Radio, 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
TVRO.NET (featuring Keith Lamonica)	S4, 16	5.80
United Broadcasting Network	C1, 2	7.50
WOKIE Network—tech talk active when Megabingo is present)	SBS6, 13B (Ku-band)	6.20 (network is
Worldwide Freedom Radio Network	GE1, 7	7.56
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–Am. Urban Radio Net.	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, 3.570, 3.750, and 4.830 MHz
Focus on the Family: .510 (ch. 1), .780 (ch. 2) and 1.230 MHz
Information Radio Network: 3.390 MHz
USA Radio Network: .330, 5.010 (ch 1) and 5.200 MHz (ch. 2)

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, 4.848, and 5.010 MHz
SRN News: .330 MHz

Galaxy 4 Transponder 3 (Ku-band)
Blank Audio Carriers: 1.000, 2.060, 3.250, 3.620, 4.340, 4.400 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 and 4.200 MHz

Galaxy 4 Transponder 4 (Ku-band)
Blank Audio Carriers: .960, 1.180, 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: 1.230 and 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, 1.350, 1.470, 1.590, 1.710, 1.800, 1.965, 2.070 and 2.730 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
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
1398.50 (61.5) Occasional audio
1398.30 (61.7) WSB-AM (750) Atlanta, GA—news and talk radio/Georgia sports/Atlanta Hawks NBA radio network
1398.00 (62.0) Occasional audio

(Continued on Page 38)

Single Channel Per Carrier (SCPC) Services Guide

By Robert Smathers

(Continued from Page 37)

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
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)	United Broadcasting Network—talk radio
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

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)	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
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

RCA C5 Transponder 21-Vertical (C-band)

1043.60 (56.4)	Blank audio carrier
1043.40 (56.6)	CNN Radio Network
1043.20 (56.8)	Blank audio carrier
1042.80 (57.2)	Blank audio carrier
1042.60 (57.4)	Blank audio carrier
1042.40 (57.6)	Blank audio carrier
1042.20 (57.8)	Data transmissions
1042.00 (58.0)	Blank audio carrier
1041.80 (58.2)	CNN Radio Network
1034.40 (65.6)	Blank audio carrier
1034.20 (65.8)	Data transmissions
1034.00 (66.0)	Blank audio carrier
1033.20 (66.8)	Blank audio carrier
1032.80 (67.2)	Data transmissions
1032.40 (67.6)	Blank audio carrier

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
19	12174-H	CNN Newsbeam (occ)

SBS 4 (SBS4) 77° W. (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
5	11800-H	Unknown User [digital video]/ 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
18	12060-V	PBS leased digital services
19	12080-H	PBS leased analog services (occ) / *The Business Channel (occ)*
20	12100-V	PBS adult learning service (ALS)
21	12120-H	PBS High Definition TV testing (occ) Occ video
22	12140-V	PBS leased digital services
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
10	11984-H	Occ video
11	12033-V	South Carolina Educational TV [4DTV]
12	12046-H	Occ video
13	12095-V	Occ video
14	12108-H	Data transmissions/Louisiana Public TV [Digicipher]
15	12157-V	DMX for Business [digital data]/Unknown User [digital video]
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]
3	11750-V	Indiana Higher Education [Spectrumsaver]
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]
17	12050-H	Westcott Communications ASTN [B-MAC]/National Weather Networks (upper half 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]
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
14	11966.5-H	Data transmissions
15	11991.0-V	Unknown User [digital video]
17	12022.0-V	Data transmissions
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
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	Chinese Television Network *Chung Ten* - Chinese/Taiwan all-news service
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° We

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]
13	11960-H	NSN data transmissions [digital]
14	11980-V	Qualcomm data [digital]
15	12000-H	NBC Contract Channel
16	12020-V	Serbian TV/TV Polonia [MPEG-2/DVB]
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 Drbit)

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	12166-H	WalMart [V2+]/Occ video
11	11748-V	Data transmissions/U.S.C. TV [digital]
12	11898-V	WMNB Russian-American TV (inverted video)
13	11994-V	Data transmissions
14	12141-V	Occ video/Data Transmissions

Satellite Transponder Guide

By Robert Smathers

	Galaxy 6 (G6) 74°	Spacenet 3R (S3R) 83°	3 Angels Broadcasting	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) 1 03°
1	Tokyo BS New York feeds	(none)	(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)	Home Team Sports (HTS)	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)	(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 7-channel [4DTV]
4	Horse Racing [digital video]	(none)	Nebraska Educational TV (NETV) [4DTV]	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+]	SC Ohio [V2+]
5	CNN feeds (o/v)	(none)	Univision [V2+]	NASA Contract Channel	Univision [V2+]	FOX feeds	fX West [Wegner]	TVN Theatre 5 [V2+]	Telequest DBS [Digicipher]	4 Media Company feeds	Data Transmissions	Hero Teleport (GEMS/HTV) [4D]
6	NHK (TV Japan) feeds	(none)	(none)	Kuwait TV	(none)	Infomercials (occ)/X! Promo (adult)	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 Ne York (PT24E) [V
7	Video Catalog Channel (VCC)	(none)	Data Transmissions	Data Transmissions	Data Transmissions	Adamant Eye 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	Data Transmissions	Data Transmissions	ABC feeds East [LEITCH]	CBS feeds/o/v	Pandamerica Home Shopping/TVN Theatre 8 [V2+]	ABC News2One Channel	Telemundo/Telemundo cas. [PowerVu]	KOMO- ABC Seattle (PT24W) [V2+]	Fox Sports Chic [V2+]
9	MuchMusic U.S. [V2+]	(none)	WPIX-Ind New York [V2+]	NASA TV	WPIX-Ind New York [V2+]	o/v	CBS Eye on People Network [PowerVu]	TVN Theatre 9-adult/TVision (adult) [V2+]	FOX Feeds	WB Dom TV/Network	Data Transmissions	Fox Sports So [V2+]
10	Horse Racing [digital video]	(none)		Data Transmissions	Data Transmissions	FOX News Edge	United Arab Emirates TV Dubai	o/v	FOX Feeds	o/v	FOXNet (PT24E/W) [V2+]	WKRN-ABC Nashville, TN (PT24E) [V2+
11	o/v	(none)	CNN/SI	o/v	CNN/SI	Xxxcite (adult) [V2+]	Encore [V2+]	o/v	Exxxtasy (adult) [V2+]	o/v	STARZ! East [V2+]	Univision [digi video]
12	TV Asia [PowerVu] Horse Racing [digital video]	(none)	Data Transmissions	Data Transmissions	Data Transmissions	Horse Racing [digital video] ACN	Romance Classics [V2+]	RAI TV Infomercials	Exotica (adult) [V2+]	o/v	Hero Teleport Contract Channel	Wisdom Network
13	RTPI (Portugal)	DayStar TV Network	SCPC/FM2 services	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)	Data Transmissions	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)	KTLA-Ind Los Angeles [V2+]	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)	CNN International/CNN fN [V2+]	Data Transmissions	CNN International/CNN fN [V2+]	Eurotica (adult) [V2+]	Access Television [Digicipher]	HBO 2 East [V2+]	UPN Network o/v	CBS West [occ VC1]	NPS Promo Channel	Fox Sports Bay Area [V2+]
17	o/v	(none)	FM2 services	Data Transmissions	FM2 services	FOX feeds	(none)	Cinemax 2 East [V2+]	o/v	CBS feeds [occ VC1]	(none)	Fox Sports Alternates (occ)
18	EWTN International Alabama Cable Network [PowerVu]	(none)	o/v	o/v	o/v	PBS National Schedule	Teleport Minnesota/CBS feeds/o/v	Inforamerica TV (Infomercials)	o/v	CBS feeds/ Eyemark syndicated feeds	STARZ! West [V2+]	Fox Sports New York [V2+]
19	Universal Network- Dr. Gene Scott (Rel)	HTS Alternate	SSN Extra [V2+]	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)	National Empowerment TV (Net)
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 [Powerv
21	o/v		SSN Pro Am Sports (Pass) [V2+]	(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 (occ)
22	Horse Racing [digital video]	Arab Network of America (ANA)	American Collectibles Network (ACN)	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]	NHK Secondary Feeds	SSN Home Teams Sports (HTS) [V2+]	NHK Secondary Feeds	(none)	o/v	fX Movies [V2+]	3 Angels Broadcasting	o/v	SCOLA [Wegner] LDS TV occ) B&W Network	Data Transmissions	o/v
24	Horse Racing [digital video]/o/v	o/v/El Commiandante Horse Racing	America One	o/v	America One	o/v	Intl Channel/Encore Themed Channels [4DTV]	Horse Racing [digital video]/ACN/o/v	o/v	CBS Newspath	KPIX-CBS San Francisco (PT24W) [V2+]	WSEE-CBS Erie PA (PT24E) [V2+]

Satellite Transponder Guide

By Robert Smathers

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
ancom [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+]	(none)	4
CBC feeds	(none)	Data Transmissions	o/v	Data Transmissions	Showtime/TMC/SD-C(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
C-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	9
com [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
BC-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	(none)	11
ncom [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
com [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+]	Showtime East [V2+]	CNNSI/CNN fn/CNN Intl/T.C.M./CNN Spanish [4DTV]	Animal Planet [V2+]	SC Florida [V2+]	15
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)	(none)	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	Unknown user [digital video]	MTV West [V2+]	USA East [V2+]	Showtime/TMC/SDC (East) [4DTV]	Cinemax East [V2+]	C-SPAN 2 [analog] CSPAN 3 [digital]	FDXNet [V2+]	19
(Inactive)	Data Transmissions	(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
lesat [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
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
u]	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

LEGEND:

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 98008.42404901 -.00000253 00000-0 10000-3 0 5272
2 14129 26.5536 108.0806 6016345 182.8280 170.9480 2.05881628 81618
OSCAR 11 (UoSAT 2, UoSAT 11, UOSAT OSCAR-11, UO-11)
1 14781U 84021B 98015.94153322 .00000209 00000-0 42956-4 0 293
2 14781 97.8588 353.9649 0012998 45.3616 314.8635 14.69651757742500
Russian Mir Space Station
1 16609U 86017A 98020.28707500 .00005798 00000-0 71889-4 0 1710
2 16609 51.6545 73.8108 0006872 224.1251 135.9181 15.61677359680920
OSCAR 16 (PACSAT, AMSAT OSCAR-16, AO-16)
1 20439U 90005D 98016.23880202 .00000010 00000-0 20758-4 0 1204
2 20439 98.5247 101.5638 0011117 307.8630 52.1536 14.30036523416681
OSCAR 17 (DOVE, DOVE OSCAR-17, DO-17)
1 20440U 90005E 98016.20337598 .00000026 00000-0 26609-4 0 1183
2 20440 98.5299 102.5478 0011084 306.5822 53.4346 14.30180675416710
OSCAR 18 (WEBERSAT, WEBERSAT OSCAR-18, WO-18)
1 20441U 90005F 98019.84429053 -.00000008 00000-0 13618-4 0 1261
2 20441 98.5276 105.9836 0011337 293.5677 66.4312 14.30145871417239
OSCAR 19 (LUSAT, LUSAT OSCAR-19, LO-19)
1 20442U 90005G 98016.22611326 .00000022 00000-0 25146-4 0 1238
2 20442 98.5300 103.2311 0011827 304.5525 55.4546 14.30264468416742
OSCAR 20 (JAS 1B, FUJI 2, FUJI OSCAR 20, FO-20)
1 20480U 90013C 98016.18991747 -.00000064 00000-0 -63562-4 0 233
2 20480 99.0725 302.9605 0540005 255.2031 98.8674 12.83241221372027
RS-12/13 (Radio Sputnik 12/13, Cosmos 2123)
1 21089U 91007A 98016.28010053 .00000012 00000-0 -37118-5 0 361
2 21089 82.9231 120.6259 0030767 64.9265 295.5077 13.74090491348421
OSCAR 22 (UoSAT-F, UoSAT-5, UOSAT OSCAR 22, UO-22)
1 21575U 91050B 98016.09082934 .00000093 00000-0 45205-4 0 8287
2 21575 98.2743 73.7932 0008217 340.4440 19.6424 14.37110048341062
OSCAR 23 (KITSAT-A, KITSAT-1, KITSAT OSCAR-23, KO-23)
1 22077U 92052B 98016.24589567 -.00000037 00000-0 10000-3 0 7179
2 22077 66.0816 59.1374 0003362 349.3563 10.7381 12.86307082255158
OSCAR 27 (EYESAT-A, EYESAT-1, AMSAT OSCAR-27, AO-27
1 22825U 93061C 98017.23070513 .00000038 00000-0 32929-4 0 6148
2 22825 98.5243 91.4561 0008888 340.3272 19.7565 14.27753344224619
OSCAR 26 (ITAMSAT, ITAMSAT OSCAR-26, IO-26)
1 22826U 93061D 98016.20157930 -.00000014 00000-0 11872-4 0 6097
2 22826 98.5258 90.7582 0009190 342.9219 17.1647 14.27863811224486
OSCAR 25 (KITSAT-B, KITSAT-2, KITSAT OSCAR-25, KO-25)
1 22828U 93061F 98015.76412245 -.00000032 00000-0 43645-5 0 5882
2 22828 98.5209 90.4231 0010086 327.1638 32.8883 14.28210438192558
OSCAR 28 (POSAT, POSAT OSCAR-28, PO-28)
1 22829U 93061G 98016.20778526 .00000085 00000-0 51212-4 0 6044
2 22829 98.5205 90.9667 0008687 324.8946 35.1665 14.28198458224538
RS-15 (Radio Sputnik 15)
1 23439U 94085A 98016.47008057 -.00000039 00000-0 10000-3 0 2734
2 23439 64.8106 167.9581 0145907 90.9971 270.7660 11.27529586125985
OSCAR 29 (FUJI 3, FUJI OSCAR-29, FO-29)
1 24278U 96046B 98016.09806013 .00000019 00000-0 55901-4 0 1344
2 24278 98.5163 33.0333 0351777 354.4919 5.2394 13.52637449 69908
RS-16 (Radio Sputnik 16)
1 24744U 97010A 98016.26028533 .00004089 00000-0 12889-3 0 1388
2 24744 97.2635 282.3484 0008890 52.1734 308.0313 15.33414225 48711

WEATHER/IMAGING SATELLITES
Geostationary Satellites
GOES 2 (Standby spacecraft-US 136.860 MHz on continuously, high power)
1 10061U 77048A 98011.26007854 .00000055 00000-0 10000-3 0 9348
2 10061 13.0516 30.7002 0010108 154.7061 205.3683 1.00300024 20191
GOES 3 (Standby spacecraft-US 137.190 MHz on continuously, high power)
1 10953U 78062A 98019.06548144 -.00000090 00000-0 00000+0 0 8932
2 10953 12.0974 33.7322 0004397 216.3627 143.6506 1.00278874 24887
GOES 7 (Standby spacecraft-US)
1 17561U 87022A 98018.53101422 -.00000133 00000-0 10000-3 0 4507
2 17561 4.1820 65.6326 0003052 240.9369 263.4844 1.00264515 23121
GOES 8 (Operational East-US)
1 23051U 94022A 98 10.67415363 .00000000 00000-0 10000-3 0 9928
2 23051 0.3422 274.1631 0004794 347.4647 16.4005 1.00267195 21210
GOES 9 (Operational West-US)
1 23581U 95025A 98019.31213207 .00000085 00000-0 00000+0 0 7637
2 23581 0.0578 95.8402 0005320 204.1398 156.3591 1.00285523 9753
GOES 10 (Standby spacecraft-US post launch testing continues)
1 24786U 97019A 98013.26716424 -.00000092 00000-0 00000+0 0 1630
2 24786 0.0511 55.3534 0008336 257.2797 149.8509 1.00262033 2667
ELEKTRO (Operational Russian spacecraft)
1 23327U 94069A 98015.79185912 -.00000107 00000-0 00000+0 0 4465
2 23327 1.2157 89.2011 0001691 142.1669 244.8916 1.00272909 11794
Feng Yun 2B (Operational Chinese spacecraft)
1 24834U 97029A 98019.79367669 -.00000328 00000-0 00000+0 0 1139
2 24834 0.7737 256.2511 0000576 206.9311 46.3571 1.00268292 2232
Meteosat 5 (Operational ESA spacecraft moving to 65 deg East, aka MOP-2)
1 21140U 91015B 98012.99439346 -.00000089 00000-0 00000+0 0 4106
2 21140 1.6949 78.3311 0004120 176.8071 205.8998 1.00273302 27377
Meteosat 6 (Operational ESA spacecraft)
1 22912U 93073B 98016.23841435 -.00000012 00000-0 00000+0 0 9647
2 22912 0.3013 310.9784 0000754 285.3114 324.8815 1.00268639 13658
Meteosat 7 (Operational ESA spacecraft)
1 24932U 97049B 98018.37379051 -.00000084 00000-0 00000+0 0 937
2 24932 1.5384 290.2488 0003751 346.8845 324.8115 1.00272876 1390
GMS 4 (Standby Japanese spacecraft, aka Himawari 4)
1 20217U 89070A 98016.67916088 -.00000371 00000-0 10000-3 0 7023
2 20217 2.9322 72.0098 0000955 302.5454 105.6007 1.00260129 31228
GMS 5 Operational Japanese spacecraft, aka Himawari 5)
1 23522U 95011B 98013.38333808 -.00000293 00000-0 10000-3 0 5677
2 23522 0.4082 3.8850 0000816 287.1188 99.7559 1.00268319 10223

Near Polar/Polar Orbiting Imaging Spacecraft
NOAA 12 (Operational morning US spacecraft 137.500 MHz APT)
1 21263U 91032A 98019.89661212 .00000070 00000-0 50207-4 0 6713
2 21263 98.5303 32.4562 0013735 26.3812 333.8063 14.22784309347175
NOAA 14 (Operational afternoon US spacecraft 137.620 MHz APT)
1 23455U 94089A 98019.83851535 .00000167 00000-0 11648-3 0 3300
2 23455 99.0199 336.9231 0010539 44.0309 316.1701 14.11731763157515
Meteor 2-21(Russian spacecraft, off at last report)
1 22782U 93055A 98016.22739581 .00000052 00000-0 33580-4 0 6171
2 22782 82.5498 249.0203 0021728 155.3446 204.8757 13.83090676221031
Meteor 3-5 (Operational Russia spacecraft 137.850 MHz APT)
1 21655U 91056A 98018.76110753 .00000051 00000-0 10000-3 0 368
2 21655 82.5511 270.4093 0011867 155.9913 204.1755 13.16858356309084
DMSP B5D2-8 (DoD meteorological polar orbiter: downlink encrypted)
1 23533U 95015A 98019.88274935 -.00000006 00000-0 20725-4 0 2696
2 23533 98.8502 26.2436 0006528 200.7508 159.3408 14.12831418145762
DMSP B5D2-9 (DoD meteorological polar orbiter: downlink encrypted)
1 24753U 97012A 98019.85738672 .00000086 00000-0 69953-4 0 3201
2 24753 98.9074 68.3304 0009066 150.0237 210.1447 14.13031002 40988

EARTH RESOURCES IMAGING SATELLITES
OKEAN 1-7 (Russian Okean 4 137.400 MHz)
1 23317U 94066A 98019.69834836 .00000185 00000-0 24618-4 0 2986
2 23317 82.5439 244.0070 0026208 353.3049 6.7806 14.74187569176206
SICH-1 (Russian Oceanographic spacecraft 137.400 MHz)
1 23657U 95046A 98015.05349168 .00000037 00000-0 22111-5 0 2250
2 23657 82.5327 29.5355 0027497 340.4743 19.5443 14.73636454127789

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.

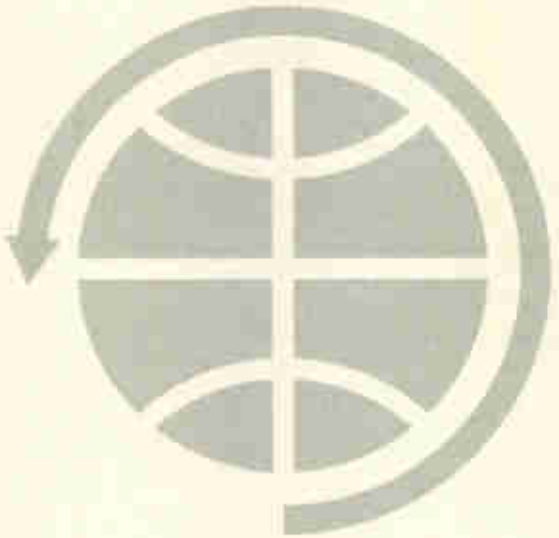
OSCAR 22 (UO-22)
Uplink 145.900 or 145.975 MHz FM/Downlink 435.120 MHz FM 9600 baud FSK

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 256 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/Janes *Spaceflight Directory* Editor: Mr. Phillip Clark; Baylin Publications: Dr. Frank Baylin; JSC NASA: Dr. Nicholas Johnson; University of New Brunswick: Mr. Richard B. Langley; Harvard-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-DESIG/COMMOM NAME	LONG (DEG)	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)
19919	1989-027A Tele X (Sweden)	4.9E#	BSS (Ku)
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)
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)
25071	1997-076A Astra 1G (Lux)	16.4E	BSS (Ku)
23331	1994-070A Astra 1D (Lux)	19.3E	BSS (Ku)
19688	1988-109B Astra 1A (Lux)	19.3E	BSS (Ku)
23686	1995-055A Astra 1E (Lux)	19.5E	BSS (Ku)
22653	1993-031A Astra 1C (Lux)	19.8E	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)
21139	1991-015A Astra 1B (Lux)	23.6E	BSS (Ku)
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)
23842	1996-021A Astra 1F (Lux)	37.9E#	BSS (Ku)
23775	1996-005A Gorizont 31 (CIS)	39.6E#	FSS (C/Ku) Statsionar 12
23949	1996-040B Turksat 1C (Turkey)	42.0E	FSS (Ku)
25110	1997-083A Intelsat 804 (ITSO)	47.0E	Intl FSS IOR (C/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)
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)
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
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)
24820	1997-027B Insat 2D (india)	74.1E#	FSS/MET (S/C/Ku)
13595	1982-097A Intelsat 505 (ITSO)	75.0E/i	Intl FSS/MSS APR (L/C/Ku)
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	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#	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)

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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	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)
18631	1987-100A Raduga 21 (CIS)	168.2W/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)
14133	1983-059B Anik C2 (Canada)	114.8W	FSS (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)

OBJ NO.	INT-DESIG/COMMOM NAME	LONG (DEG)	TYPE SATELLITE
24812	1997-026A Telstar 5 (US)	97.0W	FSS (C/Ku)
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	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)
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#	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#	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

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

*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	Downlink Frequency Assignments:
UHF Voice	243.0, 259.7, 279.0 & 296.8 MHz (all AM mode)
UHF Boosters	240.0 and 242.0 MHz (SRB recovery beacons)
S-band TLM	2217.5, 2250.0 and 2287.5 MHz (various modes)
C-band TRK	5400-5900.000 MHz

U.S. Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
March 1998	Pegasus XL	VAFB	TRACE
March 1998	Atlas	CCAS	Intelsat 806
March 1998	Delta II	VAFB	IRIDIUM (5 satellites)
March 1998	Atlas II	CCAS	UHF F8 (GBS)
March 1998	Athena	VAFB	CRSS-1
March 1998	Atlas	CCAS	Sky-2
April 1998	Pegasus XL	WFF	ORBCOMM-2
April 1998	Delta II	VAFB	Iridium (5 satellites)
April 1998	Delta II	CCAS	Globalstar-2

