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Volume 4 Number 3
January 1998

Ariane Launches #100

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Satellite Times

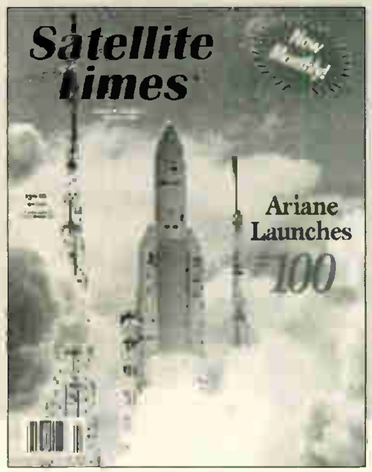
Cover Story

Cover Photo: "And we have liftoff." The cover of this month's ST is the first successful launch of an Ariane 5 rocket from Kourou, French Guiana. Ariane 502 was launched on October 30, 1997, at 0143 UTC. It was the second ESA/CNES qualification flight for the Ariane 5 rocket and it carried several payloads into orbit. (Photo by Arianespace)

Ariane Launches #100

By Philip Chien

When Europe first announced its plans to build its own launch vehicle the world aerospace industry laughed. After 100 successful launches, nobody is laughing anymore. Arianespace has proven itself the leader in the commercial launch industry. *ST*'s Philip Chien takes an in-depth look at the Ariane rocket family starting on page 10.



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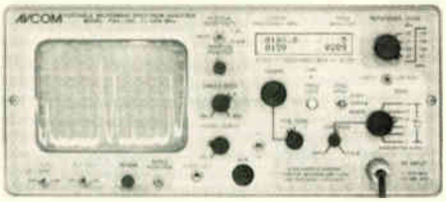
Russian Proton Rocket Program

A Satellite Times Special Profile

By Phillip S. Clark

For years the Russian space program was veiled in total secrecy. Information was sketchy and diagrams or pictures of Russian rockets and satellites weren't publicly available. But the Cold War has ended and the Russian space program has come out of the cold. For the first time ever, *ST*'s Phillip Clark profiles Russia's commercial launch program and its powerful workhorse–the Proton rocket. Story starting on page 16.



One of the handiest tools a satellite monitor can add to his listening post is a spectrum analyzer. The various modes used on satellite downlinks display unique visual signatures and the spectrum analyzer is the instrument that can display the signatures. In this month's *ST Test*, Bob Grove puts one of the best, the Avcom PSA65C Spectrum Analyzer, through its paces. Review on page 73.

DEPARTMENTS

ST

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By Larry Van Horn
Managing Editor
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Dawn of New Era for *Satellite Times*

Since Grove Enterprises started publishing *Satellite Times* in September/October 1994, the single, most frequently asked question from readers and staff alike has been, "when is *ST* going monthly?"

One of my long term goals as editor of *Satellite Times* has been to turn this wonderful resource, the only one of its kind, into a monthly publication. Since we published the first issue of *ST* we have conducted three reader surveys and the biggest negative comment in each of those was the bimonthly publishing schedule.

But to publish *ST* monthly, there were a lot of hurdles that had to be overcome. As an old friend of mine used to say, "nothing that is good comes easy."

What you hold in your hands right now is a lot of hard work by our team of talented writers and the great Grove Enterprises staff here in Brasstown, NC. Each of them worked long, hard hours so we could stick "January 1998" on the cover of this issue of *Satellite Times.* To each of you, thank you very much for your help and support. We could not have done this without your effort.

The decision to take *Satellite Times* monthly also had a profound effect on our sister publication *Monitoring Times.* Among other issues was a hard decision I had to make, personally. I would now have to give up my monthly writing assignments in *Monitoring Times.*

I wrote my first column 170 months ago in November 1983. That monthly contribution to *MT* was called *Signals from Space,* and it was the first column ever to cover space communications on a regular basis in any of the major hobby publications of the time.

In March of 1988, then *MT* editor Larry Miller asked me to switch my emphasis from space to terrestrial communications. I started writing the *Utility World* column that covered nonbroadcast communications below 30 MHz and we phased out the space column. Since starting *ST* I have continued to write the Utility World column every month. In addition, several other columns have carried my byline, and I have also penned quite a few features for *MT.* I will miss all of that a great deal. But I will especially miss the readers of *MT.* They are truly special folks.

I have made many life long friends in my 14 years with *Monitoring Times.* Hundreds of readers contributed to my columns in *MT* for which I'm eternally grateful. Many of you now also subscribe to *Satellite Times.* While it would be impossible to name or thank each of you personally, I do want each of you to know how grateful I am for your support and friendship over these many years. The reason I was able to learn and grow in the radio hobby was because of your kindness in sharing your knowledge and support.

I feel now my radio career has come full circle and I return to what got me started with Grove Enterprises 14 years ago–space communications. I look forward to being able to do more writing here in the pages of *Satellite Times.*

Finally, with our change to a monthly publication comes a change in the cost of subcriptions and the way we will handle renewals. The new cover price is US$3.95 and CN$6.25 in Canada per issue. The new subscription rates can be found on page 78 in this issue of *ST.*

We have also adjusted your renewal dates. For example, if you had one year left on your old subscription (six bimonthly issues) you will get the next six monthly issues (January-June 98) of *Satellite Times.* Be sure to check your mailing label on the front cover for your *new* renewal date.

You definitely don't want to miss any issue in 1998, a year which holds the promise of new frontiers and discoveries from LEO to GEO and beyond. You don't want to miss any exciting issue of *Satellite Times,* your magazine of record for *Signals from Space.* ST

Satellite Monitor

By Wayne Mishler, KG5BI

International Space Station to Move Ahead in '98

1998 promises to be the threshold year of the International Space Station. With the first launches approaching, representatives of the 15 nations building the ISS have finalized the station's assembly sequence. Construction remains on schedule.

"All of the partners reported they were on schedule with their contributions to the station," International Space Station Program Manager Randy Brinkley said.

"The first elements, the Functional Cargo Block and the U.S. Node 1, remain on track for launches this year. In September, during a General Designer's Review for the third element, the Russian Service Module, the Russian Space Agency promised to meet the scheduled launch date of December 1998."

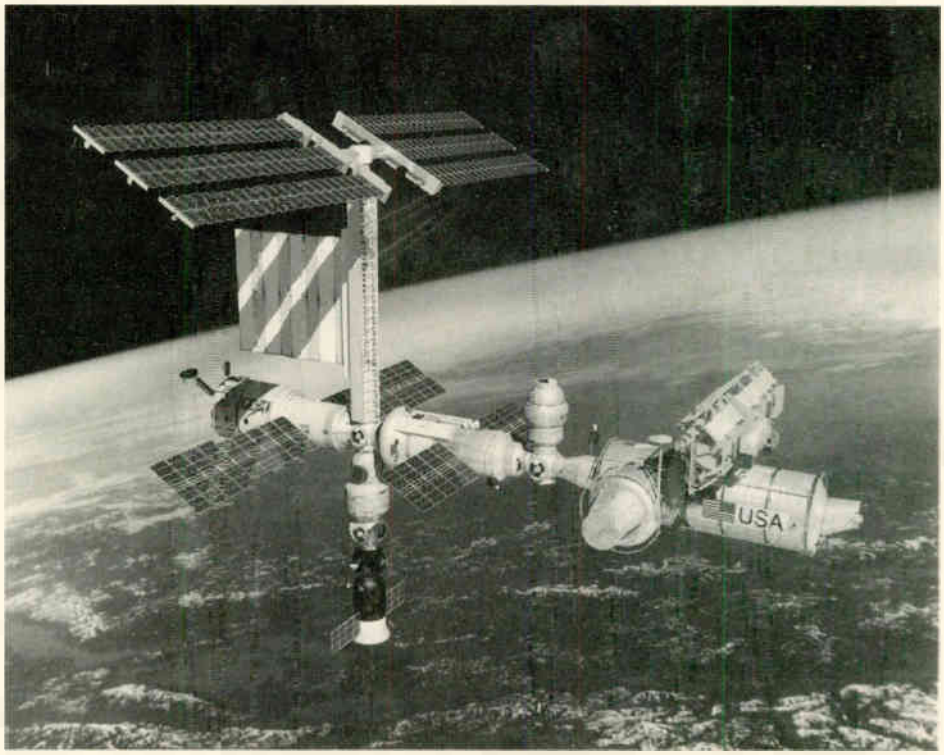
The latest assembly sequence approved by the board maintains a launch of the European Space Agency's Columbus Orbital Facility in October 2002 and establishes the launch of a third connecting module, called Node 3, to the station.

The Revision C assembly sequence was approved in preliminary form during a May board meeting. The last 15 flights of the 45-flight sequence remained under review following the May meeting, pending further evaluation of launch date options for the Columbus module.

Assembly begins in June 1998 with the launch of the Functional Cargo Block, financed by the U.S. and built and launched by Russia. The U.S. node is scheduled for launch on Shuttle mission STS-88 in July 1998. Assembly of the Space Station is to be completed in 2003.

The service module, the first fully Russian contribution to the station, completed a critical milestone Sept. 12 when the general designer's review was held in Moscow. Under construction at the Khrunichev State Research and Production Space Center in Moscow, the module has progressed rapidly this summer. It remains on target for the December 1998 launch from the Baikonur Cosmodrome in Kazakhstan.

Manufacture of the module is to be completed at Khrunichev in November and it will be moved to Rocket Space Corporation-Energia (RSC-Energia) facilities to begin final testing.



Phase II of the International Space Station is depicted with elements provided by the United States and Russia comprising the Human Tended Space Station.

Another general designer's review is scheduled for January 1998, and the module will be shipped to Baikonur to begin launch preparations in late May 1998.

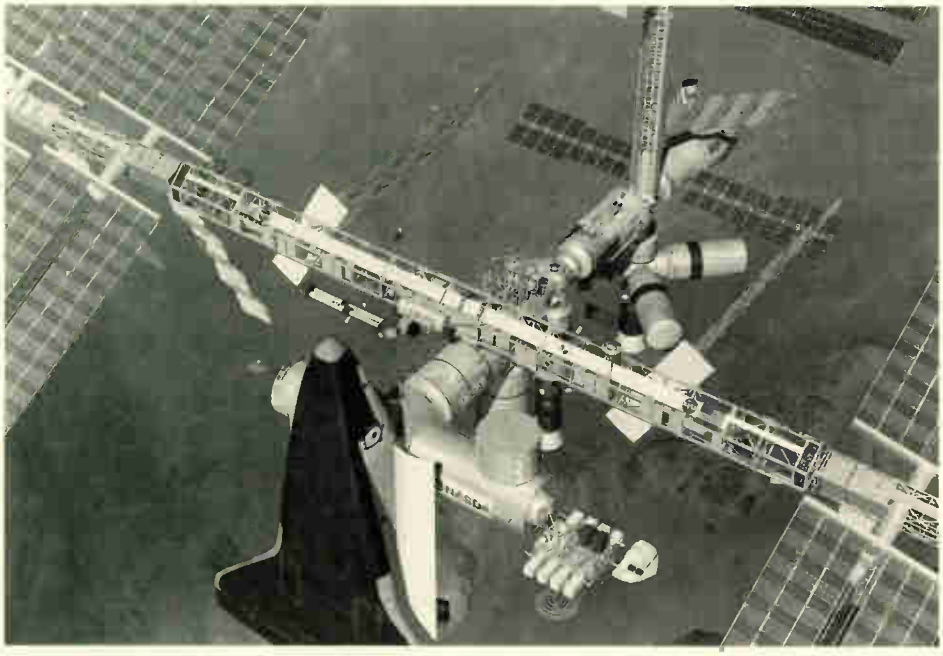
The first station element, the U.S.-funded, Russian-built Functional Cargo Block, is on track for a launch in June 1998. Modifications to the module begun earlier this year have been completed that will allow it to be refueled and to accommodate Soyuz dockings. It was completed at Khrunichev Sept. 15 and moved to the RSC-Energia facilities where it is undergoing final testing. In January 1998, it will be shipped to Baikonur.

NASA Administrator Daniel S. Goldin and the Brazilian Space Agency President Dr. Luiz Gylvan Meira have provided for the design, development, operation and use of Brazilian-developed flight equipment and payloads for the International Space Station. The Brazilian Space Agency (AEB) will provide onboard facilities for experiments requiring exposure to space on the station's exterior.

The first U.S.-built station element, Node 1, was shipped from its Alabama factory to the Kennedy Space Center, FL, last June to begin preparations for launch on the first Space Shuttle assembly mission, STS-88, set for July 1998. The second of two conical-shaped, pressurized mating adapters that will be attached to either end of the node is being shipped from its California factory to Kennedy this week.

"With the Node and pressurized mating adapters now at Kennedy for launch processing and with the FGB ahead of schedule for its shipment to Baikonur, it's a busy and exciting time as we prepare for the launch and assembly phase," Brinkley said.

During the next few months leading to the start of the International Space Station's five-year, 45-flight orbital assem-


Completed International Space Station with a visiting Space Shuttle in dock.

bly sequence, the first truss structure, a third mating adapter, and the first solar arrays, batteries, and radiators for the station will be shipped from factories nationwide to Florida to be readied for launches in early 1999. Less than a year from now, in August 1998, the first station laboratory, the U.S. Laboratory Module, will be shipped from a Huntsville, AL, factory to Kennedy to begin final testing and launch preparations.

ISS Will Help Unlock Mysteries of the Universe

NASA's Space Science Program seeks to discover the mysteries of the universe, explore the solar system, find planets around other stars, and search for life beyond Earth. From origins to destiny, scientists seek to chart the evolution of the universe, its galaxies, stars, planets, and life.

The International Space Station will offer vantage points and unique capabilities from which research in space science can be conducted as never before. ISS will provide researchers with resources required to increase understanding of the solar and space environments and their effects on the health and future of our home planet.

The ISS will complement other space science programs in several ways. The most tangible capability of ISS is the ability for humans to be directly involved in the operation and maintenance of space science sensor systems. Scientists will observe trends, respond to the unexpected, and alter the research approach when necessary. The dynamic nature of the space and solar environment demands quick response in observing, recording, characterizing, and assessing the impact of cosmic events when they occur.

The ISS capabilities go beyond the operational attributes of humans. In anticipation of the maintenance needs of complex systems that operate for long periods of time, the crew will be equipped to service and repair systems whose capabilities might otherwise be jeopardized on unmanned satellites. In addition, using the transportation capabilities of Space Shuttle, experiments and sensor systems can be returned to Earth, modified to incorporate advances in technology, and re-flown to continue the research objectives.

Looking toward the near and far reaches of space, scientists can gain further insight into the structure and dynamics of the sun and of the near-earth environment. Studying the Sun's effects on Earth, from long-term climate alteration to the temporary disruption of vital global communications, promises to improve forecasting skills. The ISS vantage point will take us farther to increase our understanding of planetary and stellar systems. Using ISS research capabilities in space science, civilization's quest for knowledge will lead us to a greater understanding of our world and its place in the universe.

A Space-borne Laboratory for Microgravity

"Microgravity" literally means a state of very weak gravity (one-millionth of what is felt on Earth). Conducting research in a microgravity environment gives scientists a unique opportunity to study processes which are obscured by gravity on Earth, test existing theories, and make new ones.