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

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

TRACE	Downlink Frequency Assignments
S-band	2275.3 MHz

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

Iridium	Downlink Frequency Assignments
L-band	1616-1626.500 MHz
Ka-band	19.4-19.6 GHz

Athena	Downlink Frequency Assignments
S-band	2208.5 and 2210.5 MHz
C-band	5765.0 MHz

ORBCOMM-2	Downlink Frequency Assignments
VHF-band	137.000-138.000 MHz
UHF-band	400.100 MHz

European Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
March 1998	Ariane 40	Guiana	SPOT-4 and NileSat-1
April 1998	Ariane 44L	Guiana	PanAmSat-7 and WorldSpace-AfriStar

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

SPOT-4	Downlink Frequency Assignments
L-band	1704.0 MHz
S-band	2218.0 MHz
C-band	5745.0 MHz
X-band	8253.0 MHz

AfriStar	Downlink Frequency Assignments
S-band	2212.420 MHz and 2214.150 MHz

List of Abbreviations and Acronyms

A/C	Aircraft
AfriStar	AfriStar, AsiaStar and CaribStar comprise of a constellation proposed by WorldSpace, Inc. based in Washington, DC. The system will provide digital audio, text, and multimedia broadcasting services to Africa, Asia, the Middle East, and the Caribbean in L-band.
C-band	3700 to 6500 MHz.
CCAS	Cape Canaveral Air Station, FL
CDR	Commander
CRSS-1	Commercial Remote Sensing System
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.
Intelsat	Telecommunications satellite for the International Telecommunications Satellite Organization (INTELSAT). A non-profit organization based in Washington DC.
Iridium	The Iridium system is a planned commercial communications network comprised of 66 low earth orbiting satellites. The system will use L-band to

Satellite Launch Schedules

By Keith Stein

	provide global communications services through portable handsets.
L-band	500 to 1549 MHz
MHz	Megahertz
MS	Mission Specialist
Neurolab	Investigates the effects of weightlessness on neurological processes using both human and animal specimens.
NileSat-1	Direct broadcast satellite (DBS) for the Eqyption Radio & Television Union (ERTU) to provide service to Africa, the Middle East, and southern Europe in the Ku-band.
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.
PanAmSat	U.S. telecommunications satellite for Pan American Satellite of Connecticut.
PLT	Pilot
S-band	2000 to 2300 MHz
SKY-2	Geostationary communications satellite. Prime contractor Space Systems/Loral.
SPOT 4	This earth observation satellite will help in accurate mapping and geologic studies.
TLM	Telemetry
TRACE	Transition Region and Coronal Explorer, the 4th small explorer (SMEX) mission to study the Sun's corona and the region of transition from chromosphere to corona.
TRK	Tracking
UFO F8	Also known as GBS F8, is a U.S. Navy communications satellite replacing the older Fleet Satellite Communications Network (FLTSATCOM).
UHF	Ultra High Frequency (390 to 499 MHz)
VAFB	Vandenberg Air Force Base, Calif.
VHF	Very High Frequency (30 to 300 MHz)
X-band	8000 to 10,999 MHz
XL	Extra Large

ST 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 December 1997. 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	Satellite Period	 Perigee	Mass Apogee
1997 Dec 2/2252	1997-075A	JCSAT 5		2,982 kg
1997 Dec 3.19	3.99 deg	631.40 min	219 km	35,784 km
1997 Dec 8.03	0.16 deg	1,435.57 min	35,752 km	35,801 km
1997 Dec 2/2252	1997-075B	Equator-S		230 kg
1997 Dec 3.19	3.95 deg	633.05 min	256 km	35,832 km
1997 Dec 12.66	3.98 deg	1,339.02 min	496 km	67,232 km

JCSAT 5 is a telecommunications satellite, operated by Japan Satellite Systems Inc. Mass quoted is at launch: in geosynchronous orbit at the beginning of operations the mass is 1,819 kg and the dry mass is 1,308 kg. Satellite initially located over 139 deg E, but to be operated over 150 deg E.

Equator-S is a science satellite operated and manufactured by the Max Planck Institute fur Extraterrestische Physik in Germany. It is intended to conduct plasma, magnetic and electrical field measurements as part of the ISTP (International Solar Terrestrial Physics) program.

Both satellites launched by an Ariane-44P from Kourou.

1997 Dec 2/2310	1997-076A	Astra 1G		3,300 kg
1997 Dec 3.62	12.37 deg	841.40 min	10,317 km	35,973 km
1997 Dec 17.93	0.03 deg	1,436.13 min	35,755 km	35,819 km

Telecommunications satellite launched for Astra Societe Europeenne des Satellites. Mass quoted is at launch: on-station at the beginning of operations the mass is 2,485 kg. Satellite initially located over 23-24 deg E, but to be operated over 19.2 deg E. Launched from Baikonur using a Proton-K with a Block DM3 fourth stage.

1997 Dec 8/0716	1997-077A	Iridium 42		657 kg
1997 Dec 8.68	86.29 deg	97.34 min	626 km	636 km
1997 Dec 19.60	86.39 deg	100.39 min	775 km	779 km
1997 Dec 8/0716	1997-077B	Iridium 44		657 kg
1997 Dec 8.61	86.29 deg	97.36 min	627 km	638 km
1997 Dec 21.22	86.39 deg	100.39 min	775 km	779 km

Eighth launch of a cluster of Iridium satellites, first operational launch using the Chinese CZ-2C/SD launch vehicle combination (a test flight with two mock-up satellites took place on 1997 Sep 1: see launch 1997-048) from T'ai Yuan. Dry mass of each satellite is 556 kg. Launched into the same orbital plane as Iridium clusters 3 (1997-034) and 7 (1997-069).

1997 Dec 8/2352	1997-078A	Galaxy 8I		3,000 kg?
1997 Dec 11.27	26.70 deg	938.90 min	333 km	50,434 km
1997 Dec 24.96	0.05 deg	1,435.92 min	35,768 km	35,798 km

Telecommunications satellite to be operated by Hughes Communications Inc: it is to provide a dedicated Latin American service (I=international), replacing Galaxy 8 (originally Galaxy 3R). Mass quoted is at launch. Located over 280 deg E. Launched from Cape Canaveral using an Atlas-2AS.

Launch Date/Time Epoch	Int Des Incl	Satellite Period	 Perigee	Mass Apogee
1997 Dec 9/0717	1997-079A	Cosmos 2347		3,000 kg?
1997 Dec 11.74	65.04 deg	92.79 min	403 km	419 km

US-P EORSAT (ELINT Ocean Reconnaissance Satellite). Satellite operating with Cosmos 2335 (1996-069A/24670). Some versions of the Russian launch announcement carried a commentary which suggested that this might be a Yantar-4K class photoreconnaissance satellite, but this was incorrect. Launched from Baikonur using a two-stage Tsyklon-M vehicle (sometimes called Tsyklon-2 or Tsyklon-2A).

1997 Dec 15/1540	1997-080A	Cosmos 2348		6,600 kg?
1997 Dec 15.70	67.15 deg	89.61 min	165 km	345 km

Yantar-4K class ("Kobalt") fourth generation close look photoreconnaissance satellite carrying 2-4 externally-mounted data return capsules which are ejected while the main payload remains in orbit: main re-entry vehicle returns the camera system at the end of the mission which can last for 2-3 months. Launched from Plesetsk using a Soyuz-U.

1997 Dec 20/0845	1997-081A	Progress M37		7,195 kg
1997 Dec 20.54	51.66 deg	88.99 min	178 km	271 km
1997 Dec 23.06	51.66 deg	92.23 min	378 km	389 km

Unmanned cargo freighter, carrying supplies to the crew of the *Mir* complex. Docked at the -X (Kvant 1) rear port of the Complex Dec 22 at 1022 UTC. Launched from Baikonur using a Soyuz-U.

1997 Dec 20/1316	1997-082A	Iridium 45		657 kg
1997 Dec 20.72	86.57 deg	97.38 min	623 km	644 km
1998 Jan 3.89	86.40 deg	100.38 min	775 km	778 km
1997 Dec 20/1316	1997-082B	Iridium 46		657 kg
1998 Jan 3.90	86.39 deg	100.40 min	775 km	780 km
1997 Dec 20/1316	1997-082C	Iridium 47		657 kg
1998 Jan 4.19	86.40 deg	100.39 min	776 km	778 km
1997 Dec 20/1316	1997-082D	Iridium 48		657 kg
1998 Jan 4.89	86.40 deg	100.39 min	775 km	779 km
1997 Dec 20/1316	1997-082E	Iridium 49		657 kg
1998 Jan 5.27	86.47 deg	99.15 min	716 km	720 km

Ninth launch of a cluster of Iridium satellites, sixth to be flown on a Delta-2 (7920) from Vandenburg. Dry mass of each satellite is 556 kg. Launched into the same orbital plane as Iridium Cluster 4 (1997-043).

1997 Dec 22/0016	1997-083A	INTELSAT 804		3,455 kg
1997 Dec 21.81	7.02 deg	630.78 min	256 km	35,715 km
1997 Dec 29.89	0.11 deg	1,436.11 min	35,768 km	35,806 km

Telecommunications satellite launched for INTELSAT. Mass quoted is at launch: mass on-station at the beginning of operations is 2,079 kg, dry mass is 1,601 kg. Satellite initially located over 46 deg E, but to be operated over 64 deg E. Launched from Kourou using an Ariane-42L.

1997 Dec 23/1911	1997-084A	Orbcomm FM 8		43 kg
1997 Dec 24.33	45.01 deg	101.28 min	815 km	823 km
1997 Dec 23/1911	1997-084B	Orbcomm FM 10		43 kg
1997 Dec 23.91	45.09 deg	101.26 min	814 km	823 km
1997 Dec 23/1911	1997-084C	Orbcomm FM 11		43 kg
1997 Dec 24.33	45.02 deg	101.28 min	815 km	823 km
1997 Dec 23/1911	1997-084D	Orbcomm FM 12		43 kg
1997 Dec 24.33	45.02 deg	101.27 min	815 km	823 km

GROVE

March 1998

Our Complete Buyer's Guide

PRO-2050 TRUNK TRACKING SCANNER DEBUTS, p. 'C'

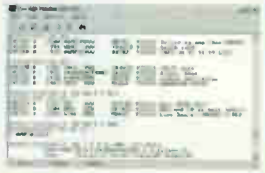
Save this Guide for your future product needs. We carry a complete line of radio scanners, shortwave receivers, satellite communications equipment, monitoring software, antennas, books, accessories, AND TWO GREAT MAGAZINES. Don't see what you need? Call us!

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

Expand the Capability of your WiNRADiO with the WiNRADiO Digital Suite!

Loaded with advanced capabilities...

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



NEW! Digital Decoder package! Use this software and your Pentium-hosted WiNRADiO (Soundblaster 16 or compatible sound card, Windows 95 or NT 4.0 or later required) to 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! Free on-line updates and added modes as they are released! Audio interconnect cable included.

ORDER SFT 15 only **$99.95**

Also see the WiNRADiO on p. "G"

Judy Bob

It's hard to believe that winter is about to leave us. Much of the country is still seeing snow, but warmer weather is on the way. Harsh weather takes its toll on outdoor antennas, so this is an ideal time to inspect those outdoor systems on mild days. Check connectors, splices, cable, antenna joints, rivets, and insulators. Replace or repair corroded parts, coax more than about five years old (or with corrosion or nicks that cut through the jacket). Remove and replace old tape, making sure that there is no moisture inside the wrap. We have featured some of our best selling antenna products in this issue for your convenience.

With the fresh, warm winds of spring come lightning storms. If you have not installed lightning protectors on your antenna lines, or even if you have they are now old, it's time to get new ones. See our low-cost, gas-discharge models on page N. I'm replacing mine with them!

And as the weather continues to warm, plan for those outings and trips. We have an excellent assortment of portable radio gear for that as well. And we are all looking forward to a summer vacation!

Bob & Judy Grove

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/hmpgbbb.html)** for a current list of our used radio equipment.

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

New 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: see BRK 2, ACC 15, and DCC 3 on page "M"; SFT2 on p. "E".**

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 "H". **Accessories: see 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 "H". **Accessories: ANT 8, ANT 14, ANT 22, on p. "D"; BAT 5, CAS-3 and DCC-7 beginning on page "M".**

ORDER SCN 10 only **$249.95**

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 "H". **Accessories: see ACC 130, BRK 2, and DCC 3 beginning on page "M".**

ORDER SCN 30 only **$399.95**

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				
BC-890XLT	SCN-19	Mobile/base 29-54, 108-174, 216-512,806-956 MHz 200 channel	$269.95	ACC-96, BRK-2, DCC-3
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

GROVE

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. "H". **Accessories: see BRK 2, ACC 15, and DCC 3 beginning on page "M". SFT2 on p. "E".**

ORDER SCN 16 only **$279.95**

RCA RP-6150

One of the most respected names in consumer electronics now offers their first programmable scanner. Covering 30-54, 118-174, 380-512, and 806-960 MHz (less cellular), the RCA RP-6150 is a triple-conversion scanner with 200 memory channels and 25-channel-per-second scan/search speed. Channels may be individually locked out and scan-delayed, and up to 10 search-discovered frequencies may be temporarily stored in monitor memory.

ORDER SCN 12 only **$199.95**

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!

ORDER SCN 15 only **$279.95**

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 "H". **Accessories: ANT 8 and ANT 14 on p. "D"; BAT 1, BAT 13, CAS 11, and DCC 3 beginning on page "M".**

ORDER SCN 08 only **$249.95**

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.**

ORDER ANT 05 only **$19.95**

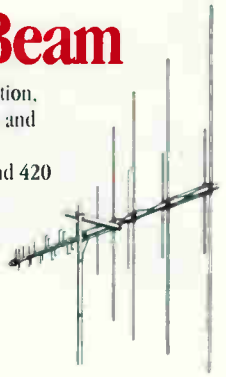
NOTE: ***special shipping rates apply to these antennas: ANT 1, 4, 5, 7, 9, 13, 15, 24, and 30. Please see page "o" for details.***

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.**

ORDER ANT 09 only **$87.95**

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.**

ORDER ANT 01 only **$59.95**

THE SCANTENNA

SPECIAL: Now includes 50' of coax cable plus Motorola and BNC connectors!

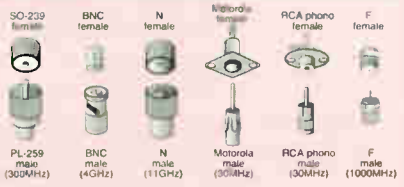
This omnidirectional scanner antenna will equal or outperform any competitor on the market. providing continuous frequency coverage from 25-1300 MHz. Public safety, civilian and military aircraft, hams, maritime, CB — anything in its frequency range! Requires TV type F connector. Approximate size 7-1/2"H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

ORDER ANT 07 only **$39.95**

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	$9.95
CBL 50	50'RG-6U	$14.95
CBL 100	100'RG-6U	$19.95



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)
AOP 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.

ORDER PRE 5A only **$89.95**

Universal Telescoping Scanner Antennas!

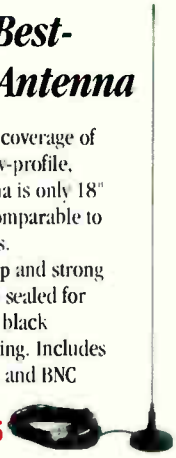
Extendable to 47-1/2 inches, the ANT-8 is made of chrome-plated brass and equipped with a standard BNC base. Receives 25-1300 MHz. ANT-19 extends to 21" and receives from 108-1300 MHz). ANT-8B has right-angle BNC adaptor. ANT-8N has right-angle N adaptor.

Order ANT 8 (47-1/2")	$16.95
ANT 19 (21")	$14.95
ANT 8B	$21.95
ANT-8N	$23.95

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 **$29.95**

High Gain Flex Antenna

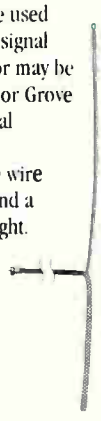
This "rubber duckie" really makes a difference on handheld scanners. The 12" Austin Condor is guaranteed to improve weak signal scanner reception—on all frequency ranges—over the original scanner antenna.

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 **$19.95**

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 **$29.95**
With straight connector for handhelds

ORDER ANT 23 only **$34.95**
With right-angle connector for desktop use (right)

UPS Second Day Air at Ground Rates on ALL PRODUCTS!

GROVE

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 your AOR, Drake, Kenwood, ICOM, Yaesu, JRC, Lowe, WJ, and Radio Shack PRO-2005/6/35/42 with this fast, all-new software program! Operates from the RS-232 port. Works with any IBM compatible system.*

Order SFT02, only $94.95

Scancat-Gold for Windows®

Computer control your BC895XLT and ICOM R-10! Offers all the Scancat-Gold features plus graphic receiver tuning by mouse, slide rule or on-screen knob, no-conversion direct scanning of DBASE, FOXPRO, ACCESS, BTRIEVE files, interactive database, map and scanning functions, 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

The SE upgrade to Scancat-Gold for Windows features unlimited graphic capabilities for spectrum analysis. Will examine your database, plot each frequency and "paint" the entire analysis on your screen, displaying it from the lowest to the highest frequency. Shows any point by frequency and tunes your radio with the click of the mouse. Four different analysis modes. "SE" supports Master Slave with us to six CI-VB addressable radios.*

Order SFT 02-SE, only $59.95

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

Great Magellan GPS Receivers

For the outdoor enthusiast who wants more in a GPS—more memory for landmarks and routes, more navigation screens, more features like landmark messaging, map projection, sunrise/sunset times, moon phase and real-time plotter with more functions—the GPS 3000 and 4000 deliver it all in a 10-ounce package!

While the GPS 3000 excels in marine conditions, the 4000 is a winner for land-based functions. Customizable navigation screens display your most often-used readouts, while experienced map readers will appreciate the map projection and triangulation features which permit them to create new landmarks by estimating distance and location. Both units enable you to establish your exact location to within 100 yards in as little as 2-1/2 minutes from a cold start (35 seconds warm start), even your altitude. Use standard alkaline AA cells. Lanyard strap included. Accessories available (please call).

ORDER GPS 4000 or GPS 3000 **$249.95 ea.**

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 Available in March 98

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 Phillips, 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.

A Word about Wide-Band Receivers

Beginning with this issue of the Grove Buyer's Guide, we are creating a new category of radio monitoring equipment which we call "**WIDE-BAND RECEIVERS.**" This nomenclature is in response to a host of new radio products which cover the frequency bands normally associated with BOTH shortwave radios and scanners.

So, you ask, are these wide-band radios suitable replacements for the best shortwave receivers and scanners on the market? The answer is: "maybe, depending on your needs."

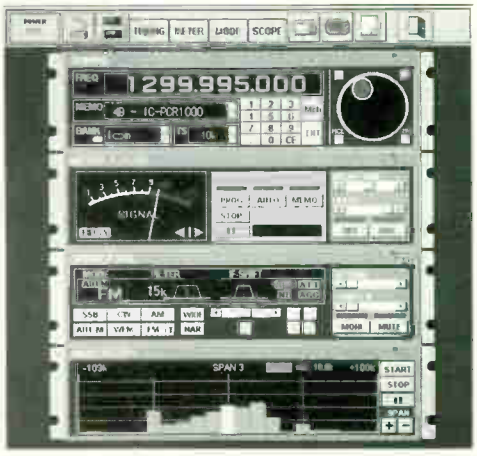
No receiver with exceptionally broad frequency range can hope to match the performance of a radio designed for a specific frequency band. If you want the best shortwave receiver, look at the top dedicated shortwave receivers of Drake, AOR and JRC.

On the other hand, wide-band receivers tend to make fine scanners, rivaling the performance of dedicated VHF/UHF scanners. We recommend that you consider purchasing a wide-band receiver if you truly need the exceptional range and flexibility they provide.

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 "H". **Accessories: DCC 2, DCC 4, and DCC05 beginning on p. "M".**



Computer screen simulation.

ORDER RCV 21 only **$499.95**

(Includes Percon FCC Database through 3-31-98)

Measure Electrostatic Discharge and RF Fields

Instruments normally used by the electronics industry for measuring electrostatic discharge (ESD) and RF environmental fields can cost between $2,000 and $3,000. But these great Trifield meters have been shown to accomplish the same tasks for under $200!

These meters were recently demonstrated to industrial, government and military officials in preparation for an important missile launch at Vandenburg AFB. The TST-2 (right) detects electric and magnetic fields and is so sensitive it will respond to the electric disturbance produced by someone—or something—moving in an adjacent room! A built-in tone provides audible indication of these phenomena. It can operate as an excellent field strength meter in the radio/microwave mode.

The TST-1 (left) takes readings of home appliances, computers, microwave ovens, TV sets, electric blankets, fluorescent lights,and other sources of electromagnetic energy.

ORDER TST 1 **$119.95** ORDER TST 2 **$199.95**

ICOM R8500

Huge $300 Discount on one of the World's Best Receivers through 3-31-98

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. And for a limited time, it's yours for only $1,699.95!

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 "H". **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. "J"; ANT 7 on p. "D".**

ORDER SCN 01 only ~~$1999.95~~ **$1699.95** Through 3-31-98

ICOM R-10!

$100 off through 3-31-98

Now get $100 off the regular price of this incredible scanning receiver, featuring 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 "H". **Accessories: ACC 3, ACC 4, ADPK 4, CAS 1-N, DCC 5 beginning on page "m"; ANT 8 and ANT 14 on p. "D"; SFT02 on p. "E".**

ORDER SCN 06 only ~~$499.95~~ **$399.95** Through 3-31-98

GROVE

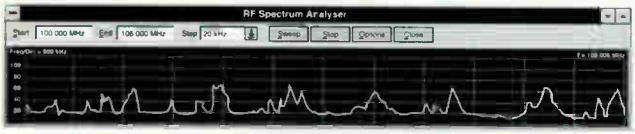
WiNRADiO WR-1000i

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.

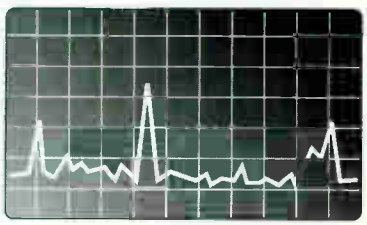
Call up a full-fledged spectrum display and see signal presence on any span between 500 kHz and 1.3 GHz! Double-click the mouse on any signal spike and the receiver immediately tunes to that frequency! Storage feature allows recall of signal traces. BNC connector allows attachment of your antenna system, 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 "H" in this Buyer's Guide. **Accessories: TUN 4A, ANT 2, ANT 3 and ANT 15 9on pp. "J" and "K"; ANT 1, 9 p. "C"; ANT 7 and CBL 50 and CBL 100 on page "D".**

ORDER RCV 16 only **$499.95**

See WiNRADiO's amazing new Digital Suite software on the cover of this Buyer's Guide!



Superb SDU5000 Spectrum Display

An ideal companion for your AOR 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-constrolled 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**

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 "H". **Accessories: ANT 2 p. "J"; ANT 7 p. "D"; SDU 5000 p. "G"; and SFT 2 p. "E".**

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.**

The Renowned 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. **Accessories: ANT 8, ANT 14 p. "D".**

ORDER SCN 27 only **$589.95**

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. "c"), RCV 12 (p. "c"), RCV 16 (p. "c"), SCN 06 (p. "b"), SCN 01 (p. "b"), and SCN 26 (p. "l").