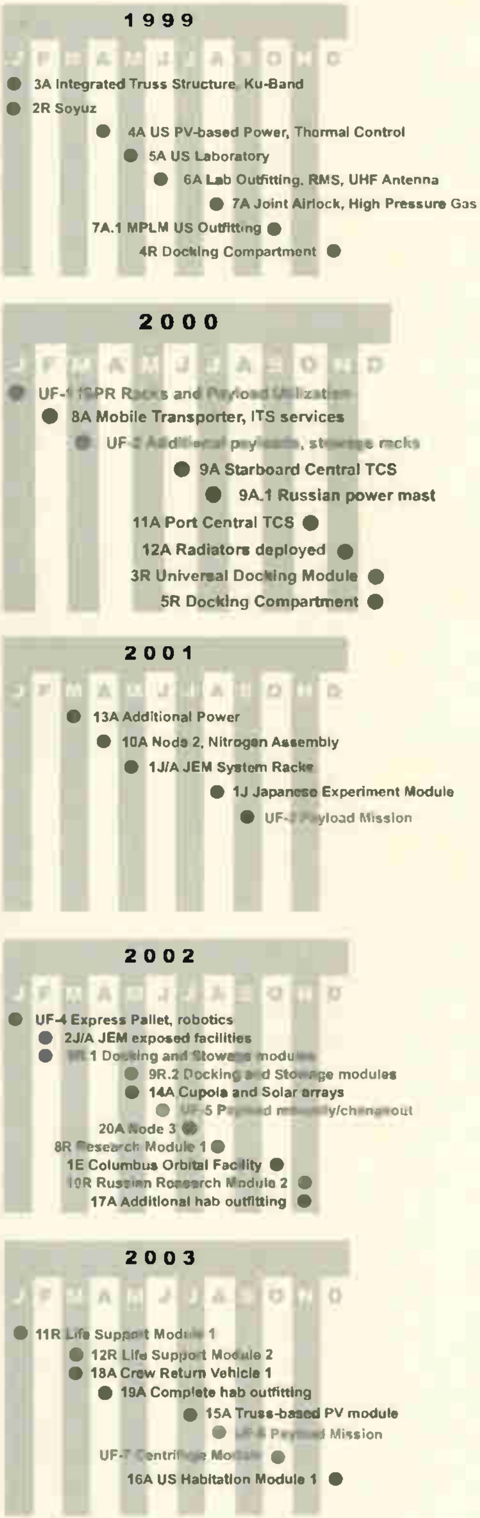
The term microgravity will become more commonplace in the era of the International Space Station (ISS), the largest space structure and multinational space endeavor in history.

The specific disciplines of microgravity science which will be studied aboard ISS include biotechnology, combustion science, fluid physics, fundamental physics, and materials science.

Materials science is a very broad field which encompasses the study of materials structures (arrangement of the atoms or molecules), properties (thermal, magnetic, chemical, etc.), and processing (how the material is created). Conducting materials science research in microgravity gives scientists a unique opportunity to isolate and control gravity-related phenomena, as well as investigate processes normally masked by gravity's effects.

One goal is to better understand how buoyancy-driven convection and sedimentation affect the processing of materials. Containerless processing may also be conducted on larger samples in microgravity

A calendar showing main Space Station construction goals through 2003.



than on Earth because the acoustic or electromagnetic forces used to manipulate them are not overwhelmed by gravity.

Ultimately this research may result in improvements to production methods and materials on Earth. Better electronic devices, improved optical fibers for telecommunication, optoelectronic and photonic devices, and even bioceramic artificial bones are possible outcomes.

Of the four states of matter–solid, liquid, gas, and plasma–three are fluid, meaning they flow in response to an applied force.

Fluid physicists are working to advance science and technology by increasing our knowledge of fluid behavior. Microgravity reduces or eliminates sedimentation and buoyancy-induced flows, as well as other behaviors caused by gravity, which mask important underlying phenomena.

Some of the topics to be studied in microgravity on ISS include colloid dynamics, multiphase fluid flow and heat transfer, capillarity, diffusive transport, magneto/ electrohydrodynamics, and solid-fluid interface dynamics.

Studies in fluid physics can contribute to improved materials processing. They can help engineers design safer buildings in earthquake-prone areas, improve the stability and performance of power-generating stations, and even assist lunar structural engineers in predicting the behavior of soils under lunar gravity conditions.

Combustion meets almost 85 percent of the world's energy needs. It is also a major contributor to air pollution. If only a two percent gain in burner efficiency could be found, the U.S. alone could save $8 billion a year.

Although combustion is vital to transportation, materials processing, hazardous waste disposal, and many other areas, there is only limited understanding of many of its fundamentals. Research in microgravity permits a new range of combustion experimentation by nearly eliminating gravity-driven forces which lead to buoyancy-induced flows and sedimentation. This allows scientists to study other types of phenomena which are difficult or impossible to study on Earth.

A microgravity environment also permits larger and longer experiments which allows more detailed observation. Combustion research in microgravity aboard the ISS may lead to enhanced energy efficiency and reduced pollution, improved processes for making high-technology materials, and advances in fire safety for space flight.

Life Sciences

Biotechnology is the application of engineering and technology to life sciences research. Two primary areas of biotechnology will be researched on ISS: protein crystal growth, and cell and tissue culturing. Protein crystal growth is essential in understanding the structure and function of proteins. Growing protein crystals in space allows some to grow larger and with greater perfection than Earth-grown ones. The larger molecular size and greater perfection makes determining their structure with x-ray diffraction much more effective. Once the structure is determined, the protein may be altered and/or synthesized in mass quantities. This process, called rational drug design, may produce more effective medicines while reducing side effects.

Growing tissue samples is one of the fundamental goals of biomedical research. Scientists use laboratory containers called bioreactors to culture samples of body tissues. Scientists could use cancer tumors and other tissues that are successfully grown outside the body to test and study treatments, such as chemotherapy, without risking harm to patients. These tissues from bioreactors will also offer important medical insights into how tissues grow and develop in the body.

NASA engineers have already created breakthrough technologies for cell culture research on the ground. For example, NASA has developed bioreactors which have already produced the first 80-day lung culture, the first normal human intestine culture, and major advances in the quality of cancer tumor cultures. In the long term, tissues cultured outside the body may be used directly for replacing damaged tissues, treating diseases, or eventually replacing organs.

Fundamental Physics

Fundamental physics uses the unique properties of microgravity to test physics theories at levels of accuracy that are impossible on Earth. This fundamental research will advance our understanding of theories relevant to everything from high-temperature superconductivity, to weather prediction, to mathematics. This research has the potential for redefining our most basic assumptions about the universe.

U.S. and Russia Name International Space Station Crews

The first four crews to live and work onboard the International Space Station (ISS) have been named by the U.S. and Russian space agencies.

"This is an historic step in the evolution of the International Space Station," said Randy Brinkley, manager of the International Space Station. "These assignments are a clear indication of the maturity of the space station and the exciting reality that the ISS will soon be operational." The first increment crew consists of American astronaut William M. Shepherd, Capt., USN, the expedition commander; Yuri Gidzenko, Col., Russian Air Force, the Soyuz vehicle commander; and cosmonaut Sergei Krikalev, the flight engineer. All three have previous space flight experience. The crew is training for an early 1999 launch on a Soyuz vehicle for a planned five-month mission on the ISS.

Shepherd, Gidzenko, and Krikalev will be relieved in the summer of 1999, when the second incremental crew is scheduled to arrive aboard Space Shuttle Atlantis. That crew will be commanded by Russian Cosmonaut Yuri Usachev. He will be joined by American astronauts James S. Voss (Col., USA) and Susan J. Helms, Lt. Col., USAF. All three have flown in space before.

The third crew to inhabit the International Space Station will begin a two-month mission launching aboard a Soyuz spacecraft in late 1999. That crew will be commanded by American astronaut Kenneth D. Bowersox, Cmdr., USN. Russian cosmonauts Vladimir Dezhurov, (Lt. Col., Russian Air Force) the Soyuz vehicle commander, and Mikhail Turin, the flight engineer, will join Bowersox to complete the crew. Bowersox and Dezhurov have prior spaceflight experience while Turin will be making his first flight into space. To provide maximum flexibility in schedule and training, this crew also will train as backup for the first resident space station crew of Shepherd, Gidzenko, and Krikalev.

The fourth resident crew will be commanded by Russian cosmonaut Yuri Onufrienko, Col., Russian Air Force. Onufrienko will be joined on this four-month mission by astronauts Carl E. Walz, Lt. Col., USAF, and Daniel Bursch, Cmdr., USN. All three have previously flown in space. They currently are scheduled to arrive at the station onboard Shuttle Discovery early in the year 2000 and will return to Earth on a Soyuz vehicle. They will train as the back-up crew for Usachev, Voss, and Helms, the second station resident crew.

The continuing cooperation in joint U.S.-Russian space operations is reflected in the selection of these first ISS crews. Krikalev and Dezhurov, veterans of the Mir space station, also flew on the space shuttle, while Gidzenko, Usachev, and Onufrienko flew with astronauts aboard Mir on long-duration and Shuttle-Mir docking missions.

These crews will continue the on-orbit construction of the space station through a series of scheduled space walks throughout the course of the first four missions. They will perform flight tests of the station hardware, conduct internal and external maintenance tasks, and develop the capability of the station to support the addition of science experiments.

And finally . . .

Like the cavalry in a low budget cowboy movie, the International Space Station may be arriving just in time. The Russians have a word for the Mir station; they equate it with the Zhiguli.

The Zhiguli is a little car in Russia. The car doesn't cost much, so it has become popular in the ailing Russian economy. It is often seen with hood raised because of its many and frequent malfunctions.

Resourceful owners somehow keep the Zhiguli cars running. Likewise, the cosmonauts, with help from astronauts and American dollars, somehow keep Mir going.

There's no applause any more when cosmonauts cheat death in space through sheer ingenuity, not from the Russian people anyway, who are more concerned with survival than space these days.

Applause is a luxury. Mir is a necessity–a life raft to keep the world's space program afloat just long enough for the calvary to arrive.

As *Atlanta Journal* writer Charles W. Holmes so aptly puts it: "In the 40 years since the Soviets launched humankind's first satellite, Sputnik I, the Russian space program remains a source–one of the few remaining–of national esteem."

Make that world esteem. It doesn't take a rocket scientist to know that America and the world owe the Russians a hand in carrying Mir across the finish line.

Make that a hand in applause as well.

Sources: *Atlanta Journal*, European Space Agency, NASA ST

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Ariane Launches #100

By Philip Chien

When Europe first announced its plans to build its own launch vehicle the world aerospace industry laughed. How could several different countries with different languages, different currencies, and different cultures join forces to build their own rockets? Only the superpowers–the Soviet Union and the United States could afford the massive efforts to build launch vehicles. Right?

Well, nobody is laughing anymore. Arianespace has proven itself the leader in the commercial launch industry. It was a difficult, long journey and mistakes made by its competitors are as important to Arianespace's success as anything it has done.

The key reason ESA cites for developing its own launch vehicle was NASA's launch policy.

NASA was willing to build additional launch vehicles, beyond its own requirements for commercial payloads. Telstar 1, by AT&T, was the first privately owned satellite, but it was launched by a government furnished launch vehicle. Certainly this was a desirable situation for U.S. satellite owners, U.S. satellite manufacturers, and the U.S. contractors which built the launch vehicles. But what about foreign companies? If a foreign satellite owner was willing to purchase a United States built satellite and a NASA launch vehicle then it would result in commercial sales for U.S. companies. But if a foreign country wanted to launch its own locally built satellite, that satellite would compete with U.S. manufacturered satellites.

NASA was not interested in supporting foreign aerospace companies. Exceptions could be made for purely scientific satellites, especially cases where the foreign partner would assume the burden of the cost of the satellite's manufacture; United States scientists might supply a couple of instruments plus the launch vehicle, and all of the parties would share in the results. The French-German Symphonie communications satellites were launched aboard NASA launch vehicles with the provision that they be used for experimental purposes only and not for commercial transmissions.

The European Launcher Development Organization (ELDO) was founded to develop an all-European launch vehicle. France had launched its own small satellites into orbit from Algeria using its Diamant launch vehicle in 1965. The United Kingdom developed an orbital launch vehicle out of its Black Arrow rockets, launching out of Woomera, Australia. The Europa launchvehicle consisted of a British Blue Streak first stage, French Coralie second stage, and German Astris third stage. Other participating countries included Italy, the Netherlands and Belgium. The early test flights were from Australia.

All three attempts to put a payload into orbit from 1968 to 1970 failed. The revamped Europa II launch vehicle was to be launched from Kourou, French Guiana, in the middle of a jungle and a swamp. It occurred on November 3, 1971–another failure. There were plans for asecond test flight, but they died when France and Germany pulled their funding in April 1973. At this point it was clear that the cheaper way to go was to purchase American launch vehicles, if satellite owners were willing to live within the U.S. government's constraints.

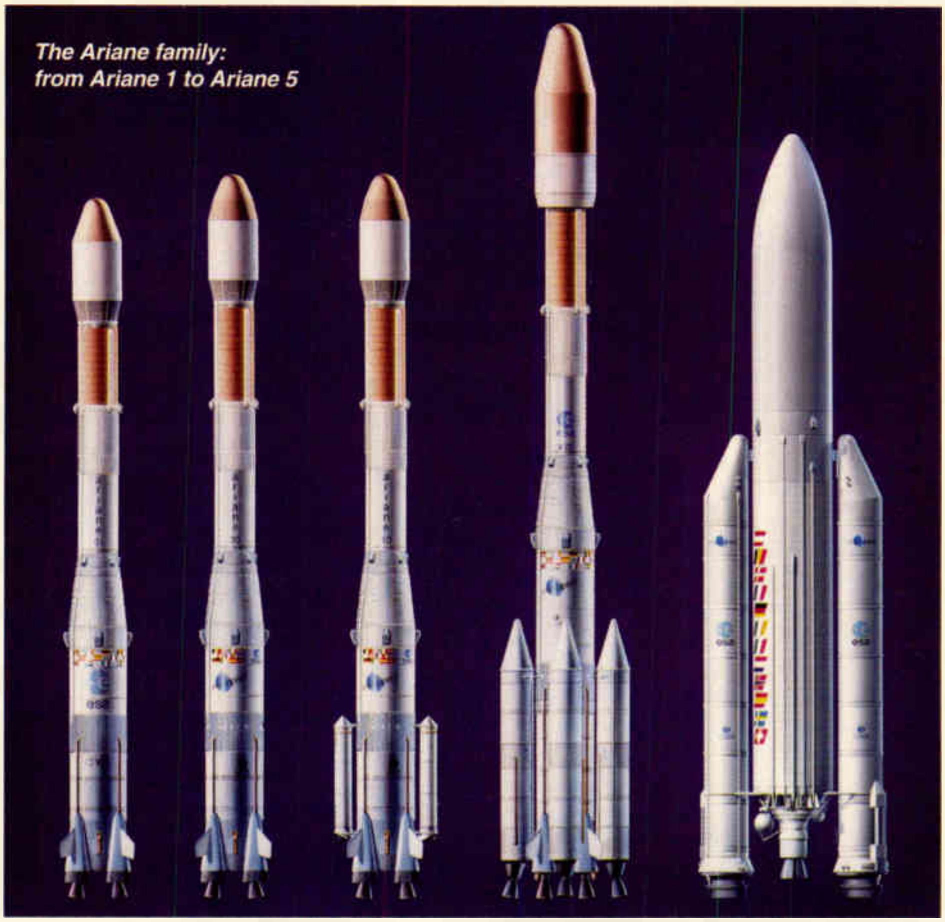
In 1974 the European Space Agency (ESA) was formed from the remains of ELDO and other European space organizations. One of its key objectives was to build a European launch vehicle. But this time, instead of three independently developed stages without a strong central management, a new system was developed in which each country would contribute a percentage of the funds. The contracts would be allotted based on that percentage; whatever country contributed the most would be awarded the primary integration contract. While this system is fairly awkward (should valuable resources in one country be rejected because of a lack of contributions from that party?) this has proven to be an important policy for ESA.