Wide Band-Receiver Specification Guide

Prices subject to change without notice

Scanner	AR 5000	AR 8000B	ICOM PCR 1000	ICOM R10	ICOM R8500	WINRADIO
Grove Order #	RCV 12	SCN 27	RCV 21	SCN 6	SCN 1	RCV 16
Grove Price	$1,895.95	$589.95	$499.95	$399.95	$1699.95	$499.95
Frequency Range	500kHz-1900 MHz (less cellular)	500kHz-1900 MHz (less cellular)	500 kHz-1300 MHz, (less cellular)	500 kHz-1300 MHz, (less cellular)	100 kHz-1999.99999 MHz (less cellular)	500 kHz-1300 MHz, (less cellular)
Keypad Entry?	Yes, plus tuning dial	Yes	Yes	Alphanumeric	Yes	Yes
Tuning Steps	Programmable, 10 kHz-1 MHz	50 Hz-999.995 kHz	1 Hz minimum, user programmable	100 kHz-999.99 kHz	10 Hz-1 MHz custom	50 kHz-1 kHz
Display	Backlit LCD	Backlit LCD	Your monitor, 640 x 480 pixels or better	Backlit LCD	Backlit LCD, alphanumeric display	On screen (PC)
Dimmer	Yes	On/Off	Your monitor	On/Off	Yes	N/A
Receiving Modes	AM/NFM/WFM/USB/ LSB/CW	AM/NFM/WFM/USB/ LSB/CW	AM/NFM/WFM/USB/ CW	AM/NFM/WFM/USB/ LSB/CW	AM/FM (w/ AFC)/ USB/LSB/CW/RTTY	AM/NFM/WFM/SSB
Memory	1000 channels	1000 channels	Unlimited, determined by computer	1000 channels	1000 channels	Visrtually unlimited
Scan	45 channels/sec. w/ priority	30 channels/sec.	Yes, 6 different modes	6 ch./sec.	40 chan./sec.	50 ch./sec. FM modes
Banks	20/40	20		10	20	16
Channel Lockout	Yes	Yes		Yes	Yes	
Priority	Any channel	Any channel		Yes	Yes	
Search	50 channels/sec.	30 channels/sec.		17 channels	40 channels/sec.	Yes
Delay	Programmable	Programmable		Programmable time, channel	Yes	Programmable
Clock	Yes	No		No	No, sleep timer	Yes
Audio Output (typical)	1 W	180 mW	200 mW	120 mW	2W	200 mW
Record Audio Output	Yes	No		No	Yes	No
Recorder Activator	Yes	No		No	Yes	8 ohm minijack
Signal Strength Ind.	Analog S-meter	LCD bargraph	Yes	LCD bargraph	Analog S meter	On PC screen
Computer Interface	RS232	RS232	RS232C	CI-V	RS232C and CI-V	Expansion slot
Conversion Scheme	Triple up-conversion (622.2/10.7 MHz, 455 kHz)	Triple up/quad. on WFM	Triple up-conversion (266.7/10.7 MHz, 450 kHz)	Triple up-conversion (429/266, 10.7 MHz, 455 kHz)	Triple conv.	Triple up-conversion
Sensitivity (NFM)	.0.6 uV	.0.3 uV	0.3 uV	0.45 uV	0.5 uV	0.35 uV
Selectable Atten.	Yes	Yes, chan. selectable	20 dB	Programmable, 20 dB	-10/-20 dB	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	2.8/6/15/50/230 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	AM/SSB 6 kHz, NFM 17 kHz, WFM 280 kHz
Antenna Connector	BNC	BNC	BNC	BNC	SO-239	BNC
Dimensions (W"xH"xD")	8.5x3.5x10	6x2.75x1.5	5x1.25x7.75	2.25x5x1.25	11.25x4.5x8.25	PC expansion slot
Weight	7 lb. 10.5 oz.	13 oz.	2.2 oz	11 oz	18 lbs.	N/A
Power Requirement(s)	13.8 VDC @ 1 A or 120 VAC @ 60 Hz	4AA cells (NiCds supplied)	12 VOC @ 700 mA, AC adaptor included	4.8-16 VDC; AC adaptor included	12 VOC/120 VAC	PC bus powered
Accessories Incl.	AC adaptor	AC adaptor/ flex antenna/ DC cord/ carrying strap/belt clip, AA bat. (4)	Whip antenna, computer cable, program disk, AC adaptor.	Belt clip, AC adaptor, flex whip, rechargeable batteries, manual	AC acaptor	3-1/2" disk

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-890XLT	Uniden BC-895XLT	Uniden BC-3000XLT	Uniden BC-[illegible]XLT	Uniden BCT-7
Grove Order #	SCN 7	SCN 8	SCN 24	SCN 10	SCN 19	SCN 9	SCN 29	SCN 30	SCN 21
Grove Price	$239.95	$249.95	$239.95	$249.95	$269.95	$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, 806-968 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)	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	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 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	Backlit LCD	Edgelit LCD alphanumeric	Backlit LCD	Backlit LCD
Dimmer	No	No	On/off	On/off	No	No	On/off	High/low/off	No
Receiving Modes	AM, NFM	AM/NFM	NFM, AM (aero) det. by freq. range	AM/NFM	AM, NFM	AM, NFM	WFM, NFM, AM (selectable)	WFM, NFM, AM	AM (air), NFM
Memory	100 channels	200 channels	200 channels	300 channels	200 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.	100/20 channels/sec.	100-300 channels/sec.	100 channels/sec.	100 channels/sec.	100 channels/sec.
Banks	10	10	10	10	10	10	20	20	12 service bands
Channel Lockout	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Priority	Yes	10 channels	10 channels	10 channels	10 channels	10 channels	10 channels	10 channels	No
Search	300 channels/sec.	Yes, with lockouts	300 channels/sec.	Yes	w/ autostore	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 sec. all 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	No
Audio Output (typical)	2 W	400 mW nom.	180 mW	180 mW	2.7 W	2.7 W	320 mW	2.2 W	3 W
Record Audio Output	No	No	No	No	Yes	Yes	Spkr. & earph. jacks	Yes	No
Recorder Activator	No	No	No	No	No	3.5 mm (1/8") earphone jack	No	Yes	No
Signal Strength Ind.	No	LCD bargraph	No	No	No	LCD bargraph	No	No	No
Computer Interface	No	No	No	No	No	RS232C	No	No	No
Conversion Scheme	Dual conv.	Double conv.	Double conv.	Triple conv.	Dual 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	0.75 uV	Unspecified	0.5 uV	0.5 uV	0.5 uV
Selectable Atten.	No	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	N/A	Unspecified	N/A	N/A	N/A
Antenna Connector	BNC	BNC	BNC	BNC	BNC	BNC	BNC	BNC	BNC
Dimensions (W"xH"xD")	7x2x7.5	2.5x6x1.5	6x2.5x1.7	2.5x6.5x1.75	10.5x3.5x7.5	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.	3 lbs. 14 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, 12VOC	Rechargeable battery, 12VOC	120VAC/12 VOC	12 VOC (AC adaptor included)	6.5 VDC	12 VOC (AC adapt. incl.)	12 VOC
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	AC adaptor/tele. whip, manual	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

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 "L". **Accessories: ACC 43, MAN 2, SPK 2, and SPK 13 beginning on page "M"; ANT 2, ANT 24, pp. "J" and "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 "L". **Accessories: CAS 10, SPK 13, beginning on p. "M"; ANT 2, ANT 24, and TUN 4A pp. "J" and "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 "l". **Accessories: ANT 2, SPK 13, ANT 24 beginning on page "m."**

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 "L". **Accessorices: ANT 2, ANT 3, p. "J"; SPK 13 beginning on page "M."**

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 "L". **Accessories: BAT 1, BAT 2, SPK 13, beginning on page "M"; ANT 3, ANT 32, ANT 21 and TUN 4A, pp. "J" and "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 "L". **Accessories: BAT 1, SPK 11, SPK 13, beginning on page "M"; ANT 21 and TUN 4A p. "K".**

ORDER RCV 24 **$359.95**

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 "L". Requires 4 AA cell batteries. **Accessories: ANT 3, ANT 2, and TUN 4A, pp. "J" and "K"; 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 "L". **Accessories: ANT 3, ANT 21, ANT 32, and TUN 4A, pp. "J" and "K"; BAT 1 (4 required), SPK 11, beginning on page "M."**

ORDER RCV 8 only **$259.95**

Versatile Sangeans

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 "L".

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

ATS-818CS w/cassette recorder

ORDER RCV 9 only **$219.95**

ATS-818 w/o cassette recorder

ORDER RCV 7 only **$149.95**

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

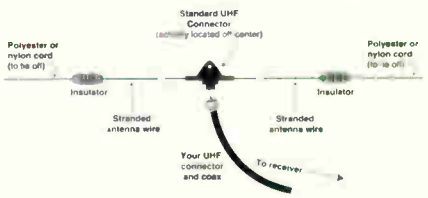
GE Superadio III for AM/FM DXing

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. "J" and "K"; BAT 2, SPK 13, beginning on page "M."**

ORDER RCV 5 only **$59.95**

FAMOUS 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 f); includes two porcelain end insulators and complete instructions. Covers 500 kHz to 30 MHz. Cable available on p. "D."

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**

UPS Second Day Air at Ground Rates on ALL PRODUCTS!

GROVE

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. "J."**

ORDER TUN 4A only **$99.95**

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**

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 @ THD	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

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
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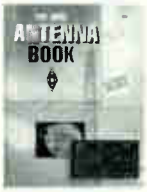

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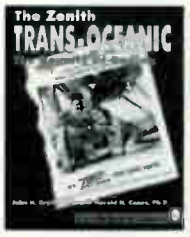

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Launch Date/Time Epoch	Int Des Incl	Satellite Period	 Perigee	Mass Apogee
1997 Dec 23/1911 1997 Dec 25.95	1997-084E 45.02 deg	Orbcomm FM 9 101.27 min	 815 km	43 kg 823 km
1997 Dec 23/1911 1997 Dec 24.47	1997-084F 45.03 deg	Orbcomm FM 5 101.32 min	 816 km	43 kg 827 km
1997 Dec 23/1911 1997 Dec 24.47	1997-084G 45.03 deg	Orbcomm FM 6 101.31 min	 815 km	43 kg 826 km
1997 Dec 23/1911 1997 Dec 24.40	1997-084H 45.02 deg	Orbcomm FM 7 101.32 min	 816 km	43 kg 826 km

Cluster of eight communications satellites to be operated for Orbcomm Global LP. The complete Orbcomm system will comprise three orbital planes, each with eight satellites, at 45 deg inclination plus 2-4 satellites in 70 deg inclination orbits for high latitude communications coverage. Launched from Wallops Island using a Pegasus-XL using a HAPS fourth stage, dropped from the L-1011 transport aircraft.

1997 Dec 24/1332 1997 Dec 24.68	1997-085A 97.30 deg	EarlyBird 1 94.28 min	300 kg? 480 km 488 km

EarlyBird 1 is a commercial remote sensing satellite, to be operated by EarthWatch Inc. Satellite has a 3-meters resolution capability. Contact lost on December 28 and it is unclear whether it will be regained. Launched from Svobodny using a four-stage Start-1 with its post-boost stage.

1997 Dec 24/2319 1997 Dec 25.90	1997-086A 51.10 deg	AsiaSat 3 638.34 min	 361 km	3,410 kg 35,999 km

Telecommunications satellite launched for Asia Satellite Telecommunications Co Ltd in Hong Kong, China. Planned mass in geosynchronous orbit at the beginning of operations was 2,534 kg, dry mass would be 1,773 kg. Planned location was to be 105.5 deg E. Following launch from Baikonur using a four-stage Proton-K, the Block DM3 fourth stage successfully performed its first maneuver to place itself and the payload in the planned geosynchronous transfer orbit with an inclination of 51.5 deg. At the first pass through apogee the Block DM3 was planned to make a second burn lasting for 110 seconds to place itself and te satellite into an orbit with an inclination of about 12 deg, altitude 10,000-36,000 km: in fact in a failure reminiscent of that of Raduga 33 in February 1996 (1996-010A) the fourth stage engine only burned for about 1 second and is reported to have exploded, leaving AsiaSat stranded in the original geosynchronous transfer orbit.

Updates for Previous Launches

1980-028A Cosmos 1172 decayed from orbit Dec 26, 1997.

1984-093D Telstar 303 has been drifting around the geosynchronous orbit band since being maneuvered off station Sep 3, 1997, and is deemed to have been retired.

1986-026A GStar 2 has been drifting around the geosynchronous orbit band since Aug 20, 1997, and is believed to have been retired from operations.

1987-070A Kiku 5 has been drifting around the geosynchronous orbit band since October 1997 and is believed to have been retired from operations.

1988-014A STTW 2 (DFH-2A) performed its last station-keeping maneuver during the period Jun 25-Jul 14, 1997. It continued to operate close to 87.5 deg E until November 1997, but by early December 1997 it had drifted well off-station and is presumably no longer operational.

1989-006A INTELSAT 515 was maneuvered off-station over 338 deg E approximately Dec 29, 1997.

1989-020A JCSat 1 has been drifting around the geosynchronous orbit band since October 1997, and has presumably been retired from operations.

1991-055A INTELSAT 605 was relocated from ~335 deg E to ~332 deg E during the second half of November 1997.

1992-010B ARABSAT 1C was maneuvered off-station over 30 deg E approximately Nov 30, 1997, and was still drifting to the east in early 1998.

1994-031A MSTI 3 decayed from orbit Dec 11, 1997.

1997-053A INTELSAT 803 was maneuvered off-station over 332-333 deg E on Dec 19, 1997, and was relocated over 338 deg E Dec 23, 1997.

1997-058A Progress M36 undocked from the *Mir* complex Dec 17, 1997 at 0602 UTC. Spacecraft propulsion system was switched on Dec 19 at 1320 UTC for de-orbit, with debris falling in the Pacific Ocean.

1997-058D Add Inspektor, which separated from Progress M36 as the cargo freighter retreated from the *Mir* complex Dec 17, 1997 at 0737 UTC. Satellite mass is 72 kg. Orbital data:
1997 Dec 18.96 51.66 deg 92.22 minutes 378 km 389 km
It was planned to use Inspektor for the inspection of the exterior of the *Mir* complex, but the malfunctioning of a star sensor used for attitude determination meant that the experiment had to be abandoned.

1997-067A Add the following orbital data for Navstar 38 (USA 134):
1997 Dec 13.04 54.90 deg 717.92 minutes 19,912 km 20,449 km

1997-069C Add the following orbital data for Iridium 40:
1997 Dec 1.07 86.42 deg 100.22 minutes 767 km 771 km

1997-069E Through to the beginning of January 1998 Iridium 38 was still in an orbit with a period of 100.23 minutes.

1997-070A Add the following orbital data for Kupon 1:
1997 Dec 8.79 0.01 deg 1,435.96 minutes 35,690 km 35,878 km The satellite is located over 54-55 deg E.

1997-071B Through to the beginning of January 1998, the latest orbital data continued to show Cakrawarta 1 in a geosynchronous drift orbit with a period of 1,437.44 minutes.

1997-072A The descent module from the spacecraft was recovered Dec 13, 1997, at 0555 UTC.

1997-074A Add the following orbital data for TRMM:
1997 Dec 12.51 35.00 deg 91.48 minutes 346 km 348 km

1997-074B Add the following orbital data for Hikoboshi+Orihime:
1997 Dec 19.20 34.96 deg 95.58 minutes 546 km 548 km

Orbital Data for Mars Global Surveyor

Mars Global Surveyor (1996-062A) has been maneuvering in Martian orbit using aerobraking: the following orbital data have been derived from material available on the Jet Propulsion Laboratory's World Wide Web site (altitudes based upon a Martian radius of 3,397 km). The orbital epochs are the times of "apoapsis" (maximum distance from Mars) passage.

The aerobraking was briefly halted due to worries concerning the partially-deployed solar panel, but it has been resumed. It is expected that it will take around a year for the spacecraft to reach its planned mapping orbit.

1997 Sep 13.00	93.26 deg	2,699.57 minutes	252 km	54,018 km
1997 Oct 15.29	93.33 deg	2,124.52 minutes	161 km	45,096 km
1997 Nov 15.22	93.36 deg	2,077.47 minutes	112 km	44,373 km
1997 Dec 15.47	93.43 deg	1,751.83 minutes	115 km	38,861 km

ST THE BEGINNER'S COLUMN

By Ken Reitz, KS4ZR
KS4ZR@compuserve.com

Understanding Satellite Basics

If you've just picked this magazine off the newsstand and are confounded by some of the technical aspects of satellite communications you should know that you are not alone. Nobody is born knowing this stuff. You might have a lot of questions about satellite reception, but don't know where to begin.

Well, you've found the right place: The *Satellite Times Beginner's Column*. No matter if it's weather satellites, military satellites or television satellites, there's a lot to know. And, as if that weren't enough, the whole business is changing all the time. Information which you might have learned five or 10 years ago about satellite technology is very nearly irrelevant today. It is among the fastest changing industries in the world. To stay up to speed in the field of satellites, you have to update your knowledge constantly.

There are three fundamental components to satellite reception, regardless of the type of transmission you are trying to receive. In fact, these components come directly from the earliest days of radio reception, and, if you understand these basics, you will be miles ahead in satellite reception. The fundamentals are the antenna, the receiver, and the cable which connects the two.

Antennas Great and Small

Satellite antennas vary from huge parabolic dishes for deep space listening in radio astronomy to little 18-inch dishes for digital satellite TV reception. Polar weather satellites and amateur radio satellites require entirely different antennas. Every satellite application requires a different approach to the antenna design.

Most of us have had some experience with various radio antennas, particularly those used at the lower frequencies found on the shortwave bands or AM radio. Some of us have had experience with antennas at VHF (commercial FM radio and 2-meter amateur radio). Still, this does little to prepare us for what we need to know to get good satellite reception. Satellites transmit at relatively low power and some are even moving!

The scope of satellite transmissions is amazingly broad. Frequencies from shortwave (HF or high frequency) to super high frequency (SHF) can be found emanating from the hundreds of satellites currently orbiting the planet. Some amateur radio satellites downlink (transmit to ground) on the 10- and 15-meter amateur radio bands. Antennas to receive these satellites can be very simple. Long wire or dipole antennas in the attic will work well. To receive 2-meter or 70-cm amateur satellites, a simple ground plane antenna (again attic mounted) can be bought at Radio Shack for about US$20.

Polar orbiting weather satellites such as America's NOAA or Russia's Meteor series transmit near the 2-meter band around 137 MHz. In order to receive good data from these satellites you should have as much gain as possible. It helps to mount the antenna outside in an area unobstructed by trees or other buildings. It will also be helpful to have a steerable antenna for, in the case of polar orbiting weather satellites, tracking the moving satellites or, in the case of geostationary satellites, moving from one satellite to another.

The ICOM R8500 is an example of a wide-band receiver that may fulfill some or all of your satellite listening needs—albeit at a price.

The World of Receivers

AR-8000

The second component is the receiver. Satellite receivers are designed for all manner of different applications. In satellite television, DBS (direct broadcast satellite) receivers are in a class by themselves because they are designed to receive only their own brand of DBS signal. Designers saw to it that the DISH network, DSS and Primestar receivers are incompatible. C-band receivers are much more flexible and all new C-band receivers can be used for Ku-band as well. Older C-band receivers may also be used for Ku-band reception if they have a "video invert" switch to change the video format.

Receivers with frequency scanning capability are used in many satellite reception applications: tuning in amateur radio satellites, for example, receiving polar orbiting and geostationary weather satellite imagery, as well as listening to military communications satellites. Key issues with scanners are:

1) tuning range (it must be able to tune the frequencies you wish to monitor);
2) bandwidth (it must be able to select between wide and narrowband FM or AM transmissions); and
3) the receiver must have excellent image rejection (to prevent powerful nearby signals or harmonics from getting into the receiver).

These requirements start to add up at the cash register, and preferred scanning receivers which are capable of receiving up to 1.3 or 2.0 GHz–such as the AR8000, AR3000A, Icom R8500, or Icom R100–are expensive. Expect to pay from US$500 to US$2,000. By the time you add the computer, programs, and antenna to the installation you might have a considerable sum

invested.

Careful shopping and a certain amount of "home brewing" may improve the price picture. You can shave US$200 to US$300 off the cost by considering a used receiver, but, here it's *caveat emptor* (buyer beware). If you're buying from a dealer make sure you get a warranty for the product. You should also consider buying stand-alone systems which are specifically designed for one satellite application. Several *ST* advertisers offer complete weather satellite systems. You can check with them for availability.

Feed Line Advice

The third component is the cable, or feed line, that connects the antenna to the receiver. This may seem like a minor point, but, in the field of communications, the right antenna cable can make the difference between successful communications and none. If you use cable without proper shielding or with poorly fitted connectors, performance will be considerably degraded.

Impedance matching is more important in transmitting than receiving. If you have a transmitter/antenna impedance mismatch you may damage the transmitter. But for reception purposes it isn't nearly as critical. However, the most important concept in satellite reception is signal loss. INMARSAT, GOES, and C/Ku-band satellite signals are of such high frequency that signal loss is a natural problem. Since your antenna can deliver only so much signal, it's up to your antenna cable to ensure that as little of that signal gets lost on its way to the receiver. RG/6 coax loses 4.4 dB per hundred feet at 400 MHz, while RG/58 loses a whopping 10 dB per hundred feet.

The distance between your antenna and your receiver is critical, too. Signal loss on all feed lines goes up as distance increases. This is important to know as you decide where to place your antenna. Try to keep the distance as short as possible. RG/6 coax cable is widely available and relatively cheap and can be bought with "F" connectors installed. It is used on all C/Ku and DBS satellite TV installations which indicates that it is a good feed line to use for frequencies up to 1500 MHz and lengths up to 100 feet. If you're installing the "F" connectors yourself, make sure the connection is done properly and always use a coax seal at the antenna to prevent moisture from getting into the line. Moisture has a disastrous effect on signals especially at higher frequencies.

Finding Your Niche

Very few of us can afford to indulge our electronic fantasies by installing a full range satellite monitoring station. It wouldn't be practical, either, because each type of monitoring can consume all of your spare time (and spare cash!). So, you need to find your place in the field of satellite monitoring. For many it's amateur satellites, for others it's weather satellite imagery, and still others it's military satellite monitoring. To find your niche, peer a little deeper into all the facets of this hobby. Read this magazine and do follow-up as reading recommended in many of the articles. It won't be long before something fires your imagination.

One of the more entertaining aspects of this hobby is learning to do-it-yourself (DIY). While most of us aren't equipped to design and build complicated satellite receivers there is plenty of DIY potential in construction projects, particularly with antennas. If you do have talent with a soldering iron and small electronic parts there are many places to capitalize on those skills. The first thing you have to do is "Get Started!"

Your First Satellite Reception

Amateur radio satellite signals are the easiest to receive and, therefore, the best place to start. All you need is a shortwave radio with the capability of tuning CW (Morse code) signals. With no more investment than that you can tune the downlink frequencies listed in the *Amateur Satellite Frequency Guide* in this magazine. Frequencies listed as "beacons" are continuously repeated Morse code identifiers or downlink telemetry automatically transmitted by the satellite.

As the satellite makes its way across your horizon the signal will grow from very weak to very strong. It will also appear to change pitch as it travels. This change is due to doppler shift and is common in all satellites which move toward and away from you as they pass. Geostationary satellites do not experience such a shift because they appear to be stationary with respect to your location. To maintain the same pitch you must increase or decrease the frequency tuning on your radio during the pass.

If you tune across the listed downlink frequencies you will hear conversations between hams who are within the "footprint" of the satellite's signal. You'll notice that these conversations are short and usually confined to name, station location and signal report. That's about all the time you have before the satellite is out of reach of one or both stations.

This is one of the big drawbacks to low earth orbit amateur satellites. At satellite speeds it takes about 20 minutes to fly coast to coast across the United States. AMSAT's new Phase 3D satellite will fly a highly elliptical orbit which will allow for greater operating periods and extended conversations.

To listen to satellites which downlink in the 2-meter or 70-cm bands you can use a simple handheld scanner which tunes the frequencies listed in *ST*'s *Amateur Satellite Frequency Guide*. The most interesting listening right now is the *Mir* space station. You can also monitor SAREX (Shuttle Amateur Radio Experiment) transmissions with the same minimal equipment.

As you might expect, it really helps if you know where the satellites are at any given time so you can tell when you are within the satellite's footprint. To do this you have to use a satellite tracking program (some of which are advertised in *ST*). These can cost from US$50 to hundreds of dollars depending on how sophisticated the program may be.

If you don't have a personal computer, a cheap, but painfully slow alternative is to dust off your old Commodore C-64 and use the VR85 tracking program (available for US$20 ppd from RLD Research, Box 888, McCloud, CA 96057). Working C-64 computers with disk drives can be found at hamfests for very little money. Its the way we use to do it when the hobby was just getting started. ST

By Doug Jessop

New 24 Hour Network to Debut

As I mentioned in my last column, an interesting occurrence in the wonderful world of broadcasting will be taking place in the coming months. By now, you would have to be a coma to not know that besides the "Big 3" networks of ABC, CBS and NBC viewers also can chose from Fox, UPN and WB.

As someone who has been in the business for a fair amount of time I can attest that getting a new network off the ground is an exercise in patience and deep pockets. Imagine my amazement when word on the street was that infomercial giant Paxson Communications was gearing up to start a new "family friendly" network called PaxNet with an estimated programming budget in the $250 million dollar range.

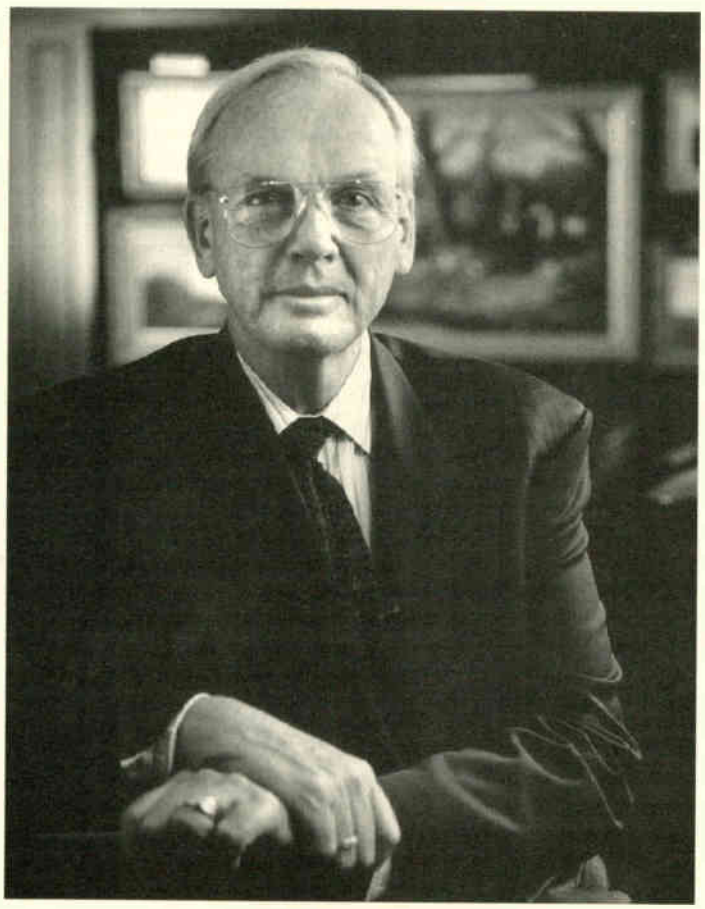
The sun, moon and stars must have been in alignment when these guys went shopping for programming. PaxNet has gathered an incredible stable of shows to anchor their prime-time line-up including *Touched By An Angel, Promised Land, Dr. Quinn, Medicine Woman* and *I'll Fly Away.*

PaxNet will launch on August 31, 1998, with a line-up of daytime and primetime network programming seven days per week. At press time, Nancy David Udell, Director of Public Relations for PaxNet, stated that the broadcast group's stations programming is currently delivered through a digital signal on Galaxy 6, but that it had not been determined which satellite would carry the new network. Let's hope that the new network realizes the scope of the available viewers throughout the country who would probably love to see their signal in the clear.

PaxNet will deliver 24 hours of programming every day to 77 broadcast outlets within the Paxson station group and other network affiliates. Paxson's Udell noted that no more than 90 minutes of infomercial programming would be featured during any one time period. In addition to their well recognized prime time shows, PaxNet will air *Christy, Sisters, New Land, Road Home, Neon Rider* and *Dave's World.* The fledgling network promises at least two original shows, *The Mike Levey Show* (the guy that hosts infomercial show *Amazing Discoveries*) and *Live Link,* hosted by Dan Stuecher. Adding to PaxNet's programming lineup are *Under One Roof, Blue Skies, Mirror, Mirror, Medical Center* and dozens of theatrical and made-for-television movies.

Noting that *Touched By An Angel,* CBS' highly rated and critically acclaimed series, will anchor the weekday 8 pm time-slot, PaxNet President Dean Goodman stated, "We have observed the strength of some of the best first-run series on television today and have invested carefully in programs that have developed a significant and loyal audience and also reflect our high network standards." Goodman added, "As our group of television stations goes from 'must' carry to 'want to' carry, the cable and satellite industries will discover how friendly PaxNet is. No subscriber fees, great programming and double the availabilities." Mr. Goodman closed his comments by adding, "All of our major programs are wholesome and focus on values."

Paxson is obviously gearing up the old marketing machine. In mid-January the largest television station call letter changeover in the history of the FCC took place with 39 stations getting new call letters. Following the lead set by Paxson's flagship station in New York (WPXN) each station's new call letters will incorporate the letters "PX." The remaining balance of Paxson's television stations will assume their new call letters shortly.



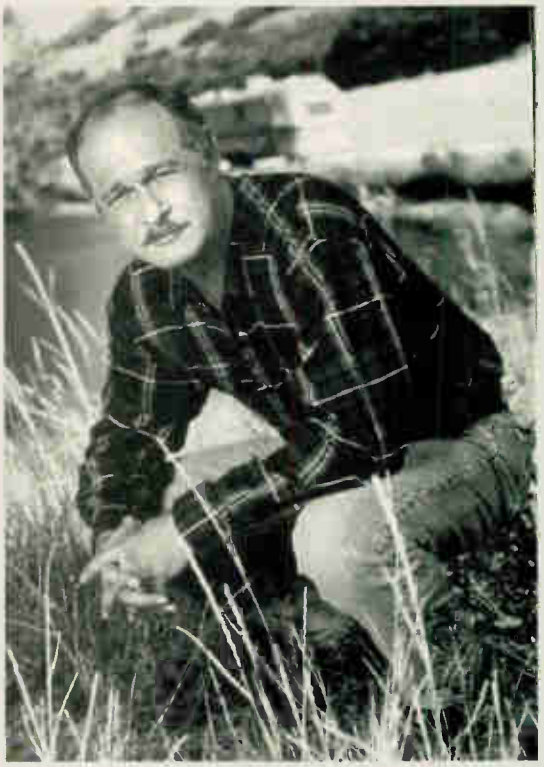
Lowell "Bud" Paxxon

DBS Watch

EchoStar, the direct broadcast satellite (DBS) service, announced its intention to begin offering local TV stations to subscribers by the time that you get this issue of *Satellite Times.* The announcement, made at the Winter CES show in Las Vegas, is attracting grief from both broadcasters and cable companies, with the latter insisting that EchoStar carry all local stations as they are required to do, not simply pick and choose.

EchoStar is gearing up for EchoStar 3, launched into orbit at 61.5 degrees West in October of last year, to start beaming local stations to the Eastern and Central zones of the country. EchoStar is licensed to use

PAX NET



Stars of the Paxson program lineup include (clockwise from left) Harry Anderson, Dave's World; Della Reese, Roma Downey and John Dye, Touched by an Angel; Jane Seymour, Dr. Quinn, Medicine Woman; and Gerald McRaney, Promised Land.

11 of the 30 transponders on the new bird. Using 7:1 compression, 77 channels should be enough to do the job. The only pain is that subscribers will need a second dish, which EchoStar is selling for just under $100. EchoStar 4, to be launched early this year, is expected to provide local stations to the Western and Mountain zones.

A source that I spoke with at EchoStar told me that while the local programming issue is a big deal, that they will still have to jump through a lot of hoops to make sure that they are providing service to someone who cannot receive a local signal otherwise. For example, if a local broadcaster makes a stink and shows that an EchoStar customer does indeed get programming just fine off the antenna stuck on the roof, then EchoStar would have to shut the local programming off for that customer.

The bigger thing to be looking at with the DBS broadcasters is the race for HDTV programming. At the latest Consumer Electronics show the darling of the show was a demonstration of High Definition Television beamed from the DirecTV teleport in Colorado. While the demonstration did have a couple of glitches, the HDTV test setup was literally put together a couple days before the dog and pony show.

At this pace you may see the DBS folks beat the networks to the HDTV punch. I have to admit that, for the broadcasting community, HDTV has really been on the back burner for a number of years. The fact that DBS has become the fastest selling consumer electronic device in history has probably served as the catalyst for improvements that ultimately help the consumer.

Fortunately all of the major television manufacturers have HDTV models that are in various stages of development. I don't know about you, but while I would be considered an early acceptor of technology I'm not quite ready to plunk down $7000 for a new TV.

Program Lineups Shuffling on DSS

DirecTV Inc. and U.S. Satellite Broadcasting (USSB) have formed a strategic partnership that will involve re-shuffling their respective program lineups, making the two direct broadcast satellite (DBS) services less competitive between themselves and more united against their mutual nemesis, cable TV operators.

The agreement calls for the basic channels currently carried by USSB to transition to the DirecTV channel lineup on March 10. The channels involved are the MTV Networks (MTV, M2, VH1, Nickelodeon and Nick at Nite's TV Land), Lifetime and Comedy Central. That will free up the transponder space necessary for USSB to tighten its programming focus on movies, adding new premium movie services from Showtime Networks Inc. and FX Networks LLC, including Showtime Extreme and fXM: Movies from Fox.

As for their pricing strategies following the move, USSB said its current basic subs would pay no more for the premium movie services, while DirecTV said it planned to add the five new nets to its Select Choice service for the same flat $19.95 price. Including pay-per-view, the additions give Hughes Electronics-owned DirecTV 175 channels of programming. The companies' respective presidents, Eddy Hartenstein (DirecTV) and Stanley E. Hubbard (USSB) issued statements that these moves were intended to widen the gap between the DSS satellite system and its DBS competitors as well as cable operators.

The 18-inch DSS system lets consumers switch between USSB and DirecTV programming. Hubbard also promised to soon have more movie nets for the St. Paul, Minnesota, based USSB.

Program Notes

The *Seinfeld* finale, expected to air on May 21, is likely to produce a bonanza for NBC, which plans to sell spots on it for $1 million each.

The figure would dwarf the $650,000 paid for a spot on the 1993 *Cheers* finale: it would not top the $1.3 million that advertisers are paying for spots on this year's Super Bowl game. NBC is also likely to pull in big bucks for ads on an accompanying one-hour "mocumentary" that Jerry Seinfeld has indicated will air on the night of the finale. The broadcast falls on the eve of the Memorial Day weekend, making it likely that movie studios will scramble to buy time on the show.

Scared to lose another one of its biggest stars, NBC announced that it has signed *Tonight Show* host Jay Leno to a long-term contract. Leno's representatives reported that he has agreed to extend his NBC contract through 2003.

"I'm thrilled," Leno said. "I like the job I have. It was a very simple negotiation. They asked me what I wanted. I told them to surprise me." Terms of the agreement were not disclosed, but sources suggested that Leno would get about $75 million over the five years of the new contract.

Fox has renewed its comedy/drama "Ally McBeal" for the 1998-99 season. The hour long show, which airs Mondays at 9 p.m., stars Calista Flockhart as a Boston-based lawyer whose innermost thoughts are revealed to viewers. Since its debut in September, "Ally" has been one of the new TV season's only real hits.

Internet Broadcasting

In an update to a recent article highlighting DirecPC, the folks at Hughes Network Systems (they bill themselves as the leading provider of satellite-based interactive entertainment services) announced that Hollywood Online signed on as the latest anchor tenant on its new DirecPC(TM) Turbo Webcast(TM) consumer push service.

"We are excited about partnering with Hollywood Online, one of the premier entertainment sites on the Web today," said Paul Gaske, senior vice president, Broadcast Products and Services at HNS.

"With Turbo Webcast, users can immediately view movie sneak previews from their hard drives without over-burdening their phone lines and never making an online connection."

Next Month

The annual National Association of Television Programming Executives convention is where deals are made that determine what is going to show up on a television near you. Next issue of *Satellite Times* we will take a peek into what you can expect to be beaming toward you in the upcoming months.

Sources for this issue include various friends in the broadcasting industry as well as *Cowles/Simba Media Daily, Los Angeles Times, New York Daily News, New York Times,* and the *New York Post* (I must have been craving New York bagels this month...) ST

Doug Jessop is a broadcasting veteran of 18 years, and was the creator of the North American Satellite Guide. Comments are always welcome at:
http://www.searcher.com/STcomments.html

By George Wood
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Digital Scandinavia

Satellite digital television has been slow coming to Britain. British Sky Broadcasting waited much longer than broadcasters in other countries before announcing its digital plans. But now BSkyB says the launch of its 200 channel digital system has been delayed even further, from spring until early summer. This may be because the manufacturers have yet to start producing the necessary digital receivers. While Sky says it is still launching on "schedule," Pace, Britain's most important satellite receiver-maker, has told Reuters that it will not begin producing the special Sky digital decoders during its current fiscal year, which ends in May.

Sky has chosen to go it alone, and has adopted somewhat different technology from other European digital satellite providers. Ironically, this was the kind of mistake that doomed Sky's original British rival, British Satellite Broadcasting. There were no receivers available for its unusual D-MAC service, and it was beaten by Sky, which used ordinary cheap PAL satellite equipment. Similiarly, while there are ordinary MPEG-2 receivers available in Britain, these cannot be used for the upcoming Sky system.

One reason manufacturers are waiting to start making the special Sky boxes is because the Europe Commission is still determining if BSkyB's joint venture British Interactive Broadcasting meets EU rules on competition. Sky already has a monopoly on analog broadcasting to Britain, and through control of the special BIB box, it may keep other players out of the digital market.

Another reason for the delay may be the postponement of the launch of the Astra 2A satellite. This is to be placed at a new orbital position of 28.2 degrees East, and will carry the new digital services from Sky, the BBC, and other British stations.

The Proton launch is now scheduled for March 30 at the earliest. But BSkyB says Luxembourg's SES, the owner of the Astra system, has confirmed it will provide a spare satellite to ensure that digital transponder capacity will be available for BSkyB by this Spring. Some weeks ago *What Satellite TV* magazine reported that with the new Astra 1G satellite is in orbit, SES could move one of the older Astra satellites to 28 degrees East for digital relays if 2A was delayed. This seems to be coming true.

Back when Rupert Murdoch started Fox News in the US, he virtually went to war with Time-Warner, which refused to make room for the new channel on its cable network in Manhattan. Since Time-Warner had just acquired CNN along with Turner Broadcasting, there might have been a degree of conflict of interest involved in the decision to keep the competition off the cable. In Europe, the war manifested itself as Murdoch's BSkyB suddenly dropped plans to carry the Warner Brothers Channel.

Now a similiar cable news struggle is being waged in Sky's own backyard. BSkyB is reported to be up in arms against a small cable company in West London, which dropped Sky News from its service. General Cable removed Sky News last November in protest, after Sky raised the subscription fee charged for the channel by 10 percent, making it twice as expensive as any rival news channel. In its place General Cable switched to the BBC's new 24 hour news channel, Sky News' first domestic competition.

This was particularly galling for Sky, because General Cable is the company that provides cable services to BSkyB's offices and studios in the London suburb of Isleworth. In response, BSkyB took out full-page ads in local newspapers denouncing the move, and urging readers to telephone General Cable's complaints hotline.

In other BSkyB news, the new Sky Box Office near-video-on-demand service now carries a 24 hour promo channel on transponder 57, in soft Videocrypt 1. This has enabled Sky Box Office 1-4, which use four separate transponders, to expand their film programming.

Following an agreement between NBC and Dow Jones, European Business News merged into CNBC Europe on January 12. The transmissions on Astra transponders 42 (06:00-12:00 hrs UTC in Videocrypt 1) and 50 (24 hours uncoded PAL), Hot Bird 1 (24 hours uncoded PAL) on 11.262 GHz, and Sirius 2 on 12.322 GHz (Eurocrypt D2-MAC) have been carrying the same CNBC programming.

The same merger was carried out in Asia between CNBC and Asia Business News on February 2. CNBC is on Asiasat-2 (3.700 and 3.785 GHz, both MPEG-2), on Palapa C2 (3.620 GHz in PAL and 11.645 GHz in MPEG-2), and on PAS-2 (4.093 GHz in MPEG-2). ABN was on Palapa C2 (4.040 GHz in PAL) and PAS-2 (4.148 GHz in MPEG-2).

Back in Europe, there have been a number of changes on Astra: Vivir and Taquilla 9 and 10 have joined the Spanish Canal Satelite Digital package on Astra transponder 110.

Swiss Radio International is broadcasting a test music program on Teleclub's transponder 55, on 8.46 GHz.

The German educational channel BR Alpha has started broadcasts on Astra transponder 32, in clear PAL. Hessen Fernsehen has begun test transmissions in uncoded PAL on transponder 40. A number of HR radio channels are included, using the Astra Digital Radio system.

Some of the (digital) services on the new Astra 1G satellite are Germany's ARD (transponders 111 and 120), ZDF Vision (transponder 115), Pro Sieben Digital Media (transponder 120) and Austria's ORF and Switzerland's SRG (transponder 117). Beta Teknik is replacing ARD on transponder 101. There are digital test carriers on tranponders 113 and 115 on 1G and on transponders 73, 79, and 101, on 1E and 1F, the former home of these German stations.

The ARD and ZDF digital packages have also started on Kopernikus 3 on 11.498, 11.616, and 12.692 GHz in clear MPEG-2, which are almost the same frequencies as on Astra 1G.

Moving to Eutelsat, the Italian adult

EUTELSAT

channel Satisfaction Club TV has switched to Hot Bird 2 on 11.977 GHz. It is in PAL and is coded in something called Ping Pong (which used to be called Nokia Line Shuffling. SCT is also reported on 11.163 GHz.

Radio Netherland's summer TV broadcasts by satellite to Dutch tourists in Europe used to be called Zomer TV. This year, when the program was extended after the end of the summer, the name changed to Wereldomroep TV, but broadcasts were only supposed to continue until December 31. But, beginning from that date, the programs on Hot Bird 1 on 11.283 GHz changed name to BVN, Beste van Nederland ("The Best from the Netherlands").

The Spanish channels TVE Internacional, Canal 24 Horas, and Onyx have begun on Hot Bird 3 on 12.111 GHz in clear MPEG-2. The Iranian IRIB's Jaam-e-Jam TV Network has started tests on Hot Bird 3 on 12.437 GHz, in uncoded PAL. Romania's Pro TV is on Hot Bird 3 on 12.206 GHz in uncoded MPEG-2, SR 5632 FEC 7/8. Another Romanian station, Prime TV, has started on Intelsat 705 (18 degrees West) on 10.978 GHz, in clear MPEG-2.

Norway's Telenor (operator of Thor 1 and 2) has opened a new digital satellite uplink station in Bratislava, Slovakia. The new station is uplinking to Telenor's satellites at 1 degree West. The channels that are already being distributed via the new station are BBC Prime, TV1 Estland, STV and VTV (both Slovakian). A Czech channel and Shopping TV are also to be uplinked.

One effect of the new station may have been VTV's switch in January from PAL to clear MPEG-2, on one of the satellites at 1 degree West, Intelsat 707, on 11.540 GHz. BBC Prime is also part of that digital package.

The new Intelsat 803 has replaced Intelsat 515 at 21.3 degrees West. Alfa TV, an international satellite channel set up by 25 countries in Eastern Europe and the former Soviet Union, is due to start tests from Budapest in March 1998, although regular broadcasts are not expected until 1999. The channel, which is being financed initially by the European Union and private sponsors, hopes to eventually become self-financing. It plans to offer broadcasts in eight languages. True to its EU financing, Alfa is intended to be a public TV channel emphasizing European cultural and intellectual values.

INTELSAT

The shareholders of Spain's newest satellite digital operator, Via Digital, have approved the sale of a stake in their company to Galaxy Latin America, the provider of the DirecTV service to Latin America and the Caribbean. The initial 6.9 percent share can be increased to 17 percent. The agreement allows the exchange of new Spanish channels between Latin America and Spain. This may help Via Digital compete with its rival Canal Satelite Plus, while Hughes' DirecTV takes on Rupert Murdoch's Sky Latin America.

Scandinavia

- Sweden's new Sirius 2 satellite has replaced Tele-X at 5 degrees East, after Tele-X was switched off on January 8. Among the channels on the satellite are:
- Swedish Television's new digital SVT Europe service (12.380 GHz, SR 27500 FEC 3/4, encoded in Viaccess), including relays of Radio Sweden.
- Digital transmissions from Denmark's new DK4 (in the SVT package) analog (12.207 GHz) and digital (12.245 GHz, SR 18750 FEC 1/2, also reported SR 27500 FEC 7/8) relays of the new Swedish business and documentary channel TV 8.
- Sweden's Kanal 5 in uncoded PAL on 12.476 GHz.
- CNBC (originally EBN, before the merger) and Sci-Fi Channel are sharing 12.322 GHz in Eurocrypt M-encoded D2-MAC.
- The Scandinavian version of Nickelodeon is sharing a transponder on Thor 2 with the Sci-Fi Channel, 11.309 GHz in MPEG-2, encoded in Conax (SR 24500 FEC 7/8).
- NRK's shopping channel Canal M is sharing the NRK transponder on 11.325 GHz in clear D2-MAC at 01:00-17:00 hrs CET.

I've have more news about Kinnevik's plans to offer digital satellite access to the

Internet. This has nothing to do with analog transponders, as indicated in the first reports. But Kinnevik is launching the service without having a digital TV service of its own (its stations are transmitting in MPEG-2, but apparently as an experiment, with no marketing for the service as yet, or even an announcement that a digital service is in the offing, or without even having to buy a digital receiver. The downlink is on Sirius 2, and at 200 to 300 kbps is 10 times the speed of an ordinary modem, with the return path by telephone).