For Ariane the lead country is France, contributing almost two thirds of the early Ariane programs. Other countries, in order of participation, include Germany, Belgium, the United Kingdom, the Netherlands, Spain, Switzerland, Italy, Sweden and Denmark.

The Europa launch site in French Guiana was selected because of technical and political reasons. Technically its equatorial location gives it two advantages for geostationary satellites–additional speed due to the Earth's rotation and less propellant requirement to reach geostationary orbit. The location has wide ocean regions to the North andEast, making it suitable for a wide range of orbits. And while movies about "Devil's Island" have given a bad impression it's actually a fairly benign tropical climate, with no hurricanes, and a stable climate, overall.

Politically, French Guiana is an overseas territory of France and its population are French citizens. On the negative side, French Guiana was not a high technology country and there were few local resources which could be used. Transportation was primarily limited to oceangoing ships and aircraft. All necessary materials would have to be transported across vast oceans, increasing the infrastructure costs.

Finally ESA was ready to show its Ariane 1 launch vehicle. For the first flight the


The Ariane family: from Ariane 1 to Ariane 5

only payload was CAT (Technological Capsule), diagnostic equipment to measure the launch vehicle's environment. Its launch took place on December 24, 1979, and Europe finally succeeded in achieving orbit using its own launch vehicle.

But one success doesn't bring in the contracts–you have to prove that the vehicle's reliable. Ariane flight 2 proved just how difficult that would be. It was launched on May 23, 1980, carrying another CAT, the scientific Firewheel satellite, and the amateur radio satellite, AMSAT's Phase 3-A. Its first stage failed, dumping the satellites into the Atlantic Ocean.

A total of eight test flights of the Ariane 1 were launched under ESA's control with five successes, two failures, and one partial failure. In the unique case of Ariane L06 the third stage of the launch vehicle accidentally recontacted AMSAT's Phase 3-B satellite. The collision resulted in damaged antennas and a leak in the propulsion system. Nevertheless Phase 3-B ended in a usable orbit, and was commissioned in orbit as OSCAR 10.

The Birth of Arianespace

While the test flights proceeded, attempts were made to sell flights to commercial customers. ESA recognized that a commercial company would be much more flexible than a multi-national government agency, so the commercial firm Arianespace was founded in 1980.

Arianespace's primary offices are in Paris, France; it also has marketing offices in the United States, Japan and Singapore. ESA retains responsibility for launch vehicle development, the test flights and marketing space on the test flights. Arianespace is responsible for marketing the commercial flights and the day-to-day operations.

This particular arrangement has been criticized by U.S. launch companies, claiming that it's unfair for Arianespace to get its launch vehicle development costs and launch site for free. On the other hand Arianespace points to the U.S. government contracts which fund launch vehicle development and improvements. Overall all of the parties grudgingly admit that without support from their respective governments they couldn't exist on their own, and each party does receive subsidies–directly or indirectly.

There have been legitimate complaints about certain Arianespace marketing policies, though. While European satellite owners and manufacturers were heavily pressured to "buy Europe," they were also charged 10 percent more than non-European customers.

The Competition Heats Up

Ariane had many problems with its third stage which resulted in several failures. The temperamental turbopump required just the right amount of lubricating oil–too little and it would seize up too much and it wouldn't function properly.

In 1983 the European EXOSAT had to be flown on a U.S. Delta rocket due to the failure of the L05 mission in 1982. But gradually with the Ariane 2 and Ariane 3 improvements Ariane's performance reliability increased.

In the early 1980s the space shuttle and Arianespace were in heavy competition to launch the limited number of communication satellites available. NASA offered discounts for early satellite owners who signed up and Arianespace quickly matched those prices. The Reagan administration had little interest in space science so most shuttle flights were commercial satellite launches. Since NASA was hungry for customers it couldn't afford to be choosy.

Without Ariane's existence it's questionable whether or not the U.S. State Department would have permitted the launch of Arabsat 1B on the shuttle since it was partially owned by Libya and the Palestine Liberation Organization. Had the United States refused to launch Arabsat, it would have resulted in one more sale for Arianespace.

First test firing of the P230 rocket booster for the Ariane-5 launcher.

Cagey satellite owners would split their contracts with some launches on the shuttle and some on Ariane. This would result in lower launch prices and less delay each time the shuttle's schedule slipped or Ariane experienced a failure.

Arianespace was successful in getting one key U.S. customer–GTE. GTE flew eight Spacenet and Gstar satellites on Arianes, crediting the much more commercial approach and reduced paperwork (as opposed to dealing with the U.S. government) for their decision.

The shuttle did have one unique marketing advantage. Commercial satellite owners were offered a spaceflight for a passenger without any actual flight responsibilities! Passengers from Saudi Arabia, Mexico, RCA and Hughes got to fly aboard the shuttle because their countries/employers flew satellites aboard the shuttle.

On January 28, 1986, Greg Jarvis of Hughes flew aboard the STS 51-L mission– the ill-fated *Challenger* flight. At that point passengers from the United Kingdom, Indonesia and India were in training for future flights which were on indefinite hold or cancelled.

The *Challenger* accident was a stroke of luck for Arianespace. Suddenly Ariane was the only game in town. Almost immediately the price for commercial satellite launches doubled and European customers were no longer asked to pay premiums for their satellites. Even a failure a couple of months later didn't slow down sales, since it was questionable whether commercial satellites would be permitted once the shuttle resumed its flights–whenever that might be.

The three U.S. manufacturers of expendable launch vehicles–McDonnell Douglas (Delta), General Dynamics (Atlas), and Martin Marietta (Titan)–studied whether or not it was worth the investment to restart assembly lines and restore almost-abandoned launch pads to compete with Ariane while Arianespace continued to sign contracts. Many customers were even willing to sign up for backup slots in case other satellites weren't ready in time to fly.

Ariane 40 launch vehicle in preparation for flight.

Payloads Shifts to Ariane

In 1988, Ariane 4 was introduced with two key operational improvements. While the core vehicle remains the same, the number of strap-on boosters can be customized to meet the mission's requirements. Getting a rocket moving and out of the lower atmosphere is the most difficult part of any mission so different booster permutations add flexibility. An Ariane 4 can have no boosters, two solid boosters, two liquid boosters, two solid plus two liquid boosters, four solid boosters, or four liquid boosters. The six permutations can place anywhere from 1.9 to 4.2 tons into geosynchronous transfer orbit.

The other change is most Ariane 4s launch two satellites at the same time. The incremental cost for adding an additional satellite is relatively small, increasing the profitability of the launch vehicle. Clearly it's less expensive to launch two 1.9 ton satellites on an Ariane 44L launch vehicle (four liquid strap-on boosters) than two Ariane 40 (no strap-ons) vehicles. So the Ariane 40 (no strap-on) version is only used for low altitude Earth-observation satellites.

Arianespace has been very successful in scheduling launches and pairing together appropriate mass satellites for dual-launch missions. Only the largest satellites require their own launch vehicles. In only one case has a medium-sized communications satellite flown by itself because another satellite couldn't be scheduled as a sister passenger.

Most of the world's satellite manufacturers and owners have used Ariane. There still is a "buy Europe" mentality where some manufacturers won't even think about going elsewhere. Significantly no French-owned satellite has ever used any other launch vehicle. Aerospatiale has always chosen Ariane whenever it has been responsible for selecting the launch vehicle. But a couple of European satellite owners, most notably Eutelsat and DFS (Germany), have chosen to fly at least some satellites on U.S. launch vehicles.