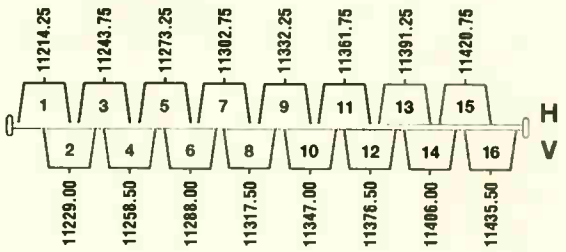
The one major requirement is that your PC is new enough to carry PCI card slots. The system involves a complete satellite receiver on a PCI card, which means that while you surf the Net at blinding speed, your family can continue to watch satellite TV (as long as its on the same satellite, or you have a multi-LNB set-up, which is typical in Scandinavia where the most-viewed satellites are at 5 degrees East and 1 degree West). Kinnevik also owns Sweden's largest Internet Service Provider, Tele2, and the system includes an ordinary Tele2 subscription.

Kinnevik's rival Canal Digital has yet to start marketing digital receivers for its new service, which officially launched last fall. But the newspaper *Aftonbladet's* TV commentator Frank Oestergren got his hands on a Nokia Mediamaster box. However, it seems there are some problems. Frank writes:

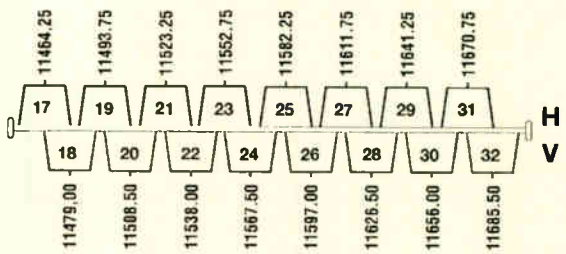
"Nokia and Canal Digital should think about user-friendliness. When the Mediamaster was upgraded a short time ago, I swore a bit when the new software was downloaded. Now you can't use the automatic channel search to save channels from different satellites. If I've downloaded everything from Thor and, for example, go over to Astra, then the Thor channels are erased. I'm forced to individually save the approximately 250 Astra channels. It's not hard to work out that this has to do with Canal Digital wanting us to limit outselves to its package. But Canal Digital should have learned enough about the Nordic market by now to know that you can't afford to make things even more difficult if you want to succeed digitally."

ASTRA System Frequency Plan

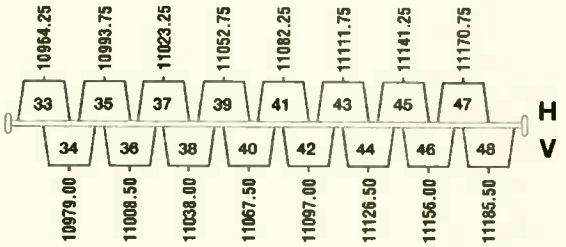
ASTRA 1A
A–Band 11200 MHz - 11450 MHz



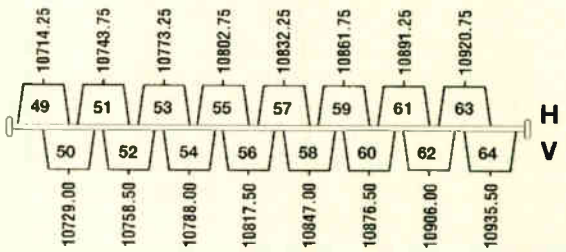
ASTRA 1B
B–Band 11450 MHz - 11700 MHz



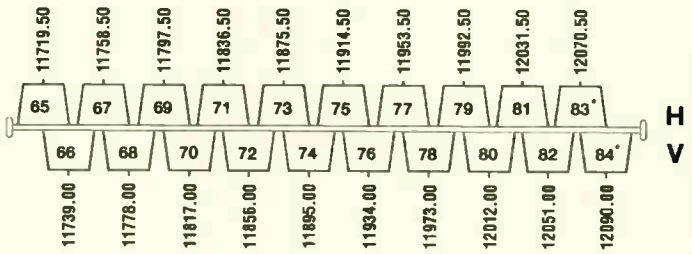
ASTRA 1C
C–Band 10950 MHz - 11200 MHz



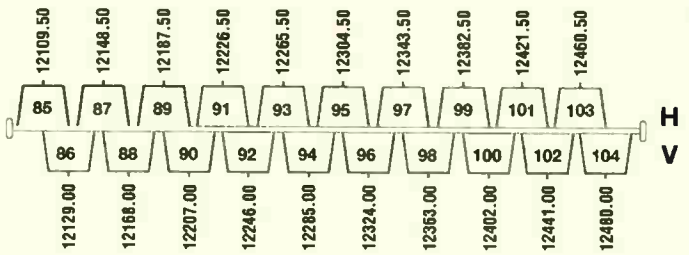
ASTRA 1D
D–Band 10700 MHz - 10950 MHz



ASTRA 1E
E–Band 11700 MHz - 12100 MHz



ASTRA 1F
F–Band 12100 MHz - 12500 MHz



Africa/Middle East

Remember the horrible glitch a few months ago when France Telecom technicians uplinked a pornographic movie intended for the French pay-channel Canal Plus to the Canal France International transponder on the Arabsat system, instead of the scheduled children's program? That would be a bad mistake anywhere, but it was particularly outrageous to a region which often regards Western values as decadent. Arabsat immediately removed Canal France International, depriving the station of millions of viewers. It was a serious set-back for France's desire to maintain cultural influence in the Middle East and North Africa.

Canal France International is suing France Telecom over the fatal error. But all is not lost, as on January 25 the French international and multinational broadcaster TV5 started trial transmissions via Arabsat to the Arab world in French and Arabic.

Canal France International and TV5 are also broadcasting separate services to Africa. CFI Afrique has started on Intelsat 605 on 3.935 GHz in clear MPEG-2, SR 8448 FEC 1/2. TV5 Afrique has started on Intelsat 803 (21.5 degrees West) on 4.082 GHz in clear PAL.

On this same satellite, the British Forces network, BFBS TV, has started transmissions on 4.082 GHz in encoded MPEG-2 (SR 6398 FEC 1/2), along with these radio stations (in the clear): BFBS World 1/2/3, BFBS Falklands, BFBS Belize, and BFBS Cyprus.

Nigeria's NTA has started on Intelsat 605 (27.5 degrees West) on 4.093 GHz, in clear PAL. On January 7 the Portuguese state broadcaster RTP launched a new service to Portugal's former African colonies, RTP Africa. The 24 hour channel will feature public service programming from RTP, including news and sports, and special programs for Africa. It can be found at 3.836 GHz on Express 2 at 14 degrees West, in clear MPEG-2. RTP already beams RTP International by satellite to North America, Europe, and Asia.

After the recent presidential elections in Iran it seemed the moderates slowly winning ground from the anti-Western hardliners. But at the end of December, Iranian Revolutionary Guards seized 200 satellite dishes and related equipment in Tehran, as part of a campaign to check Western cultural inroads. The Islamic republic banned satellite equipment three years ago, to keep people from watching "depraved and anti-Islamic" foreign television programs.

There's been an interesting shift in Rupert Murdoch's channels to the Middle East: Fox Sports World has replaced Star Sports on Intelsat 703 (57 degrees East) in the Orbit Nework package. Star Sports is the channel otherwise aimed at the Far East. Presumably Fox Sports World originates in the US. A shift in the demarcations within the Murdoch empire?

Asia/Pacific

Meanwhile, the Japanese market is apparently not big enough for three digital DBS services. Murdoch's Japan Sky Broadcasting and rival digital satellite broadcaster PerfecTV have reached a tentative agreement to merge. This follows the launch of Japan's third digital DBS broadcaster, Hughes' DirecTV, in December.

There are also new DBS services to and from China. On December 25, Beijing's BTV 1 started transmissions on Asiasat-2 on 12.329 GHz in clear MPEG-2. BTV is hoping to reach Chinese outside China, as well as non-Chinese viewers. The service includes a 30 minute program in seven other languages.

In the other direction, the Hong Kong-based APT Satellite Holdings is planning to set up a DBS system to China, pending approval from the authorities in Beijing. The service, which would also be aimed at Macau and Taiwan, hopes to have the go-ahead by March. APT operates the Apstar satellites.

Thailand also has a new international satellite station. Thai TV5 Global Nework has started on Intelsat 702 (177 degrees East) on 12.612 GHz, in clear MPEG-2. It has also begun transmissions to Europe on Hot Bird 1 on 11.248 GHz, in clear MPEG-2, SR 5632 FEC 3/4.

I've recently received a number of letters from readers asking about how they can pick up European satellite broadcasters in North America. In most cases you can't, unless you live along the East Coast and can tune into some of the Atlantic region relay satellites like Intelsat-K, Intelsat 803, Orion, or one of the PAS satellites. There are a number of European broadcasters available on North America satellites, such as Portugal's RTP, the German Deutsche Welle and the French TV5. You can find them included in the listings in other parts of *ST*. The best source of European radio in North America is the World Radio Network, on Galaxy 5, transponder 6, audio 6.80 MHz.

Thanks to Curt Swinehart, *SATCO DX*, Richard Karlsson, Frank Oestergren, James Robinson, Martyn Williams and *SatNytt*.

ST

ST PERSONAL COMMUNICATIONS

By Donald E. Dickerson

Iridium

You may wonder what places like Rome, Italy, and Yellowknife, Northwest Territory, have in commmon. Or you might be curious what Snjoholt, Iceland, has in common Chandler, Arizona, Oahu, Hawaii, or Leesburg, Virgina. They do have one common element–Iridium.

Iridium is a satellite-based, wireless personal communications network designed to permit any type of telephone transmissions–voice, data, fax, paging–to reach its destination anywhere on earth, at any time. It will soon bring a whole new dimension in communications. The system will be compatible with the commercial, rural and cellular mobile phone services, providing world-wide roaming and handheld portability.

The above sites are locations of ground stations that are in place, ready to service the 66-satellite constellation as soon as it becomes operational. Leesburg, Virginia, is the home of Iridium master control, and Rome, Italy, is the system's backup control facility. Chandler, Arizona, houses the Iridium Satcom Control Center, and telemetry, tracking and control of all the satellites will be handled by the stations in Iceland, Hawaii, and the Northwest Territories.

Motorola is the prime contractor and the originator of the Iridium system concept. Subscribers will use pocket-sized digital communicator to place calls anywhere in the world.

The Iridium system uses 66 satellites to track the location of the communicator. In areas where standard cellular is available, the communicator will be compatible with local systems. When out of range of the local cellular network the phone will access the Iridium satellite system directly.

This concept in telephone service can be used in many ways. It can be used by world travelers whether businessmen or tourists. It is most valuable during natural disasters as the system is the only communications medium that will not be directly affected by interruption of land-based systems.

Iridium Gets Off the Ground

Motorola began work on Iridium in 1987 just as NASA and Jet Propulsion Labs (JPL) were beginning their research and development on the mobile satellite service (MSS). Engineers selected a low earth orbit or LEO for the system orbital architecture. Satellites in low orbit are more easily and economically replaced, but it does take more spacecraft than the higher orbits to provide world-wide coverage.

In 1992 Motorola was granted a license from the FCC to begin experimentation and to construct and launch five satellites. The first five spacecraft were launched on May 5, 1997, from complex two at Vandenberg Air Force Base in California. A McDonnell Douglas Delta II carried the five Iridium spacecraft into a circular polar orbit of 421 nautical miles at an inclination of 86.4 degrees.

The Khrunichev Space Center at Russia's Baikonur Cosmodrome launched seven more satellites on its Proton launch vehicle in September. This was the Russian Proton launch vehicle's second contribution to the system.

Following the launch Motorola's Chief Executive Officer Christopher Galvin stated, "we are pleased with the results of the second Proton launch and thank Khrunichev State Research for playing such a major role in the build-out of our satellite constellation. Khrunichev should be very excited about their country's emergence in the area of telecommunications."

TABLE ONE: Iridium Frequencies

1616.0-1626.5 MHz	Iridium satellites to users FDMA/TDMA
19400-19600 MHz	Iridium satellites to gateway/earth terminals
23180-23380 MHz	Iridium intersatelite links
29100-29300 MHz	Gateway/earth terminals to Iridium satellites

Even China will launch two satellites using their Long March booster. At this writing Iridium has over half of its fleet in orbit and on station...right on schedule.

The Mechanics of Placing a Call

The completed network of 66 satellites will orbit the earth at an altitude of 420 nautical miles. The constellation will include six orbital planes, with 12 satellites in each plane. Using the LEO orbital architecture the time delay now noticed in all international satellite telephone transmissions will be eliminated. This echo effect is due to the fact that all spacecraft currently used for telephone service are in the geostationary belt at 22,300 miles above the earth.

Low earth orbit will also allow the use of low power, handheld units. These units will have a small extendible whip antenna–all that will be needed to access the satellites. Each of the satellites in the system has a 48 degree spot beam antenna. Caller ID and billing information will be detected and stored by the gateway (ground) stations accessed by the satellites to process your call.

The 1,500 pound satellites of the Iridium system are cross-linked or interconnected in order to relay your phone call through several satellites if necessary to get it to it destination. The cross-linking of satellites also provide the caller with uninterrupted service, preventing the dropping of calls or fading of signals found in other systems.

The Iridium system uses a combination of Frequency Division Multiple Access (FDMA) and Time Division Multiple Access (TDMA) multiplexing to make effective use of the limited radio spectrum.

Cross-link transmissions and the transmissions to the ground stations for telemetry and tracking take place on the Ka-band. Communication between the handheld communicator and the satellite will take place in the L-band.

Here is how it all works. When you activate your phone, the nearest satellite will first determine if you are a valid subscriber, determine your location, and enable the L-band frequency to access the spacecraft. Your call is then cross-linked to various satellites to its destination. The satellite will connect you to a ground station if the person you are calling has a standard phone or directly to another Iridium space phone. These communicators are digital,

which will maximize clarity. They will be capable of sending voice, paging, fax and data, all in a pocket sized version smaller than many current cellular phones.

The global service Iridium provides will have several benefits. You will have the freedom to roam the entire planet with a single phone that can connect you with anyone else anywhere in the world with any type of phone. Previously remote and unserved areas of the world will be able to communicate with the rest of the world without building a conventional land-based wire system. Relief organizations, members of the press, government agencies, and others will have a system available that is unaffected by weather, war or natural disasters.

So watch the pages of *Satellite Times* in 1998. We will present more details on the operational status and equipment that you can use to conduct your own personal communications via satellite and the Iridium system. ST

TABLE TWO: Iridium Keplerian Two Line Orbital Elements

IRIDIUM 8
1 24792U 97020A 98008.17366991 -.00000023 +00000-0 -15108-4 0 01582
2 24792 086.3987 045.3617 0004125 067.4243 292.7386 14.34216986035549
IRIDIUM 7
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2 24793 086.3985 045.3479 0004998 096.4836 263.6927 14.34216428035541
IRIDIUM 6
1 24794U 97020C 98008.16098899 -.00000020 +00000-0 -14324-4 0 01162
2 24794 086.3958 045.6549 0005572 071.1788 289.0006 14.34217286035541
IRIDIUM 5
1 24795U 97020D 98008.15535300 -.00063802 00000-0 00000+0 0 1308
2 24795 86.3972 45.4004 0009674 79.2373 281.0554 14.33713655 35571
IRIDIUM 4
1 24796U 97020E 98008.18002307 -.00000032 +00000-0 -18538-4 0 01664
2 24796 086.3994 045.3702 0007696 092.7051 267.5025 14.34216818035566
IRIDIUM 14
1 24836U 97030A 98008.18343072 -.00000152 +00000-0 -61168-4 0 01476
2 24836 086.3958 076.9902 0003297 035.6502 324.4845 14.34217486029303
IRIDIUM 12
1 24837U 97030B 98008.24051341 -.00000078 +00000-0 -34997-4 0 01612
2 24837 086.4013 076.9607 0002737 161.3490 198.7806 14.34215669029300
IRIDIUM 10
1 24838U 97030C 98008.22148389 +.00000023 +00000-0 +13034-5 0 01450
2 24838 086.3993 076.9316 0001412 141.4404 218.6891 14.34217493029300
IRIDIUM 9
1 24839U 97030D 98008.22783095 +.00000044 +00000-0 +86829-5 0 01646
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IRIDIUM 13
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IRIDIUM 16
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IRIDIUM 11
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IRIDIUM 15
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IRIDIUM 17
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2 24870 086.4005 108.5581 0002494 000.5830 359.5368 14.34226666026275
IRIDIUM 18
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2 24871 086.4163 108.5651 0004270 045.7972 314.3574 14.37205974026271
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IRIDIUM 33
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2 24946 086.3964 013.7617 0000601 333.6478 026.4687 14.34216289016740
IRIDIUM 27
1 24947U 97051D 98008.03453169 .00001048 00000-0 76373-4 0 998
2 24947 86.6428 12.1767 0006976 201.8507 158.3047 15.03770210 17504
IRIDIUM 28
1 24948U 97051E 98008.06242424 +.00000009 +00000-0 -40195-5 0 01062
2 24948 086.3949 013.8009 0003663 044.8044 315.3446 14.34217481016728
IRIDIUM 30
1 24949U 97051F 98008.07511015 -.00000033 +00000-0 -18793-4 0 01357
2 24949 086.3917 013.7616 0002491 103.7297 256.4175 14.34215763016736
IRIDIUM 31
1 24950U 97051G 98008.08144773 -.00000016 +00000-0 -12642-4 0 01104
2 24950 086.3947 013.7854 0002582 056.6225 303.5214 14.34216945016745
IRIDIUM 19
1 24965U 97056A 98008.47888112 -.00001099 00000-0 00000+0 0 953
2 24965 86.3913 45.1844 0005098 228.4966 131.6438 14.33890477 14369
IRIDIUM 37
1 24966U 97056B 98008.14195366 +.00000014 +00000-0 -18854-5 0 01252
2 24966 086.3986 045.3665 0002172 064.4434 295.6975 14.34218712014871
IRIDIUM 36
1 24967U 97056C 98008.14829847 +.00000112 +00000-0 +32866-4 0 01279
2 24967 086.3951 045.3494 0002197 103.7991 256.3443 14.34218827015014
IRIDIUM 35
1 24968U 97056D 98008.11658273 -.00000053 +00000-0 -26081-4 0 01515
2 24968 086.3981 045.3656 0002218 053.9044 306.2326 14.34216766014875
IRIDIUM 34
1 24969U 97056E 98008.13561260 -.00000079 +00000-0 -35153-4 0 01357
2 24969 086.3976 045.3572 0002155 058.1049 302.0350 14.34216277014877
IRIDIUM 43
1 25039U 97069A 98008.19319851 +.00000050 +00000-0 +10777-4 0 01197
2 25039 086.4018 108.5527 0001307 062.6658 297.4673 14.34217295008666
IRIDIUM 41
1 25040U 97069B 98007.76824279 +.00000001 +00000-0 -68016-5 0 01104
2 25040 086.4039 108.7439 0002558 067.3375 292.8066 14.34217695008605
IRIDIUM 40
1 25041U 97069C 98008.24594819 -.00000907 +00000-0 -31495-3 0 00994
2 25041 086.4265 108.5932 0002446 060.9368 299.2084 14.36689244008684
IRIDIUM 39
1 25042U 97069D 98008.21857225 -.00000505 +00000-0 -18738-3 0 00792
2 25042 086.3944 108.5552 0004487 086.0248 274.1506 14.34214397008669
IRIDIUM 38
1 25043U 97069E 98008.64619183 .00040684 00000-0 13613-1 0 693
2 25043 86.4176 108.4097 0005638 120.7183 239.5130 14.37451243 8905
IRIDIUM 42
1 25077U 97077A 98008.66272515 -.00027329 00000-0 00000+0 0 578
2 25077 86.4167 108.3625 0004534 103.3511 256.8752 14.37723241 4643
IRIDIUM 44
1 25078U 97077B 98008.22490443 -.00000501 +00000-0 -18616-3 0 00674
2 25078 086.4018 108.5465 0002687 088.3355 271.8156 14.34214171004478
IRIDIUM 45
1 25104U 97082A 98008.50340126 -.00032986 00000-0 00000+0 0 421
2 25104 86.4026 342.0338 0004500 132.1614 228.0481 14.34220731 2868
IRIDIUM 46
1 25105U 97082B 98008.23070248 -.00047340 +00000-0 -17019-1 0 00507
2 25105 086.3972 342.1465 0003337 060.3534 299.8113 14.34252192002729
IRIDIUM 47
1 25106U 97082C 98008.37645682 -.00009197 00000-0 00000+0 0 409
2 25106 86.3980 342.0864 0002135 130.9879 229.2019 14.34261424 2812
IRIDIUM 48
1 25107U 97082D 98008.52233887 .00000182 00000-0 65051-4 0 425
2 25107 86.3995 342.0233 0002445 121.5887 238.6065 14.34288090 2899
IRIDIUM 49
1 25108U 97082E 98008.59916874 -.02857630 00000-0 00000+0 0 370
2 25108 86.3920 342.0013 0004957 47.9097 312.3036 14.34984394 2829

ST ON THE AIR

By Steven J. Handler

A Month for Firsts

Want to host a television game show? For Mattie Majors of Detroit that wish has come true. Making her national television debut January 26th, Mattie became the first African-American woman ever to host a game show. Majors is hosting the Game Show Network's new interactive game show, *Trivia Track*.

The route to stardom for Majors wasn't easy. In 1997, the Game Show Network announced their "Coast-To-Coast Search for a Host." Competition was tough. Six finalists, one each from Boston, Chicago, Detroit, Hartford, Los Angeles and Orlando, represented a broad geographic cross section of the United States selected from more than 800 contestants nationwide.

Each of the finalists persevered through a series of auditions. A celebrity panel including veteran game show host Wink Martindale, Casey Kasem, Joshua Morrow (Young & the Restless), Marc Summers (Hollywood Squares/Double Dare), and Brook Lee, (Ms. Universe) chose Majors as the winner of the Game Show Network's "Coast-To-Coast Search for a Host."

Before being selected, Majors worked as a media relations director at the Detroit Medical Center. When not working, her hobbies include sewing and gardening. A long time game show fan, her charming charisma and enthusiasm catapulted her to the top of the contestants. In addition to the chance of hosting a game show, Majors won a prize package worth more than $30,000.

The Game Show Network appears to have discovered a previously unserved or underserved programming niche, interactive game shows, which they have expertly exploited. *Trivia Track* joins *Decades* the Game Show Network's first interactive program. *Decades* allows viewers to participate in the program. Viewers from among those who have registered with the Network are selected and play the game by telephone. They are asked to choose the correct decade in which an event took place. *Numbers Please*, the Game Show Network's second interactive game program, was added to the Network lineup in June 1995. Similar to *Decades*, contestant viewers also play by using their telephone.

The Game Show Network, a Sony Pictures Entertainment Company, launched December 1, 1994, and broadcasts 24 hours a day using Hughes Communications, Galaxy 7 satellite, channel 6. It is available by subscription through most satellite program carriers. In a 1995 interview with this columnist, Russell Myerson, Game Show Network's Vice President, of Operations, outlined their future plans. His forecast–that in the next five years they would produce and air more original interactive programming–is coming true.

In addition to their interactive offerings, the Game Show Network features a mix of traditional game show programs from the 50s, 60s, 70s, 80s and 90s. Included in theNetwork's extensive library are episodes of such classic game shows as *Beat The Clock, Card Sharks, Child's Play, Family Feud, I've Got A Secret, Jeopardy!, Joker's Wild, Match Game, Newlywed Game, Password, Super Password, Tattletales, Tic Tac Dough, To Tell The Truth*, and *What's My Line?*

This is one of my favorite channels: I personally enjoy viewing game shows from the 50s and early 60s, including *I've Got A Secret, What's My Line?* and *To Tell the Truth*. Although many of the classic programs are over 40 years old, I find them more entertaining than many of the current game shows.

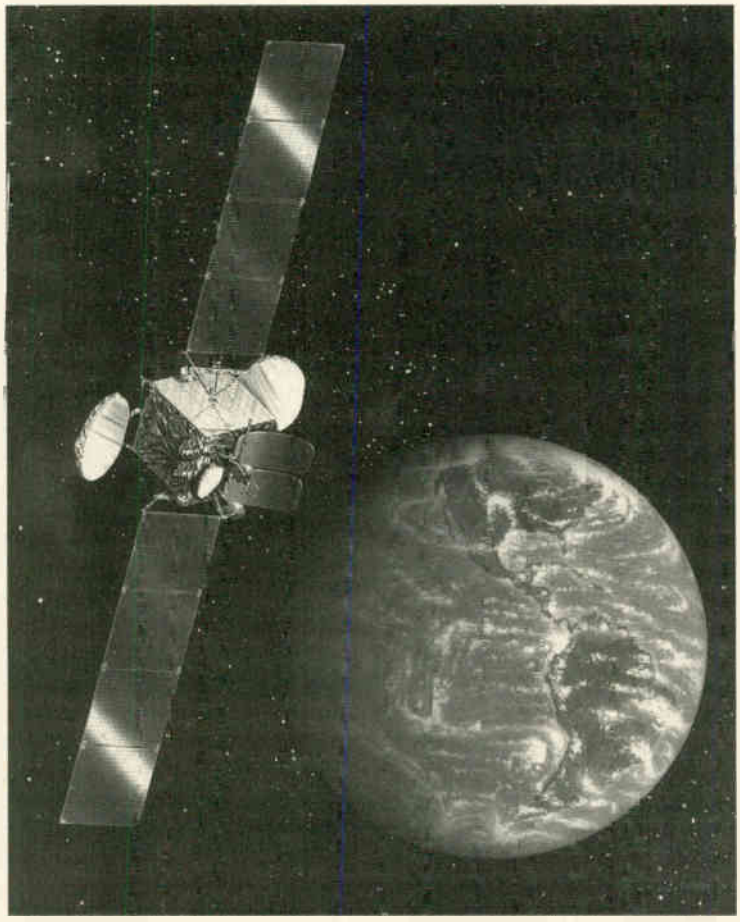
Another Shovel of Direct Being Tossed Into C-band's Grave

Last November I raised the question of whether delivery of programming to consumers via C-Band satellite was dying a slow death. The migration to small dish systems such as DirecTV, EchoStar and PrimeStar is in no small part due to the small dish systems' simplicity and ease of use. Their remote control resembles that long-familiar conventional TV remote, and their ease of use, including on screen program selection as well as the excellent selection of programming, appeals to consumers. I concluded that C-band's days may be numbered as an option for satellite viewers. Worse, there may be

nothing we as C-band viewers can do to stop it.

Now comes word that DirecTV is seeking approval from the Federal Communications Commission to add six additional satellites to its fleet. They are also requesting the allocation of new spectrum for these satellites.

DirecTV proposes to position their new birds in pairs at 96.5, 101, and 105.5 degrees West longitude, downlinking signals in the 17 GHz band. Their current fleet of three satellites is co-located at 101 degrees West longitude, downlinking on the 12 GHz band. They have also requested the FCC to permit licensing of the 24 GHz band for uplinking. Allocated for broadcast service feeder links internationally, that band was recently reallocated by the FCC for use by digital electronic messaging services. DirecTV is requesting that the FCC reconsider the use of the 24 GHz band.



Hughes Communications' Galaxy III-R satellite is home to the first direct-to-home television entertainment system for Latin America.

If DirecTV succeeds in their plans to launch these satellites, small dish users might eventually be rewarded with the availability of more programming choices and selections. The downside for C-band viewers is that such small dish success will possibly come in part from existing C-band and potential C-band users. The reduction of C-band viewers may affect the economics of serving a potentially ever smaller market. This might lead to an increase in programming costs or possible abandonment of the market altogether.

EchoStar Scores a First

Speaking of small dish systems, EchoStar Communications Corporation pulled off a coup at the Winter Consumer Electronics Show. They announced that the DISH Network will offer their subscribers in twenty of the top U.S. television markets the ability to receive their local network channels direct from EchoStar's satellites. By doing so, the Dish Network has dealt a competitive kick in the teeth to their competitors in both the small dish marketplace and C-band marketplace. The Dish Network will be the first of the small dish systems to offer this programming to their subscribers. C-Band programmers do not currently offer similar programming packages.

A prime complaint of some small dish subscribers–as well as C-band viewers–has been the lack of availability of local network channels. Those seeking to view their local network affiliates using their satellite receiver were out of luck unless they happened to live in an area covered by one of the superstations or affiliates carried by Prime Time 24. The integration of an outside television antenna with a satellite receiver to view local affiliates appears to be a solution shunned by consumers. This option is cumbersome, unattractive and often impossible for those in fringe reception areas and residences covered by restrictions against outside antennas.

EchoStar realized the consumer demand for this service and appears to have found a solution for much of the nation. "This is a significant achievement for DISH Network and a strong selling point for consumers," said Charles Ergen, chairman and CEO, EchoStar Communications Corporation. EchoStar's coup may yield a competitive advantage over both their small dish rivals-as well as the C-band dish alternative.

Plans call for the DISH Network to uplink the ABC, CBS, NBC and FOX affiliates in the New York, Boston, Washington, D.C., Chicago, Atlanta and Dallas markets. Additional markets in the Eastern and Central Time zones should be available by the time this issue reaches the newsstand. The DISH Network will also add network affiliate stations from the Mountain and Pacific Time zones following the launch of EchoStar IV, scheduled for the spring of this year. EchoStar indicates the Digital Local TV Channel package will retail for $4.99 a month for eligible subscribers.

Consumers want programming. How it gets to their television set is irrelevant. The simpler the delivery system, the better. I believe that C-Band currently is not as simple to set-up or to operate as the small dish systems. Players such as EchoStar, DirecTV and PrimeStar are not sitting still. Their technical and marketing departments are hard at work seeking to lure subscribers.

As the small dish systems' hardware and programming choices continue to expand, I think the number of small dish subscribers will continue to grow. New subscribers may come in part from the ranks of current cable TV and C-band viewers. The seductively low cost and ease of use of small dish systems will continue to entice and instill defection from C-band of those viewers whose equipment requires upgrading or replacement.

C-band is by no means dead, yet. However, I think the trend will favor the small dish at the expense of C-band for those choosing to use satellites to view what's *On The Air.*

To contact the author, Steve Handler, E-mail him at: **ontheair@grove.net** ST

SATELLITE TECHNICAL FORUM

By Larry Van Horn

Deep Space Network (DSN)

The Deep Space Network (DSN) is an international network of antennas that supports interplanetary spacecraft missions and radio and radar astronomy observations for the exploraton of the solar system and the universe. The network also supports some Earth-orbiting missions, including emergency support of the shuttle Space Transportation System.

The DSN currently consists of three deep-space communications facilities placed approximately 120 degrees apart around the world: at Goldstone, in California's Mojave Desert; near Madrid, Spain; and near Canberra, Australia. This strategic placement permits constant observation of spacecraft as the Earth rotates, and helps to make the DSN the largest and most sensitive scientific telecommunications system in the world.

NASA's scientific investigation of the solar system is being accomplished mainly through the use of unmanned automated spacecraft. The DSN provides the vital two-way communications link that guides and controls these planetary explorers, and brings back the images and new scientific information they collect. All DSN antennas are steerable, high-gain, parabolic reflector antennas.

Deep Space Bands (for spacecraft greater than 2 million km from Earth)

	Uplink (Earth to space)	Downlink (Space to Earth)
S-band	2110-2120 MHz	2290-2300 MHz
X-band	7145-7190 MHz	8400-8450 MHz
Ka-band	34200-34700 MHz	31800-32300 MHz

Near Earth Bands (for spacecraft less than 2 million km from Earth)

	Uplink (Earth to space)	Downlink (Space to Earth)
S-band	2025-2110 MHz	2200-2290 MHz
X-band	7190-7235 MHz	8450-8500 MHz

Deep Space Network (DSN) Coherent Frequency Channels

The DSN has designated channels in the allocated frequency ranges for tracking support associated with a given transponder ratio. These frequencies are for deep space use only. Channel assignments for near-Earth bands do not exist. All frequencies below are in Megahertz (MHz).

S-band DSN Discrete Uplink Frequencies

2110.243056, 2110.584105, 2110.925154, 2111.266204, 2111.607253, 2111.948303, 2112.289352, 2112.630401, 2112.971451, 2113.312500, 2113.653549, 2113.994599, 2114.335648, 2114.676697, 2115.017747, 2115.358796, 2115.699846, 2116.040895, 2116.381944, 2116.722994, 2117.064043, 2117.405092, 2117.746142, 2118.087191, 2118.428241, 2118.769290, 2119.110339, 2119.451389, 2119.792438

S-band DSN Discrete Downlink Frequencies

2290.185185, 2290.555556, 2290.925926, 2291.296296, 2291.666667, 2292.037037, 2292.407407, 2292.777778, 2293.148148, 2293.518519, 2293.888889, 2294.259259, 2294.629630, 2295.000000, 2295.370370, 2295.740741, 2296.111111, 2296.481481, 2296.851852, 2297.222222, 2297.592593, 2297.962963, 2298.333333, 2298.703704, 2299.074074, 2299.444444, 2299.814815

X-band DSN Discrete Uplink Frequencies

7147.286265, 7148.442131, 7149.597994, 7150.753857, 7151.909723, 7153.065586, 7154.221449, 7155.377316, 7156.533179, 7157.689045, 7158.844908, 7160.000771, 7161.156637, 7162.312500, 7163.468363, 7164.624229, 7165.780092, 7166.935955, 7168.091821, 7169.247684, 7170.403551, 7171.559414, 7172.715277, 7173.871143, 7175.027006, 7176.182869, 7177.338735, 7178.494598, 7179.650464, 7180.806327, 7181.962190, 7183.118057, 7184.273920, 7185.429783, 7186.585649, 7187.741512, 7188.897378

X-band DSN Discrete Downlink Frequencies

8400.061729, 8401.419752, 8402.777779, 8404.135802, 8405.493826, 8406.851853, 8408.209876, 8409.567903, 8410.925927, 8412.283950, 8413.641977, 8415.000000, 8416.358023, 8417.716050, 8419.074073, 8420.432097, 8421.790124, 8423.148147, 8424.506174, 8425.864197, 8427.222220, 8428.580248, 8429.938271, 8431.296294, 8432.654321, 8434.012344, 8435.370371, 8436.728395, 8438.086418, 8439.444445, 8440.802468, 8442.160492, 8443.518519, 8444.876543, 8446.234570, 8447.592593, 8448.950616

Ka-band DSN Discrete Downlink Frequencies

31909.913580, 31915.074083, 31920.234571, 31925.395059, 31930.555562, 31935.716050, 31940.876538, 31946.037042, 31951.197530, 31956.358033, 31961.518521, 31966.679009, 31971.839512, 31977.000000, 31982.160488, 31987.320991, 31992.481479, 31997.641967, 32002.802470, 32007.962958, 32013.123462, 32018.283950, 32023.444438, 32028.604941, 32033.765429, 32038.925917, 32044.086420, 32049.246908, 32054.407411, 32059.567899, 32064.728387, 32069.888891, 32075.049379, 32080.209867, 32085.370370, 32090.530858, 32095.691361, 32100.851853, 32106.012342, 32111.172845, 32116.333333, 32121.493822

Ka-band DSN Discrete Uplink Frequencies

34324.150460, 34329.701396, 34335.252316, 34340.803236, 34343.235337, 34346.354172, 34348.789359, 34351.905092, 34354.343365, 34357.456012, 34359.897372, 34363.006948, 34365.451394, 34368.557868, 34371.005401, 34374.108804, 34376.559407, 34379.659724, 34382.113429, 34385.210644, 34387.667436, 34390.761580, 34393.221458, 34396.312500, 34398.775465, 34401.863420, 34404.329471, 34407.414356, 34409.883493, 34412.965276, 34415.437500, 34418.516196, 34420.991507, 34424.067132, 34426.545529, 34429.618052, 34432.099535, 34435.168988, 34437.653542, 34440.719908, 34443.207564, 34446.270828, 34448.761571, 34451.821764, 34454.315593, 34457.372684, 34459.869599, 34462.923604, 34465.423606, 34468.474540, 34470.977628, 34474.025460, 34476.531635, 34479.576396, 34482.085641, 34485.127316, 34487.639663, 34490.678236, 34493.193670, 34496.229172, 34498.747692, 34501.780092, 34504.301699, 34507.331012, 34509.855705, 34512.881948, 34515.409727, 34518.432868, 34520.963734, 34523.983804, 34526.517741, 34529.534724, 34532.071763, 34535.085644, 34537.625769, 34540.636580, 34543.179791, 34546.187500, 34548.733798, 34551.738420, 34554.287805, 34559.841827, 34565.395833, 34570.949840 ST

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By Philip Chien

Watching a Space Shuttle Launch In Person

Space Shuttle launches are nice to watch on television, but have to be seen in person to be really appreciated. Eighteen hundred tons of high performance propellants are used to put five to seven astronauts and the 100 ton shuttle into orbit. Most of that energy is actually wasted–as excess sound and light, it puts on an incredible show.

One of the most common questions is what's better–a day launch or a night launch? When you attend a day launch you get to see a bit more detail, with the shuttle's orange external tank clearly standing out. Night launches are better for seeing a more spectacular "big picture," turning the night into day. Certainly night launches can be seen from great distances; a couple have even been observed by cosmonauts aboard the *Mir* space station! In either case, if the weather's clear you should be able to see the solid rocket boosters separate about two minutes after launch.

NASA provides passes which permit you to drive on to the Kennedy Space Center on the launch day. The passes are limited and are handed out on a first come first served basis. You should send in requests as early as possible for a car pass; six months isn't too early to start planning. Call 407-867-6000 for a recording with information on obtaining car passes. The KSC Worldwide web site for car pass information is **http://www-pao.ksc.nasa.gov/kscpao/carpass/carpass.htm**.

To request a pass, send a postcard with your name, address, and the mission number of the launch you wish to see to: Car Passes, PA-PASS, Kennedy Space Center, Florida 32899.

Another way to obtain a car pass is from your congressperson. Each member of Congress is given a number of passes. You can write your congressperson a letter telling them how much you support the space program and include a request for a pass for a specific mission.

Three Sites from which to View Shuttle Launches

There are three sites for visitors. NASA Causeway is the public site with the largest capacity. The Static Test Road site is a bit closer and is used primarily for the astronauts's extended families and other special visitors. The Banana Creek VIP site is used for invited guests and immediate family members. Table 1 shows the line-of-sight distances to the two shuttle launch pads.

A car pass permits you to bring any number of people who can legally fit into your vehicle. NASA used to require a special pass for oversize vehicles but that's no longer needed. If you have individual invitations to the VIP sites there are age restrictions. The viewing sites open about four hours before launch and you have to arrive at the gate by an hour before launch.

Paradoxically, while giant crowds no longer show up for every launch it can be more difficult to get a launch pass. Many of the areas which were used for Apollo-era launch crowds are no longer in use; there just isn't enough justification to provide the additional infrastructure for a crowd which may or may not show up.

NASA typically mails 1300 car passes to the public for each shuttle launch. However, a pass does not guarantee that you can get in! More passes are handed out than spaces are available since only a fraction of the passes are actually used. Under extremely unusual circumstances it is possible for all of the designated viewing areas to fill up and cars with passes will be turned away at the gate.

For the STS-75 launch a combination of perfect weather predictions several days in advance, a high interest in that particular mission, and a large vacation crowd already in Florida for Spring Break and Bike Week resulted in the viewing areas getting filled over two hours before launch!

You are responsible for keeping track of when launches are scheduled and any delays. There's a recorded launch schedule at 407-867-INFO (4636). The Kennedy Space Center maintains a web page at **http://www-pao.ksc.nasa.gov/kscpao/schedule/schedule.htm**

In the past couple of years an excellent skilled launch team with a lot of experience and fortunate weather conditions have resulted in every launch occurring on the first attempt. However, there have been cases where launches were delayed before the tanking was started for technical reasons, and one unusual case where managers decided not to even try due to the unfavorable weather forecast. On the other hand, there have been cases where it's taken up to six times to launch a shuttle due to a combination of different technical problems. Statistically one out of every two launch attempts results in a successful launch.

Practical Notes

There are several important items to remember:

No gasoline is available onsite so check your tank ahead of time. The closest gas stations are within two miles from each of the gate entrances.

You should dress appropriately. Florida nights can be extremely cold in the winter and the summer sun can be a scorcher. Check local weather forecasts ahead of time and bring sunglasses and sunblock if necessary.

Mosquito Lagoon got its name for a very good reason and there are lots of insects, especially around sunset or sunrise.

Firearms and alcoholic beverages are pro-

hibited. Do "not" feed the wildlife (except the insects) and do not enter the water–there are alligators in the lagoon!

There are large Port-o-Lets available for handicapped access. The outside viewing areas are just grassy areas which may be difficult to navigate in a wheelchair. The area can be extremely muddy so you should wear comfortable closed shoes.

Loudspeakers carry the countdown and instructions from the site managers. If you do have a problem then look for the flag indicating the site manager's station, or ask one of the NASA folks for assistance.

Photography is encouraged. Due to the distance to the launch pads you may need a very long telephoto lens to get a good photo. If you only have a medium length lens your best shot may be a wide shot showing the vehicle and its trail several seconds after launch. For night shots you should limit yourself to time-exposure 'streak' shots, or leave the photography to the professionals. Electronic versions of the launch photos are available on the worldwide web within a couple of hours after launch. The web site **http://www-pao.ksc.nasa.gov/kscpao/captions/hotpics.htm** has the latest photos from KSC.

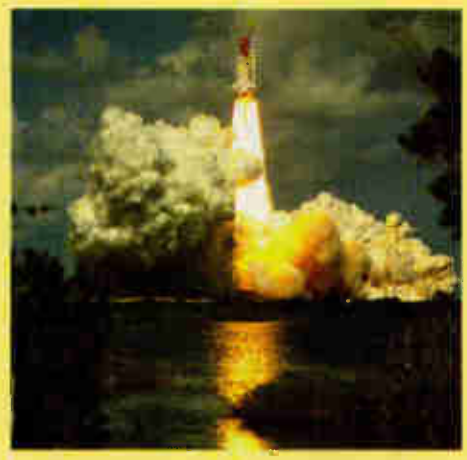
It helps to bring out a cooler with ice and beverages, and maybe a picnic lunch. Beach blankets or fold-up chairs are also useful. Binoculars are highly recommended. Food and beverages are available for sale along with some souvenirs.

The most desirable items are ones with the shuttle crew's logo. Envelopes are available with the crew logo and there are temporary post office stations. Even if the launch is delayed and you can't see it in person the cover will have the launch date postmark. You may want to bring a booklet of stamps and several address labels for yourself and friends. It only takes a couple of minutes to prepare the envelopes and drop them into the mail bag.

The NASA Causeway viewing locations are labeled "A" through "I", with "A" on the far east end of NASA property close to the Cape Canaveral Air Station. If you're located at site "D" you may see manatees in the large holding pens. This is a joint NASA/U.S. Fish and Wildlife program where injured manatees are nursed back to health before they're released.

Other Ways to Witness a Launch

A scanner can be your most valuable tool for monitoring what's happening, especially if there's a scrub or something unusual occurs. I've left the Cape after scrubs and seen cars just arriving for the launch because they didn't get the word. The March 1996 issue of *Satellite Times* featured a list of radio frequencies in use at Kennedy Space Center and Cape Canaveral Air Station. The list is available on the worldwide web at **http://www.grove.net/~larry/nasa.html.**



The Kennedy Space Center's Radio Frequency Spectrum Management permits amateur radio, Citizen's Band (CB), and General Mobile Radio Service (GMRS) voice communications as long as you're properly licensed.

Since 1983 amateur radio operator John Anderson K4GCC has been retransmitting NASA audio on 146.94 MHz. John's 'coverage' starts about three hours before the planned liftoff time and goes through the shuttle's landing. The K4ATV amateur television transmitter on 421.75 MHz retransmits the NASA TV signal. Its signal can be received on some portable television sets which tune below UHF channel 14, or on cable-ready televisions tuned to channel 57. The ATV repeater is located in Cocoa, about 20 miles from the launch viewing sites, so it helps to use a directional antenna.

If you can't obtain a car pass in time you can purchase bus tickets at the visitor's complex. The tickets go on sale five days prior to launch and are usually sold out by the day before launch. A bus ticket is US$10, or US$15 with admission to an IMAX film. Tickets must be purchased in person and only promise that you'll be taken out to the viewing site–you don't get a refund if the launch is scrubbed for any reason. If the launch is scrubbed before you board the bus, then the tickets are good for the next launch attempt. However, if there is a scrub after you reach the viewing site you have to purchase another ticket for the next launch attempt.

Alternatively, you may wish to just view the launch from the waterfront in one of the local communities. Popular viewing sites include Jetty Park in Cape Canaveral, US 1 in Titusville, or the SR-402 Garden Street bridge at the north end of Titusville. There are nominal launch day parking fees. Many of the restaurants along the waterfront in Titusville have launch day specials. Be wary of tourist traps which offer free parking, but then charge admission for each person to go to the viewing area.

Wherever you watch a launch, there's an important rule to remember. The viewing sites fill up gradually over time as people arrive. But once the launch occurs everybody wants to leave at once. Major traffic jams occur, especially at bottlenecks and toll plazas. The time after a launch is a great opportunity to just enjoy the outdoors or have a picnic while everybody else is trying to rush out at once.

Launch days and after scrubs are the busiest times at the Visitor Complex. The exhibits and gift shops remain open. The bus tours resume about two hours after launch, after NASA's safety people have inspected the launch pad area to ensure that there aren't any fires or other safety hazards.

Regrettably, shuttle landings are not open to the general public. A shuttle launch is an incredibly noisy, bright event which is still spectacular from a distance. In comparison, shuttle landings are rather sedate, with a small distinctive spot in the sky which only becomes recognizable a couple of seconds before landing. From a distance a shuttle landing looks pretty much like any other airplane landing–except its descent angle is "much" steeper. The VIP site for shuttle landings is extremely close to the shuttle's runway which makes it difficult from a logistics and safety point of view to accommodate more than a couple of hundred people. If there is an accident then poisonous propellants would be released, and a fast evacuation would be required.

A launch is something which is pretty amazing to watch on television–but incredible to watch in person. It's phenomenal how many components have to work together properly to ensure a safe and successful launch. ST

TABLE 1

Distances to the Shuttle Launch Pads (statute miles)

Site	Pad 39A	Pad 39B
Banana Creek VIP Site	4.0	3.3
Static Test Road	5.4	6.7
NASA Causeway	6.6	8.0
Titusville SR-402 bridge	12.0	10.9
Titusville US-1 at SR-50	12.6	12.0
Jetty Park Cape Canaveral	14.3	15.6

ST WHAT'S NEW

by Wayne Mishler, KG5BI

New GPS receiver and hand-held chart plotter unveiled

Magellan has introduced a new hand-held GPS satellite navigator with special features for mariners. It features a color display to improve the visibility of buoys and reefs. It is waterproof. It runs on four AA batteries which last for 30 hours in continuous use. It even tells when the fish are biting ... theoretically, of course.

And, the task of handling charts aboard small boats just became easier with the recent introduction of another Magellan device: the NAV 6000 hand-held chart plotter.