Most European scientific satellites have flown on Ariane vehicles. For most NASA-ESA cooperative programs a U.S. launch vehicle is provided by NASA while the international partners provide either the satellite or instruments. In one rare exception, the TOPEX/Poseidon mission, NASA provided the satellite while France provided the launch vehicle. So TOPEX became the only NASA satellite to fly on an Ariane launch vehicle.

The Titan turned out to be too expensive as a commercial launch vehicle. So Arianespace's primary competition is the Atlas and Delta launch vehicles. Commercial launch service contracts are won by whatever launch vehicle offers the best price, schedule, insurance and other options. In a couple of unusual cases satellite owners have jumped ship and moved to different vehicles. Due to contractual issues AT&T switched its planned Atlas launch of the Telstar 402R satellite over to Ariane. At almost the same time Indonesia chose to move its Palapa C1 satellite from Ariane to Atlas, so basically things evened out.

The World Shifts Again

Satellites are gradually increasing in size. Since there are a limited number of orbital locations, it often makes sense to build a larger, more capable satellite. An Ariane 4 class vehicle can only launch one of today's largest satellites at a time, or one large satellite with a fairly small satellite. On the other hand, there's a limited market for smaller HS-376-class satellites, so there have been several launches where Arianespace has been forced to launch a 3 ton class satellite by itself.

An additional factor is the fact that the European Currency Unit (ECU) has been holding its value while the U.S. dollar has decreased in value. Arianespace purchases its components and services in European currencies, but most launch contracts are defined in dollars since most satellites are manufactured in the United States.

Now, non-market economies–Russia, China and the Ukraine–are offering their launch vehicles for commercial western satellites. Although the pricing and quotas are regulated by international treaties, to prevent oversaturating the market or unfair competition, satellite owners now have more choices for getting their payloads into space. The Russian Proton and Soyuz, Chinese Long March, and Ukrainian Zenits are all being offered, both separately and in partnerships with Western aerospace companies.

These factors have all decreased Arianespace's profitability, so in 1987 ESA made the decision to develop the Ariane 5 vehicle. But this time the engineers would start from scratch, developing a brand-new vehicle. The requirement was for a cost-effective vehicle which could launch two 3-ton satellites.

France also pushed for the vehicle to be man-rated. France has always wanted its own crewed spacecraft. Hermes was supposed to be a European spaceplane–basically a scaled down version of the space shuttle similar to the 1970's U.S. Air Force Dynasoar project. The French space agency even selected nine spationauts.

Outside and cut-open view of the Ariane-5 launcher configured for its maiden flight with a payload of four identical CLUSTER satellites. The first launch was a failure.

But France was never able to convince the rest of ESA that there was a pressing need for its own crewed spacecraft.

Eventually most of the spationauts flew as passengers aboard U.S. and Russian spacecraft. Nevertheless Ariane 5 has always retained man-rating as one of its goals. This basically means a very reliable rocket, with an intelligent fault detection system which could permit the crew to escape if the rocket does fail. There is a possibility that Ariane 5 may eventually be used as a crew transfer vehicle for the International Space Station (ISS).

By 1996, Ariane 501 was finally ready for launch. Its payload consisted of the four identical Cluster spacecraft. It was launched on June 4, but the mission quickly ended in a failure. The investigation board eventually attributed the failure to software and the design philosophy. The computers were developed with the assumption that the design was perfect: if any problems were encountered then it had to be a manufacturing defect and it should shut itself off.

The software was based on the Ariane 4 flight software, but programmers failed to recognize that the Ariane 5 would ascend more rapidly. That resulted in an overflow error which caused the computer–and its backup–to shut down. Without any control the vehicle quickly tipped over and was destroyed. Less than a minute of data was collected from the Ariane 501 flight. The upper stage, fairing separation system, and many other components never had the chance to be tested.

After the Ariane 501 launch vehicle failed the pressure was on for a successful flight of the Ariane 502 vehicle. Its primary purpose–more than any other use–was to prove to satellite owners that Ariane 5 could reliably place spacecraft into geosynchronous transfer orbit.

It took 16 months to correct the errors, perform a complete review of the vehicle's systems, and prepare 502 for launch. The small amount of data from the 501 mission indicated that the vibration environment was higher than anticipated and rougher than the design limits for most commercial communications satellites.

The primary "payloads" for the Ariane 502 mission were two MAQSATs (MAQuette (dummy) SATellite). The MAQSATs included accelerometers and load sensors to measure the 502 vehicle's flight environment. A small scientific satellite, TEAMSAT, was added to the vehicle only a year before the launch. AMSAT's Phase 3-D satellite, a large amateur radio satellite, was supposed to fly on Ariane 502. Phase 3-D could not be readied in time, due to the higher loads which ESA required as a precaution for the test flight.

Ariane 502 was launched on October 30, 1997, five weeks after the 100th Ariane flight. It appeared that everything was working properly and the vehicle did place its payloads into orbit. However, the core vehicle shut down about 10 seconds early, resulting in a final orbit 9,300 km. lower than what was planned. It turns out that the first stage was rolling more than anticipated, confusing the propellant level indicators (basically, fancy gas gauges). The flight computer thought that there wasn't enough propellant remaining and instructed the engines to shut down. The upper stage worked properly, though, and deployed the satellites on time.

Certainly the test flight accomplished the vast majority of its goals. But it did not place the satellites into the planned orbit. ESA Director General Antonio Rodotà said "Europe is once more in Space! This is another good example of what European cooperation can do." Certainly the mission accomplished the vast majority of its goals–but it was not an unqualified success.

A Volatile and Exciting Market

As we go to press the Ariane 503 test flight is scheduled for the spring of 1998 with commercial flights following later in the year. The Ariane 4 vehicles continue to be launched on the average of once per month and will gradually be phased out as commercial Ariane 5 flights start.

It's clear that Arianespace's percentage of the commercial launch services market will decrease. There are too many companies offering launch services for any one company to have a majority. But as the commercial launch market expands there will be more opportunities for every launch vehicle, and even competitors admit that Ariane will get a significant portion of that market.

ESA and Arianespace claim that Ariane 5's operational flights will have a 98.5 percent reliability factor–one failure per 78 missions. This much reliability has only been achieved by Boeing's Delta, the Russian Soyuz, and the space shuttle. Hopefully Ariane 5 can live up to this incredibly high goal.

TABLE 1: Ariane improvements

Configuration	First Flight	Mass to Geosync Transfer Orbit
Ariane 1	1979	1935 kg
Ariane 2	1986	2275 kg
Ariane 3	1984	2650 kg
Ariane 4	1988	1900-4730 kg
Ariane 5	1986	6800 kg

Satellite Times Profile

Russian Proton Rocket Program

By Phillip S Clark

For years the Russian space program was been veiled in secrecy. Information was sketchy and diagrams of rockets and satellites were pure conjecture. When the Cold War ended the veil over the Russian space program lifted and much more is know about it today.

The commerical workhorse of the Russian space program is the Proton launch vehicle. For the first time ever, here is an indepth look at that program.

All launch profiles of the Proton-K launch vehicle with an added fourth stage have involved at least two planned burns of that fourth stage to place the payloads into their planned final orbits: on a few occasions three maneuvers have been seen. Before western commercial satellites started to fly with the vehicle, the Proton-K flew a few standard mission profiles (generally one profile for each class of mission), but with the advent of the commercial launches the vehicle has shown itself to be more versatile than western observers had expected.

Two classes of fourth stages have flown atop Proton-K: the Block D for deep space missions and the Block DM for Earth orbital missions. There are differences in the mode of operating these fourth stages. The Block D (which was originally the fifth stage of the N-1/L-3 manned lunar launch vehicle) would receive its commands via the attached payload. In comparison, the Block DM would generate its own commands with the payload being passive until the time of separation from the fourth stage.