The GPS receiver is called the ColorTRAK, and Magellan minces no words in pointing out its features and performance capabilities.

"It is the most feature-rich hand-held GPS receiver to date," says Margaret Goodall of Magellan. "The Magellan ColorTRAK's ultra-sharp, four-color display is easy to read in the harshest marine conditions, and helps boaters, fishermen, sailors, and others to spot critical points like buoys, reefs, markers, hot spots and more." The price is US$298.

The unit automatically tracks your course and plots a return route, without requiring you to manually mark waypoints. It automatically marks up to 1,200 track points based on changes of speed and direction. It has a built-in thermometer and altimeter.

A "fishing time calculator" determines sunrise/sunset times and moon phases for any location in the world on any date. It displays sun and moon positions to help you choose a direction even while stationary.

A trip odometer tells you how far you've traveled, so you can estimate the time and distance to return to dock so you won't run out of fuel.

The ColorTRAK is a powerful 12-channel receiver with lock-on tracking designed to perform in any environment. The receiver stores up to 500 manually entered waypoints and 20 reversible and editable routes with up to 30 legs.

You can save waypoints, routes, and fishing hotspots, and then upload and download them to and from a PC computer, using Magellan's Map 'N Track CD-ROM software to edit and delete information.

Map 'N Track is a street guide and trip recorder bundled into one package. Linking GPS navigation with CD-ROM computer mapping, this software is ideal for in-car navigation, pre-trip planning, and post-trip reviewing.

In the ColorTRAK unit, there are nine graphical navigation screens, including a real-time multiple route track plotter with adjustable scale to show you where you're going, the path you've traveled, and the distance to your destination.

When linked to the Magellan DBR differential beacon receiver (or similar device), the unit receives corrections broadcast by the U. S. Coast Guard and other sources, and is accurate to within 10 meters.

An internal lithium battery keeps the unit's memory active for up to 10 years.

Built to withstand rigorous marine use, the waterproof receiver has wraparound rubber armor, water-sealed battery compartments, and an all-rubber backlit keypad that keeps water and salt spray out of the housing.

The unit measures 6.3 x 2.5 x 1.4 inches and weighs a scant 10 ounces, so it is at home on a yacht or a canoe. And if you need it, there is an optional kit with power source and antenna that lets you operate the unit below decks.

The NAV 6000 plotter with 77,000 pixels features unusual sharpness, says Margaret Goodall of Magellan. It incorporates C-MAP NT cartography with GPS technology to give you palm-top information on inland lakes, rivers, navigation buoys and markers including marinas and other shore facilities and services.

"With a growing library of inland lakes and rivers on C-MAP NT cartridges, the NAV 6000 shows you where you are, points you to the best fishing spots, and provides chart data while en route," says Goodall.

Built-in worldwide charts and optional regional C-MAP micro-cartridges contain detailed information on lighthouses, spot soundings, landmarks, and depth contours.

"The data is displayed on the sharpest, highest-resolution LCD display ever put into a hand-held chart plotter," says Goodall, adding that the backlit display is easy to read even in direct sunlight due to special Magellan technology.

Priced at US$600, The NAV 6000 has language options for English, French, German, Italian, and Spanish.

Like the ColorTRAK, the chart plotter is waterproof and rugged. It operates on six AA batteries, and comes with an external power adapter and bracket mount which tilts and swivels 360 degrees.

Other Magellan products include the GPS Pioneer satellite navigator, billed as the world's first portable GPS receiver priced under US$100. It is also waterproof and built for marine and outdoor use.

You can get more information on these and other Magellan products at **www.magellangps.com** or by telephoning 800-707-5221.

Life at sea not so lonely any more

"In the past, yachtsmen have been lonely individuals who sail the seas without contact with loved ones. But now sailors can privately call, fax, e-mail and access the Internet for a price that is competitive with

cellular phone rates."

That's how Anne Albanese, of Austin/Lawrence Group, describes a new marine personal satellite phone service from British Telecommunications (BT) and Norwegian partner Telenor.

They call the new service Mobiq Marine, and describe it as the world's smallest mobile communication system. It is about the size of a notebook computer. It features simple operation, direct dial, and, in the satellite telephone marketplace, a competitive price tag.

Air time is billed at US$3 per minute, and the telephone unit sells for US$7,000.

"Communication from open bodies of water has generally required large equipment to obtain a clear signal from the Inmarsat satellite system," Pat Ryan of BT explains.

"But our new Mobiq Marine phone allows customers to use cost effective satellite communications from the smallest system available."

Mobiq Marine offers high-quality voice, fax, and data communications, including email.

Additional information is available by telephoning 800-331-4568, or by visiting **www.globalmobile.bt.com** on the Internet.

War escalates between DBS and cable

Beginning March 10, DIRECTV satellite television service will add eight channels to its programming, including the MTV Network services, at no additional cost.

The additional channels include MTV Music Network, M2, Nickelodeon and Nick at Nite Classic TV (East and West), Nick at Nite's TV Land, VH1, Comedy Central, and Lifetime Television.

This further widens the gap between DIRECTV and cable operators, says Eddy Hartenstein, president of the DBS giant.

The new channels are moving to DIRECTV from U. S. Satellite Broadcasting (USSB) which will be adding new premium movie networks to its lineup, also at no additional cost to subscribers.

It is a win-win move for the companies and viewers, says Hartenstein, giving DIRECTV a more complete lineup of popular cable channels including sports and pay per view movies. It also gives USSB a stronger focus on movies.

All eight of the new channels will be available on DIRECTV's Total Choice package starting at US$29.99 per month.

Five of the channels will be included in DIRECTV's Select Choice package for US$19.99 per month.

For information on how you can access more than 175 channels of programming via satellite, visit DIRECTV's Internet web site at **www.directv.com.**

Space pen defies gravity

Okay astronaut-to-be, reach for your space pen. Hmmm. Don't have one? Then you need to peruse the pages of the 1998 Edmund catalog for science and engineering enthusiasts.

Edmund has space pens of the type used by NASA for use on manned space flights. These pens are specially designed to write in weightless conditions, upside down, sideways, right side up–whatever position you happen to find yourself in when you need to write.

Not only that, Edmond says their space pens are built to write in 50 degree below zero cold or 250 degree heat (Fahrenheit, of course). They reportedly even write under water. So if you happen to be the one who discovers water on the moon, you'll be ready to write about it, from the bottom up if necessary.

Now you wouldn't expect such a mind-boggling pen to be cheap. And you'd be right. This baby, in chrome or matte black finish, sells for US$41.95.

But in space–and in some places on Earth–anything less could be no pen at all.

Space pens are just one of many products you'll find for space enthusiasts in the Edmund catalog. You can ask for a copy by telephoning 800-728-6999 Monday through Friday from 9 a.m. to 5 p.m. eastern standard time or visit their website at **http://www.edsci.com.**

The ultimate connection

If you can't find the electronic connection, cable, adapter or other related item you need for hooking up your satellite equipment, give Pasternack Enterprises a call. They specialize in such things.

PE offers a pocket-sized catalog filled with attenuators, coaxial switches, connectors, DC blocks, directional couplers, and cables of various types.

You can contact them by telephoning 714-261-1920, faxing 714-261-7451, or writing Box 16759, Irvine CA 92623.

Get weather warnings by pager

A firm called AccuWeather, Inc., wants to be your personal weather warning center. They are the new owners of WeatherPage, a service which sends severe weather warnings to clients by pager. This service is available for any alphanumeric pager from any paging company.

Clients receive warnings and forecasts from both the National Weather Service and those of AccuWeather's own meteorologists.

The service can be customized to provide specific information for the client's area of interest.

"This is a vital service for protection of life and property," says Dr. Joel Myers, president of AccuWeather.

AccuWeather was founded in 1962 and serves more than 10,000 clients worldwide. Their offices are located in State College, Pa. You can learn more about the company and its services by visiting: **www.accuweather.com/.**

Catalog offers unusual aerospace books

Zenith Books specializes in books on military and civilian aircraft dating back to World War I. They offer an illustrated catalog sure to enthrall any aerospace fan.

The catalog is printed in full color on glossy paper and its 24 pages are filled with photographs and descriptions of books you probably would find nowhere else.

They also offer books on military history, and calendars featuring military aircraft nose art.

You can telephone Zenith at 800-826-6600, or e-mail them at: **mbibks@win.bright.net.** ST

ST SPACE WATCH

By Larry Van Horn

Auroras Light the Night on Jupiter ...

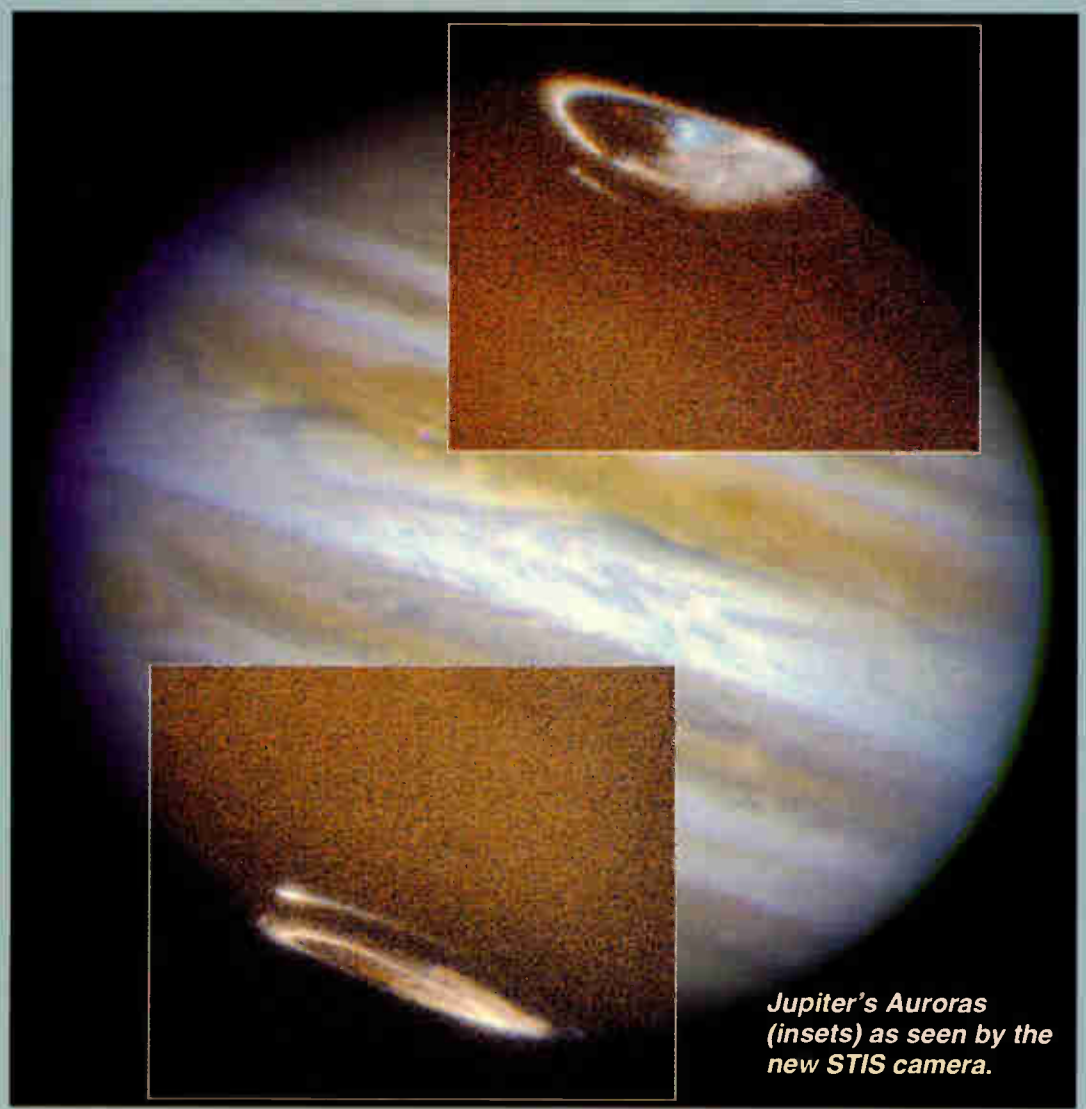
NASA's Hubble Space Telescope has captured a complete view of Jupiter's northern and southern auroras.

Images taken in ultraviolet light by the Space Telescope Imaging Spectrograph (STIS) show both auroras, the oval-shaped objects in the inset photos. While the Hubble telescope has obtained images of Jupiter's northern and southern lights since 1990, the new STIS instrument is 10 times more sensitive than earlier cameras. This allows for short exposures, reducing the blurring of the image caused by Jupiter's rotation and providing two to five times higher resolution than earlier cameras.

The resolution in these images is sufficient to show the "curtain" of auroral light extending several hundred miles above Jupiter's limb (edge). Images of Earth's auroral curtains, taken from the space shuttle, have a similar appearance.

In this photograph Jupiter's auroral images are superimposed on a Wide Field and Planetary Camera 2 image of the entire planet. The auroras are brilliant curtains of light in Jupiter's upper atmosphere.

Jovian auroral storms, like Earth's, develop when electrically charged particles trapped in the magnetic field surrounding the planet spiral inward at high energies toward the north and south magnetic poles. When these particles hit the upper atmosphere, they excite atoms and molecules there, causing them to glow (the same process acting in street lights).



Jupiter's Auroras (insets) as seen by the new STIS camera.

The electrons that strike Earth's atmosphere come from the sun, and the auroral lights remain concentrated above the night sky in response to the "solar wind," as Earth rotates underneath. Earth's auroras exhibit storms that extend to lower latitudes in response to solar activity, which can be easily seen from the northern U. S.

But Jupiter's auroras are caused by particles spewed out by volcanoes on Io, one of Jupiter's moons. These charged particles are then magnetically trapped and begin to rotate with Jupiter, producing ovals of auroral light centered on Jupiter's magnetic poles in both the day and night skies.

Scientists are comparing the Hubble telescope images with measurements taken by NASA's Galileo spacecraft of Jupiter's magnetic field and co-rotating charged particles. They believe the data will help them understand the production of Jupiter's auroras. (Credits: John Clarke–University of Michigan and NASA)

This is the first image of Saturn's ultraviolet aurora taken by the Space Telescope Imaging Spectrograph (STIS) on board the Hubble Space Telescope in October 1997, when Saturn was a distance of 810 million miles (1.3 billion kilometers) from Earth.

The new instrument, used as a camera, provides more than ten times the sensitivity of previous Hubble instruments in the ultraviolet. STIS images reveal exquisite detail never before seen in the spectacular auroral curtains of light that encircle Saturn's north and south poles and rise more than a thousand miles above the cloud tops.

Saturn's auroral displays are caused by an energetic wind from the Sun that sweeps over the planet, much like the Earth's aurora that is occasionally seen in the nighttime sky and similar to the phenomenon that causes fluorescent lamps to glow. But unlike the Earth, Saturn's aurora is only seen in ultraviolet light that is invisible from the Earth's surface, hence the aurora can only be observed from space.

New Hubble images reveal ripples and overall patterns that evolve slowly, appearing generally fixed in our view and independent of planet rotation. At the same time, the curtains show local brightening that often follow the rotation of the planet and exhibit rapid variations on time scales of minutes. These variations and regularities indicate that the aurora is primarily shaped and powered by a continual tug-of-war between Saturn's magnetic field and the flow of charged particles from the Sun. (Credits: J.T. Trauger–Jet Propulsion Laboratory and NASA) Sf

ST EARTH WATCH

By Larry Van Horn

Eastern Morocco

This spaceborne radar image shows how the Atlas Mountains in northwestern Africa dominate the geography of Morocco. The image shows a part of the eastern flank of these mountains near the town of Rissani, approximately 50 kilometers (31 miles) from its border with Algeria. The striking bright patterns are the complex folds in the layered rocks of this region. Careful examination of the image shows areas where the folded structures have been disrupted due to fault movement and earthquakes. Dark areas between the rock outcrops are covered in sand and serve as channels for seasonal streams in this arid region.

Scientists can use images like this one to map the geology and drainage patterns in arid regions. The area shown is 44 kilometers by 34 kilometers (27 miles by 21 miles) centered at 31 degrees north latitude, 4.4 degrees west longitude: north is toward the upper right.

Colors are assigned to different radar frequencies and polarizations as follows: red is L-band horizontally transmitted, horizontally received; green is C-band horizontally transmitted, horizontally received; blue is C-band horizontally transmitted, vertically received.

The image was acquired by the Spaceborne Imaging Radar-C/X-band Synthetic Aperture (SIR-C/X- SAR) imaging radar when it flew aboard the space shuttle *Endeavour* on April 15, 1994. SIR-C/X-SAR, a joint mission of the German, Italian and United States space agencies, is part of NASA's Mission to Planet Earth program.

ST

ST THE SATELLITE SLEUTH

By Larry Van Horn

My Favorite Satellite Band

For nearly 33 years I have tuned, scanned, searched, poked and prodded the VHF radio spectrum from 135.5 to 138.0 MHz looking for signals from orbiting satellites. It is and always has been my favorite satellite band. The sheer variety of satellites and strong signal strengths on even the simplest of receiving setups allows most newcomers the chance to hear their first satellite signals transmitting in this range.

But there is even more mystery in this frequency range than is first evident by looking at various published frequency lists. Classified Department of Defense (DoD) research payloads occasionally show up in this band. Some European geostationary satellites use this band for telemetry downlinks. In this frequency range weather satellites and even Russian earth resource imaging missions send their fax-like signals that can be readily decoded.

And then there are satellites from the early days of the space program that occasionally rise from the dead and start transmitting again on their own during the fall and spring equinoxes. Mix the right amount of sunlight at just the right angle on an aging solar panel and that old workhorse sometimes starts transmitting away. The batteries might be dead, but those old transmitters still manage to put out a decent receivable signal from time to time.

Want to listen to some interesting drama from one of the coldest spots on earth? Then you should swing your directional antennas toward the inclined orbit of the ancient NASA ATS-3 satellite. Tune your receiver to 135.600 MHz in the narrowband FM mode and you might get lucky and hear some of the interesting communications originating from the South Pole.

One of the more interesting intercepts I have heard from ATS-3 occurred several years ago when the folks down south were discussing with a ground station about the various state entrants in the yearly Miss Antarctica contest. In fact, at one point in the history of ATS-3, it was reported that the experimental communications satellite was being used for anti-drug smuggler communications by a U.S. government agency.

If you really want to test your VHF receiving station's ability to receive weak satellite signals, then the ATS-3 offers an interesting target of opportunity. Table one is the complete downlink VHF bandplan for the ATS-3 satellite.

ATS-1

So what does it take to become a VHF satellite band monitor? I will discuss in the next few columns some basic components to effectively monitor this frequency range. But first and foremost I recommend a good quality VHF/UHF multi-mode communications receiver. An Icom R-7000, R-7100 or R-8500 will be your best bet. A WinRadio or Icom PCR-1000 will also provide excellent results if you want to tie your receiver to a computer.

While you will hear some signals on a less expensive, consumer grade scanner, you will get the best results using a good quality dedicated VHF/UHF communications receiver. Some of these satellites can only be heard when the receiver's reception mode is in upper sideband (USB) or lower sideband (LSB), so you need the multi-mode capability of the more expensive receivers.

TABLE 1

1967-111A (3029) ATS-3 VHF Bandplan

135.555	Channel 1 (uplink 149.175 MHz)
135.575	Channel 2 (uplink 149.195 MHz)
135.600	Channel 3: Antarctica to U.S. link (uplink 149.220 MHz)
135.625	Channel 4 (uplink 149.245 MHz)
135.645	Channel 5 (uplink 149.265 MHz)

More importantly you won't even hear a peep from some of these satellites in the narrowband FM mode to which most consumer scanners default.

Of course, there are other factors which need to be considered such as antennas, coax and preamps, but more on that in future *Satellite Sleuths.*

Tip of the Month

Our *Satellite Sleuth* tip this month comes from Laura Halliday, VE7LDH, in Canada. Laura found that she needed a source of 137 MHz signals for some tinkering she was doing, and came up with a cheap way to do it.

After a rummage through the junk box she found that a PAL color burst crystal (4.43 MHz) has a harmonic in the right place. Her quick and dirty oscillator oscillates a little higher than the nominal frequency on the crystal, giving her a weak, but useful marker on the crystal's 31st harmonic, 137.550 MHz.

She used one gate of a 74HC04 as the oscillator, driving the other five gates in parallel as a buffer/amplifier. Using this, it only took two minutes to find out why her homebrew VHF receiver was insensitive– bad coax between the preamp/image filter (MAR-6+filters) and the main guts of the receiver (MC3362).

You can reach Laura via email at **ve7ldh@direct.ca** for more information on this cheap but interesting signal generator.

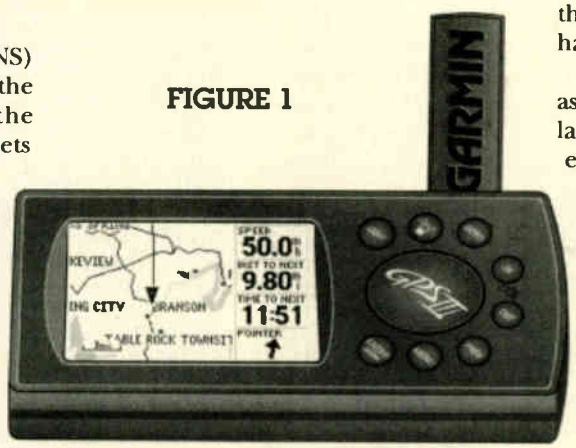
If you have a question or tip for the *Satellite Sleuth* you can send it to P.O. Box 98, Brasstown, NC 28902 or email it to **steditor@grove.net**. Till next month, good hunting! ST

By Steve Dye, gpsyes@aol.com

GPS Receiver Review: The Garmin GPS III

Personal Navigation Systems (PNS) have been slowly appearing in the market place recently and the Garmin GPS III is one device that sets itself apart from the rest. Forget struggling with old paper maps and GPS receivers that display just coordinates and trails to show your location. The Garmin GPS III features millions of miles of highways, interstates, railroads, rivers, and shorelines, all crammed into the handheld unit's memory. This compact, powerful GPS receiver will guide you safely and accurately from intersection to intersection or even city to city.

FIGURE 1



Besides calculating position and displaying it on a real-time, moving map, the GPS III also provides crucial travel information. Such data as speed, time and distance to destination, a trip odometer, average and maximum speed readings are all displayed on the many pages the user easily selects.

The GPS III represents a breakthrough in GPS receiver technology in the respect that this little unit is in fact a handheld Graphical Information System (GIS). The GPS III boasts a 12 channel parallel receiver, a large database of highways, rivers, etc. and an ease of use that will present no challenge even those who consider themselves technically disadvantaged.

Using the GPSIII

The GPS III, seen in figure 1, is a small, compact unit that boasts a built-in map of the major highways of Northern America. A recent trip to Orlando was made rather easy with the GPS III. I entered the coordinates of my destination, easily obtainable from the Internet-and upon arrival in greater Orlando, I periodically checked my distance and bearing to it. While enroute, the GPS III kept me constantly informed of my position, showing my exact whereabouts relative to other highways, lakes, rivers or even railway lines. Figure 6 shows an example of a display indicating major highways and a lake.

The high resolution display provides a clear, accurate read out and can be viewed in either portrait or landscape format. The GPS III is a handheld portable unit, and, despite the small size of the display, offers a tremendous amount of information.