Table 1 provides a summary of the different Block D and Block DM stages which have flown over the years in the domestic space program.

Original Block D Launch Profile

Western observers originally misunderstood the launch profile for the Proton-K vehicle which carried the Block D fourth stages. It was first thought that the three-stage Proton-K placed its own third stage into orbit which then separated from the Block D fourth stage/payload assembly, and that the Block D would then perform a single maneuver to take the payload out of low Earth orbit (LEO) and place it onto a trans-lunar or trans-planetary trajectory. (Astron and Granat remained in highly eccentric Earth orbits reaching out to 200,000 km, and they used the Block D class stage rather than the DM because they used the standard Venera spacecraft "bus.")

In recent years Russian literature describing the launches of early lunar missions and the more recent Fobos and Mars 8 missions have shown that the above analysis to be incorrect. In reality, all three stages of the Proton-K launcher are sub-orbital, with the Block D performing a small burn to reach Earth orbit. As the stage prepares for its second burn, two ullage motors are fired to settle the remaining propellant. As the main engine ignites these small motors are shut down and discarded in LEO. When the Block D completes its burn, both it and its payload are on either a trans-lunar, eccentric Earth orbit trajectory (apogee around 400,000 km after acceleration by the lunar gravitational field) or on escape trans-planetary trajectories.

Granat/Proton-K launch vehicle on pad.

Proton 219 launches the Inmarsat III F2 satellite.

The Fobos 1 and 2 missions in 1988 and Mars 8 in 1996 had slightly different launch profiles. In these instances the fully-fuelled spacecraft were heavier than the Proton-K/Block D-2 combination could accelerate into a trans-Mars trajectory.

Therefore, on these missions the launch profile called for the second Block D-2 burn to leave the spacecraft in an eccentric Earth orbit (apogee ~130,500 km for Fobos 1): the spacecraft would then separate and use its own Fregat propulsion module to complete a small maneuver to take the spacecraft out towards Mars.

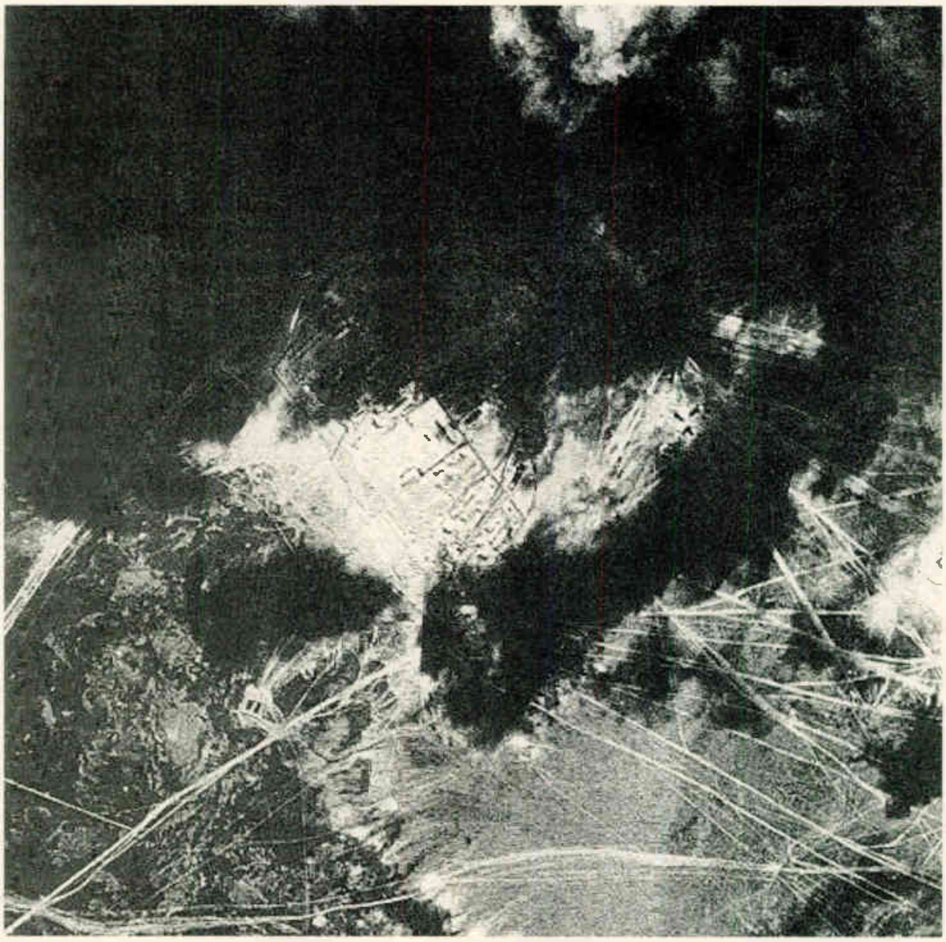
This profile worked for the two Fobos missions but failed for the Mars 8 mission: a communications problem between the spacecraft and its Block D-2 prevented the second ignition from taking place, although the on-board automatic sequencer ensured that the spacecraft separated from the Block D-2 at the planned time after launch and then performed its own small "trans-Mars" maneuver (which in reality simply raised apogee to around 1,500 km) using the Fregat module.

Using the Block DM to Reach Geosynchronous Orbit

The standard launch profile for payloads intended to reach geosynchronous orbit was introduced with Russia's first geosynchronous launch–Cosmos 637 in March 1974–and it is still the standard profile for domestic geosynchronous orbit launches.

Since the payloads carried to geosynchronous orbit are far lighter than the normal planetary probe (typically ~2 tons compared with ~4.5-5.5 tons), the Proton-K launch vehicle can use its third stage for orbital injection, with the Block DM being fully fuelled for its planned maneuvers to geosynchronous orbit.

Table 2 presents the orbital data for a typical Russian launch to geosynchronous orbit: Gorizont 32, launched in May 1996. After reaching orbit the Block DM (DM-2 version in this instance) and its attached payload separate from the third stage soon after orbital injection. A hollow cylindrical casing which surrounds the Block DM is discarded and the stage performs attitude control and thermal roll maneuvers in preparation for its first main engine burn. The burn comes at the first pass through the ascending node of the orbit (equator crossing from south to north), around an hour after launch.



Proton SL-12 launch site. This twin-pad launch site was photographed by the U.S. spy satellite, KH-4 Corona.

Once the first burn has been completed the fourth stage and payload are put into a roll to even out the heat created during the ascent to geosynchronous altitude. The transfer orbit inclination is typically close to 47.5°–the theoretical inclination that permits a minimum total velocity change while using a two-impulse maneuver to transfer from a 51.6° LEO to a 1.5° geosynchronous orbit.

The coast to apogee takes around five and a half hours and at the first pass through the apogee altitude (which is over a descending node of the orbit, passing north to south over the equator) the ullage motors briefly fire and are discarded just as the Block DM main engine fires for a second time. This second maneuver reduces the orbital inclination to around 1.5° and rounds out the orbit at around 36,000-36,500 km.

The variation in this altitude is not due to launch vehicle inaccuracy (something which by inexperienced western commentators misunderstood when the Russians first discussed the Proton-K for commercial launches) but is intended to allow the payload to rapidly drift into its planned geosynchronous orbit longitude. Once there it can fire its own thrusters to adjust the orbit to a near-circular one at 35,800 km.

After the second burn of the Block DM the satellite performs a small separation maneuver, and then the fourth stage itself

TABLE 1
Block D and Block DM Stages Used on the Proton-K

Version	Designator	Missions
Block D Family–Deep Space Missions		
Block D	11S824	Luna 15-24, Mars 2-7, Venera 9-10, Zond 4-8
Block D-1	11S824M	Astron, Granat, Vega 1-2, Venera 11-16
Block D-2	11S824F	Fobos 1-2, Mars 8 (aka Mars-96)
Block DM Family–Earth Orbit Missions		
Block DM	11S86	Geosynchronous orbit (1974-1990),
Block DM-2	11S861	GLONASS satellites, geosynchronous orbit (1986-date), Cosmos 1603 and 1656
Block DM-2M	11S861-01	Gals 1, Ekspress 1

It should be noted there was a period when both the Block DM and the DM-2 were flying missions to geosynchronous orbit.