Following my progress on the map display, I am also informed of my speed and bearing along with any other item of information I configure it to display. Hitting the page button, I get another display, with even more information. Such user definable parameters as altitude, maximum speed, average speed, time elapsed, sunset and sunrise times, even your latitude and longitude are selectable if you like!

Satellite visibility can be an issue if you are using your portable receiver without an external antenna. Placing the GPS III on my dashboard gave sufficient visibility to more than eight satellites, and I did not lose lock at all. The 12 channel receiver was capable of finding more than the four satellites needed to provide the fix.

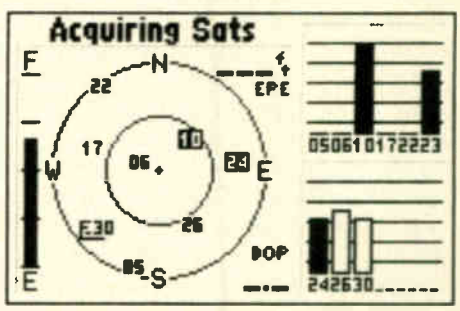
Meanwhile, on vacation in the Rockies along US-40, the GPS III very kindly informed me of the long and winding road ahead, and was actually useful when visibility was down, warning me of curves ahead! On a snowmobile excursion, the GPS III reliably informed me of my position relative to the base, and was also able to tell me that the adventurers to the west of me were in fact on the edge of a rather large, but frozen lake, which I was glad not to be on! Upon return, I used the useful "TracBack" feature to guide me back through the low visibility snow fall that had begun to fall.

On a recent road trip in Jacksonville, as part of my job finding candidate cellular radio sites, I easily navigated my way to each site, taking short cuts through smaller roads that I could see on the moving map but which were not immediately obvious otherwise. It was almost if the GPS III was giving me the same view an overhead satellite would have! Using the zoom function, the GPS III was able to show me the big picture of Northeast Florida, accurately showing St. Johns River, its bridges, railroads and lakes. Zooming in, I was shown a clearer view of my position along with local road names. The GPS III truly is an intelligent map and a productivity tool.

The database of information in the GPS III is an admirable feat considering the size and portability of the unit. For the sheer fun of it, I powered my GPS III up at a window seat on a Boeing-767 on my way to Denver via St. Louis. Considering the size of the windows on the plane, it was amazing that the receiver actually found five satellites. After a short while, the GPS III indicated that I was 32,000 feet, doing 530 miles per hour, and that I was over the state of Kentucky!

The display and readout is user selectable, so if bearing, distance to destination and time to destination were of importance, I could have easily configured it.

FIGURE 2



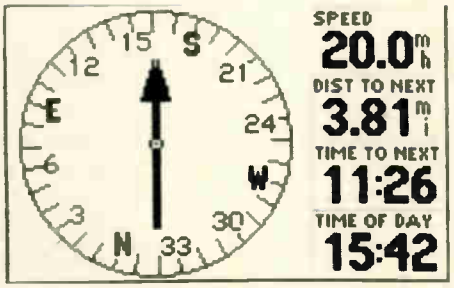


FIGURE 3

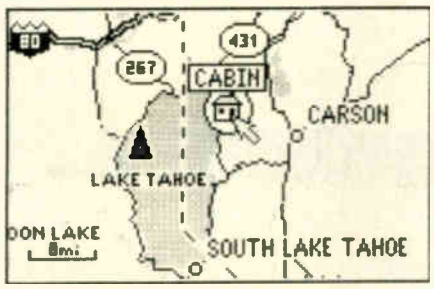


FIGURE 4

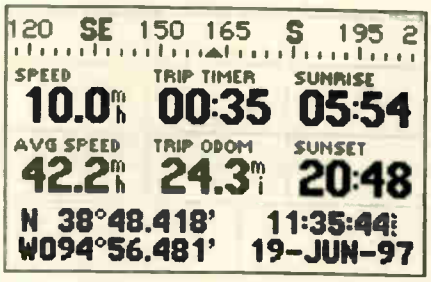


FIGURE 5

Using the zoom out function, I saw the entire United States, state borders, and major highways. Zooming in, I could see how fast we were moving as the display efficiently refreshed itself to update the new location. This example was purely for entertainment purposes, but does reveal the ability and flexibility of the unit.

Whether you are in the air or on the ground, the GPS III could be a life saver. If you have absolutely no clue as to where you are, zoom in or out to get a fix relative to a major highway, a lake or railroad. It's that simple. Imagine being snowbound in the upper Midwest, completely disoriented in an unfamiliar town or stuck in low clouds in a light aircraft. The GPS III could get you out of a very sticky situation, and it fits in your pocket.

Waypoints

A waypoint is position data for a particular location that can be named and stored in memory by the user. The GPS III can store up to 500 waypoints in its memory, and allows the user to assign a symbols and or name. You may decide to enter your home, where you moor your boat, where your weekend cottage is or perhaps where you seem to catch most fish.

A waypoint can be entered in a variety of ways. The user can enter it by manually entering the coordinates and naming it with the option of assigning a symbol, or by actually being at the location and entering the current coordinates into memory.

Another way to enter a location into memory, which will be useful for mariners is the man over-board (MOB) feature. Should a person or your child's favorite teddy bear fall into the water, holding the "GOTO" key will instantly place the coordinates where it fell into memory, and assign it MOB. The user then hits the enter key to show the way back to the location.

Breadcrumbs

A long hike or journey does not mean you have to constantly enter landmarks' coordinates so as to find the way back again. The track feature allows you to retrace your steps back to base, by following the "breadcrumb trail" you left on your outbound route.

The breadcrumb trail is actually a set of points the GPS III stores into memory automatically, along the route traveled. Simply selecting the "TracBack" feature, lets the GPS III steer you to your point of origin.

Having discussed some of the many features of the GPS III, let's look at some of the GPS III's many pages it displays. Figure 2 shows the GPS III in the satellite acquisition mode. The circles represent the horizon and 45 degrees above, along with visible satellites, indicating their last known position. To the right, the bars represent signal strength by height and are shown black if being used, and clear if the GPS III is collecting data from it.

Since the GPS III knows where you are and where you are going, it can always give you a bearing and heading reading. Figure 3 shows the compass page and the graphical compass. The other four items to the right are, again, user definable and are extremely useful in navigating to any destination. Here, the GPS III informs us it will take another 11 and a half minutes to our destination at the current speed of 20 miles per hour.

Going west now to northern California, we see how the GPS III displays Lake Tahoe, Interstate 80 with local roads, and the user-defined waypoint known as "cabin" in Figure 4. Here the user applied one of the many symbols assignable to any waypoint.

Figure 5 shows an alternative display, the position page. This useful page consolidates a host of user-definable information that provides such items as sunset and sunrise times for that location–very useful for planning daylight activities; it also indicates the heading at the top of the page, and can also provide data such as average speed, time elapsed, local time and, of course, your coordinates.

In conclusion

The GPS III is a remarkable device boasting an enormous amount of data pertaining to roads, highways, railways and rivers and more for Northern America in one small, compact package. It also contains a map of the entire world, showing each country and its borders, too!

The GPS III is effectively an intelligent map that knows where it is, and tells you where you are. The super sensitive 12 channel parallel receiver gives fast satellite acquisition and did not require an external antenna in the many vehicles I drove or was passenger in. Urban or natural canyons presented no real challenge to the receiver and positioning accuracy was very impressive. A 500 waypoint memory with 40 different user-assignable symbols and a Man Overboard feature proves the small device is big on memory and features.

The GPS III is differential ready, and its interface will accept a variety of differential formats. The battery pack, consisting of four AA cells, will give eight hours of life, so do be careful. An external power connection is available, and this may prove beneficial for long trips. The GPS III is very easy to use and all pages can be user-configured to display whatever contents are desired. The unit also features a removable antenna allowing it to be externally mounted.

At a suggested price of US$570.00, the GPS III is not cheap, but is a much better alternative to other GPS receivers currently on the market, and is well worth the price considering the features. Having tested the GPS III, I can certainly say that it would be money well spent, and is clearly a leap forward in personal navigation systems technology,The GPS III is a definite must for business persons, weekend travelers, hikers, or just about anybody!

Usability ★★★★★
Functionality ★★★★★
Affordability ★★★★★
Overall figure of merit ★★★★ 1/2

ST

Dr. T.S. Kelso

More Frequently Asked Questions

In the last edition of this column we discussed the frequently asked questions about two-line keplerian element set formats. Now that we have that subject out of the way (see *Frequently Asked Questions: Two-Line Element Set Format Satellite Times* Volume 4 Number 3), we can move on to addressing questions 5–13 below from our last column.

5. How does one convert two-line elements to some other format?
6. What is the accuracy of predictions using the two-line element sets?
7. How often are element sets generated?
8. What is the reference frame of the resulting coordinates?
9. Are there two-line element sets for the moon and/or sun?
10. How do new satellite elements get added to the *Celestial WWW*?
11. How does one find source code for the SGP4/SDP4 orbital models?
12. How does one obtain historical element sets?
13. Where does one find a list of satellite frequencies?

5. How does one convert two-line elements to some other format?

Actually, this is one of the most common questions I get asked. Usually, the user has data in some other format that they want to use in a program that uses two-line element sets or they have two-line element set data that they want to use in their favorite satellite-tracking program. The simple answer is: Just don't do it! Here's why.

The common misconception is that the two-line element sets are simply a format for standard data. After all, if both the two-line element set format and Format X have an eccentricity term, it should be a simple matter of substituting the value. Other terms could simply be interchanged by using a straightforward mathematical transformation (such as the relationship between mean motion and semi-major axis). Isn't there a program to automatically handle this conversion? Unfortunately, it's not quite that simple.

The elements in the two-line element sets are mean elements calculated to fit a set of observations using a specific model—the SGP4/SDP4 orbital model. Just as you shouldn't expect the arithmetic and geometric means of a set of data to have the same value, you shouldn't expect mean elements from different element sets—calculated using different orbital models—to have the same value. The short answer is that you cannot simply reformat the data unless you are willing to accept predictions with unpredictable errors. The long answer is that I will discuss a method for transforming element sets—which involves a much more complicated process—in a future column.

6. What is the accuracy of predictions using the two-line element sets?

Accuracy of the two-line element sets is dependent upon a number of factors. These range from the particular sensors used and amount of data collected to the type of orbit and condition of the space environment. Unfortunately, since these factors vary for each element set, so does the accuracy. While NORAD has experimented with methods to incorporate prediction quality into
the element sets, none of these methods has yet proved successful.

It is possible, however, to assess the *consistency* of the element set data, rather than their accuracy. That is, how well one element set's predictions agree with those of its successor or predecessor element set. By comparing the magnitude of the vector difference of the predictions from two successive element sets at the epoch of the newer element set (when it should be most accurate), it is possible to gauge the consistency between those element sets. Taken in aggregate for a particular satellite over time, it is possible to gauge the general accuracy of the data (assuming that the element set production process is statistically unbiased) and get a sense for how long an element set is valid.

While NORAD maintains specific target tolerances for the overall level of accuracy as a system performance metric, it can be expected that accuracy will vary depending upon the type of orbit and satellite involved. For this reason, it is probably best to independently assess the accuracy of each specific satellite for which accuracy is a consideration. For more information on this topic, see my column titled *Real-World Benchmarking* in *Satellite Times* Volume 3 Number 2.

7. How often are element sets generated?

New element sets are generated by NORAD on an as-needed basis rather than according to an established timetable. How often these updates occur depends upon a number of factors such as the orbit type or maneuvering capability of the satellite.

For example, a satellite in low-earth orbit—such as the US space shuttle—would have its element sets updated several times a day because of the somewhat unpredictable results of atmospheric drag as it varies its attitude and the maneuvering being performed. A satellite in a low-drag orbit which doesn't maneuver—such as LAGEOS II—might only need updates once or twice a week. Objects such as rocket bodies, defunct payloads, or other space debris, won't be updated as frequently, either—unless there is a prediction of a close approach with an operational payload. Special-interest objects—such as a large object reentering the earth's atmosphere—normally get special treatment.

8. What is the reference frame of the resulting coordinates?

This question is a bit more technical than most we have covered. To be precise, the reference frame of the Earth-centered inertial (ECI) coordinates produced by the SGP4/SDP4 orbital model is true equator, mean equinox (TEME) of epoch.

In layman's terms, this simply means that the cartesian coordinates produced by the SGP4/SDP4 model have their z axis aligned with the true (instantaneous) North pole and the x axis aligned with the mean direction of the vernal equinox (ac-

counting for precession but not nutation). This actually makes sense since the observations are collected from a network of sensors fixed to the earth's surface (and referenced to the true equator) but the position of the earth in inertial space (relative to the vernal equinox) must be estimated. For more details on this coordinate system, see my article on "Orbital Coordinate Systems, Part I" in *Satellite Times* Volume 2 Number 1.

9. Are there two-line element sets for the moon and/or sun?

The short answer to this question is no. Assumptions made in the SGP4/SDP4 orbital model—made to reduce the computational burden of tracking thousands of earth satellites—are completely invalid when applied to other celestial bodies. Details on why this is so were covered in the January/February 1997 issue of this column titled—naturally enough—*Tracking the Sun and the Moon.* If you want to track the sun, moon, planets, or the latest comet, you're going to need to use an orbital model specifically designed to track these objects.

10. How do new satellite elements get added to the Celestial WWW?

Normally, all new objects are added to the master list as soon as the object is catalogued by NORAD. After 30 days have elapsed, elements are only maintained if someone requests that they be—otherwise, they are removed. At present, the master list contains a broad range of satellite element sets used by a large number of people around the world. It contains elements for various communications, navigation, weather, and other scientific satellites. Over the years, it has grown to include 300 satellite element sets.

The master list was originally intended as a single source of distribution back when this was originally done via the *Celestial BBS* and (later) the Usenet newsgroups. However, many users are interested in only a particular category of satellites for their applications, such as amateur radio satellites, and don't want a large list. As such, the *Celestial WWW* breaks out the satellite element sets into separate categorical lists to make it easier to find the elements of interest to you. Check out the *Current Data* section to see what lists are currently available.

In the future, the master list will probably be replaced with a list which contains only new objects catalogued within the past 30 days. All other elements will be contained within the individual categorical lists. Eventually, I hope to be able to provide users an option of defining their own list of elements to provide the ultimate in customization.

11. How does one find source code for the SGP4/SDP4 orbital models?

The primary source for the SGP4/SDP4 orbital models is found in *Spacetrack Report Number 3: Models for Propagation of NORAD Element Sets.* It contains the equations for most of the model along with the associated FORTRAN source code. This document is available on the *Celestial WWW* in *Adobe Acrobat* Portable Document Format (PDF). The FORTRAN source code can be copied directly from this document and pasted into any text editor. There is also a $LaTeX$ version online.

If you need source code in some language other than FORTRAN, you can also find a Pascal version of the complete SGP4/SDP4 orbital model on the Celestial WWW in my *SGP4 Pascal Library.* It contains not only the NORAD orbital model, but routines for doing various coordinate transformations and calculating the position of the sun. These routines were used to develop my *TrakStar* program—a simple program intended to show how easy it is to use the library but often used as a standalone analysis tool. While I still plan to produce a C version of this code, I have not had time to do this yet and I know of no publicly-available C version which contains both the SGP4 *and* SDP4 orbital models.

12. How does one obtain historical element sets?

As of mid-January 1998, there is now an online form on the *Celestial WWW* to request historical two-line element sets. Current archives run from January 1980 through the present and contain over ten million two-line element sets. Those historical element sets which are requested frequently are kept online in the *Historical Archives* section. However, it is impossible to keep all of the current archives—over 1.5 gigabytes of data—online. If you have a need for historical data which cannot be found online, please use this form (found at the bottom of the main *Historical Archives* page) to request the data you need.

13. Where does one find a list of satellite frequencies?

The best source of information on satellite downlink frequencies that I've seen can be found on *Launchspace.com* in their *Reference* section. It contains a list of over 600 downlink frequencies in the range of 3 MHz to 32 GHz covering everything from satellites to NASA support aircraft and is compiled by *ST Satellite Listening Post* columnist Keith Stein.

Watch the *Satellite Listening Post, Satellite Launch Schedules,* and *Satellite Sleuth* columns in each issue of *ST* for current and past frequency information. Also watch the *What's New* column in future issues of *ST* for the announcement of a new expanded and specialized satellite frequency list from *ST*'s managing editor Larry Van Horn. Rumor has it he is working on a huge new satellite "by frequency list" at night on the kitchen table.

Correction: In my last column (*Frequently Asked Questions: Two-Line Element Set Format. Satellite Times* Volume 4 Number 3), I suggested that the format for fields 1.10 and 1.11 owed its heritage to the FORTRAN programming language. Instead, as one of our readers pointed out, it originated with the Philco 2000/Model 212 and the TAC assembly language used on the original 496L system. The FORTRAN language just happens to follow the same convention.

Well, that's it for now. As always, if you have any questions or comments regarding this column, please feel free to contact me at **tkelso@grove.net**. Until next time, keep looking up!

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SATELLITE TIMES ADVERTISERS' INDEX

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.

RETROGRAOE 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 oassages 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.

By Bob Grove, Publisher
E-mail address: st@grove.net

The Search Goes On

Since our kind started the great epochs of exploration, we have been searching for kindred civilizations. With the closure of the terrestrial search, we began to look skyward. After all, life has such diversification here on our own earth, could not different environments support variants of life forms elsewhere?

Our eternal quest has created a cornucopia of monsters and aliens, from Loch Ness monsters and Sasquatch to bulb-headed UFO occupants. Even when we recover lunar and Martian debris, our hopeful–even expectant–bias is accused of coloring our conclusions in favor of life.

And the search goes on; after all, the statistical odds for discovering life forms in space are favorable. We reason that, given enough time for competitive evolution of those inevitable life forms, reasoning beings should prevail in their hostile environments.

There have been some arousing discoveries in our own lifetimes to fan the flames of space exploration. Karl Jansky's discovery that radio emissions from deep space could be heard on humble radio equipment on earth was one of those. And the later, low-noise, cryogenic amplifiers attached to dish antennas, revealing tantalizing signals from the stellar beyond, is another.

The most recent–and current–formal effort to make that first contact is, of course, the late Carl Sagan's Search for Extra Terrestrial Intelligence. SETI is largely a one-man show, headed by H. Paul Shuch, assisted by a worldwide team of volunteers. But how can just a few people provide the continuous manpower and equipment to search the spectrum, a few hertz at a time, and in vanishingly small arcs of the celestial sphere, until that first intelligent signal is heard?

Shuch is an amateur radio operator (N6TX) with laudable ideals. He is currently trying to organize a worldwide listening team of volunteer monitors. He feels that, given enough serious listeners following a rigid schedule, and using modest-cost equipment, the task may be less daunting.

Shuch notes, "Searching for life in space requires the kind of radio skills which hams possess...it involves the design and construction of antennas, receivers, and signal analysis hardware and software."

SETI monitoring concentrates on the classic "water hole," the resonant hydrogen line spectrum around 1420 MHz, for their monitoring efforts. While large dish antennas are desirable, smaller apertures may work–they're better than nothing. And radical new listening technologies such as the WiNRADiO and ICOM computer receivers may prove to be a boon to SETI searches.

We are living in exciting times. Man has finally discovered space, its allure and its utility. Competing technologies are already petitioning for spectrum in the few remaining radio astronomy bands. Let's hope that we will hear the tantalizing signals from other stars, other galaxies, before the earth is enclosed by transmitting satellites, deafening our electronic ears forever.

We will bring you more on this exciting frontier as it develops. In the meantime, for more information on how you can help, contact the SETI League at 433 Liberty St., PO Box 555, Little Ferry, NJ 07643 (ph. 201-641-1770) **http://www.setileague.org**, or e-mail them at **join@setileague.org**.

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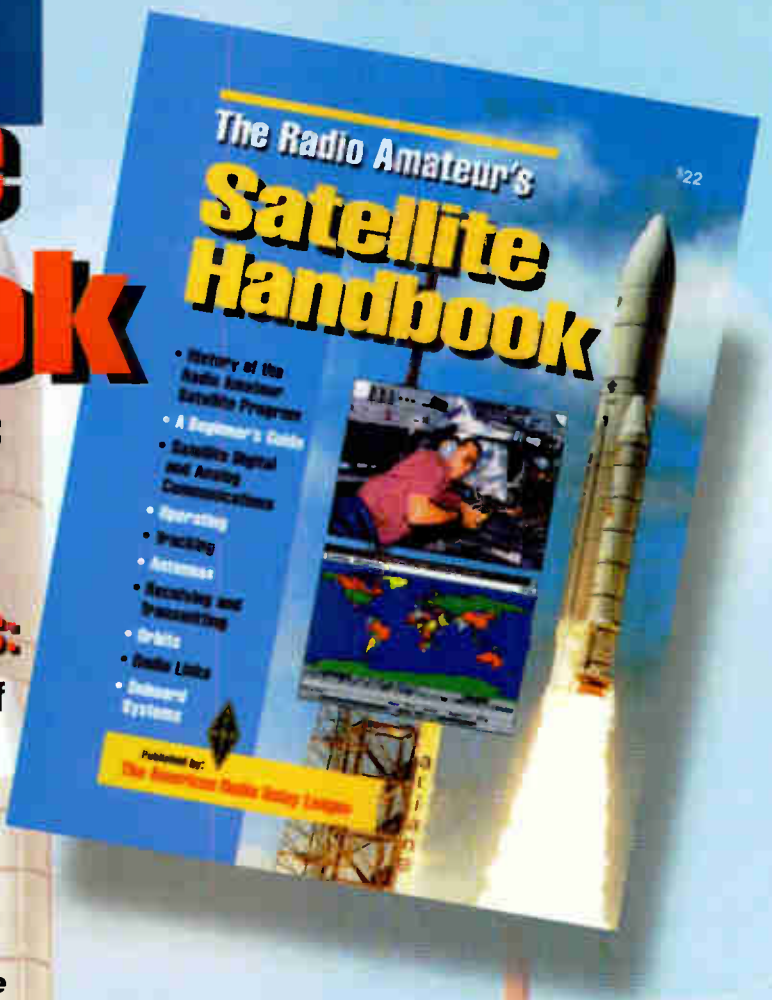

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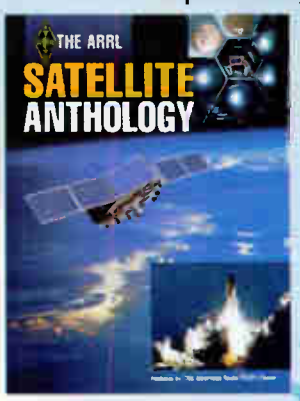

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– QST Magazine, March 1997
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2M/440MHz All Mode Dual Band Base Station *More Satellite Fun for EVERY Ham!*

Sub Band Transmit and Independent Main/Sub Band Reception

Enjoy cross band full duplex operation! The IC-821H is really two separate receivers within one compact case. Use the independent RF attenuators, RIT, IF shift circuits, and scan functions. Each band also has its own S-meter, squelch, volume control, and independent mode selection.

Continuous Adjustable Transmit Power

Better than just using a high/low setting, the continuous adjustable transmit power feature is satellite "friendly". You'll get precise power control while you help extend the life of amateur radio satellites by running the minimum power necessary.

9600 Baud Plug and Play*

Enjoy great 9600 baud packet operation right out of the box! There's a packet connection point right on the back of the rig. ICOM's famous CI-V serial communications port is included.

Visit your authorized ICOM dealer today, or call for a free brochure: (425) 450-6088

*Options required for PC operation:
CT-17 CI-V Level Converter,
third party serial cable with pins 1-8 & 20,
third party software

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