TABLE 2 Orbital Data for Gorizont 32 Launch

Object	Inclination Deg	Period min	Perigee km	Apogee km
Gorizont 32	1.43	1,477.37	36,510	36,671
Proton-K third stage	51.62	88.25	180	196
Fourth stage casing	51.61	88.24	183	192
Fourth stage (DM-2)	1.52	1,469.28	36,368	36,499
Ullage motor (1)	47.36	646.85	275	36,521
Ullage motor (2)	47.43	647.94	331	36,520

These orbital data are taken from *Worldwide Satellite Launches*, June 6, 1996, pages 40-41.

performs a separation maneuver to ensure that the two objects do not collide. As a result, the Block DM and the payload are always tracked in slightly different orbits.

Varying the Standard Launch Profile

Since the standard launch profile has a fixed starting point and fixed points for the two Block DM burns, injection into the geosynchronous drift orbit always takes place over ~90°E. If the satellite is to be located east of this location then the drift orbit period will be less than 1,435.8 minutes (the Earth's rotation period and thus the geostationary orbital period): for locations to the west of 90°E the orbital period is significantly in excess of 1,435.8 minutes. As seen in Table 2, Gorizont 32 was to be located over 52°E and thus had a drift orbital period in excess of 1,435.8 minutes.

Four Cosmos satellites (all part of the Prognoz early warning system) have used a slight modification of the standard launch technique: Cosmos 1940 (1988), Cosmos 2155 (1991), Cosmos 2209 (1992) and Cosmos 2345 (1997). On these four missions the Block DM-2/satellite assembly remained in LEO for an additional four circuits before the Block DM-2 fired for the first time: the second burn took place as normal after half a circuit of the geosynchronous transfer orbit.

Since each additional circuit in LEO shifted the injection longitude by approximately 22.5° to the west, these four satellites were injected into the geosynchronous drift orbit close to 0 °E (~90° - 4 x 22.5° = ~0°). This reduced the time required for the satellites to reach their planned operating location over 336°E.

Two things are interesting concerning this variation on the standard launch profile. First, an additional circuit in LEO would have shifted the injection point by a further 22.5°, permitting injection over 337.5°E–far closer to the operational longitudes. Is it possible the Russians did not take this approach since it would have permitted little time for trajectory measurements and refinements of the orbit between drift orbit injection and the satellites' planned longitude being reached?

Secondly, other Russian payloads have been launched to longitudes similar to these four Prognoz satellites (e.g., Raduga to 335°E, Luch/Cosmos to 346°E, Cosmos/Potok to 346.5°E and Gorizont to 349°E) and although these could have benefited from the same launch profile they have all used only the unmodified original profile with orbital injection close to 90°E.

The latest of these Prognoz satellites was unusual in that the LEO had an inclination of 53.2° instead of the standard 51.6°. There are some Russian reports that this was due to an error in programming the ascent trajectory, but there is no official confirmation of this. On the other hand, once in LEO the Block DM-2 fourth stage maneuvered so that, by the time geosynchronous drift orbit was reached, the orbital inclination of about 1.4° was the standard one. If there was a programming error in the ascent trajectory, then this launch shows that the Russians have the capability of updating the planned maneuvers for the fourth stage to correct any launch errors (so long as they are not too large).

Launches of GLONASS and Tselina-2 Satellites

The launch technique of Cosmos satellites in the GLONASS network has used a profile which parallells the standard geosynchronous launches. The original launches started at 51.6° and, via an intermediate transfer orbit, the Block DM-2 would perform two maneuvers (one in LEO, one at the apogee of the transfer orbit, the latter discarding the ullage motors) before deploying three Cosmos satellites into a near-circular 19,100 km orbit inclined at 64.8°.

This profile was used for the first six launches in the GLONASS program. Starting with the launch of Cosmos 1778-1780 the initial LEO used an inclination of 64.8°, ensuring that all of the maneuvers were co-planar.

A new launch profile was seen for the launches of two Tselina-2 test payloads (in the guise of Cosmos 1603 and Cosmos 1656) in 1984-1985. On each mission, after launch the usual two objects were tracked in LEO (Proton-K third stage and the fourth stage casing). At the first pass through the descending node of the orbit the Block DM-2 ignited for the first time, placing the assembly into a 51.6°, 190-835 km orbit.

As the assembly passed through the ascending node the Block DM-2 ignited for a second time, raising the orbit to 815-855 km, inclined at 66.6°. A third maneuver took place as the ullage motors fired and were separated, changing the orbit to 71° and 850 km. This maneuver took place over the northern Plesetsk cosmodrome; as a non-equatorial orbital plane change it was extremely expensive in terms of propellant.

This launch profile was only seen on these two missions. Subsequent Tselina-2 satellites were launched directly to 71° and 850 km orbits using the Zenit-2 launch vehicle. However, until recently this profile has been the only one which required a member of the Block DM family to perform three orbital maneuvers.

TABLE 3

Fourth Stages Flown on Commercial Proton-K Launches

Original Designator	Revised Designator	Commercial Payload(s)
Block DM-3	Block DM3-1L	Astra 1F
Block DM-1	Block DM1-1L	INMARSAT-3 2
Block DM-4	Block DM4-1L	Telstar 5
Block DM-5	Block DM2-1L	Iridium cluster 2
Block DM-3	Block DM3-3L	PAS 5
Block DM-5	Block DM2-2L	Iridium cluster 6

Block DM Variants for Commercial Launches

The Russians have indicated new designators for Block DM stages which have been used to launch the commercial missions, and these are listed in Table 3.

The designators for the fourth stages used for domestic launches appear to be unchanged: Blocks DM, DM-2 and DM-2M. However, two sets of designators have been used for the commercial fourth stages. The series of designators DM-1, DM-3 and DM-4 were originally used for the commercial launches: indeed, when Astra 1F was launched the fourth stage shroud was painted "DM-3".

In the summer of 1997 a revised series of designators appeared, so that (for example) the DM-3 became the DM3-1L: these have been discussed in the June 16-29, 1997 issue of *Novosti Kosmonavtiki* (pages 46-48).

Clearly, the Russians have now added a third designator system for the commercial launches, with the fourth stage being tailored for specific clients: thus, the DM1 (no hyphen) is used for Lockheed Martin payloads and is derived from the domestic DM-2 stage. The DM2 is used for the Motorola Iridium launches, and DM3 for Hughes satellites, based upon the domestic Block DM-2M and DM4 for Space Systems/Loral payloads.

The fourth stage used by the domestic Cosmos 2344 photoreconnaissance satellite was described as a Block DM-5, which appears to be the DM2 but without the special Khrunichev-built Iridium multiple payload carrier/dispenser.

The Russians have indicated that the Blocks DM1, DM2, DM3 and DM4 stages differ in the payload interfaces and in also the flight control software. Certainly, the fourth stage used for the first Iridium launch differed radically in its flight program, since it performed three maneuvers and finally de-orbited itself (Cosmos 1603/1656 were the only other Block DM class stages to perform this number of maneuvers).

In addition, the commercial Block DM missions have not had any ullage motors tracked in an intermediate transfer orbit: it is possible that the ullage motors are simply not separated for commercial missions.

Commercial Launches to Geosynchronous Orbit

As of mid-November 1997 the Proton-K has been used for the following launches of western commercial satellites (Iridium satellites are discussed in the section 8):

Astra 1F	April 8, 1996
INMARSAT-3 2	September 6, 1996
Telstar 5	May 24, 1997
PAS-5	August 27, 1997

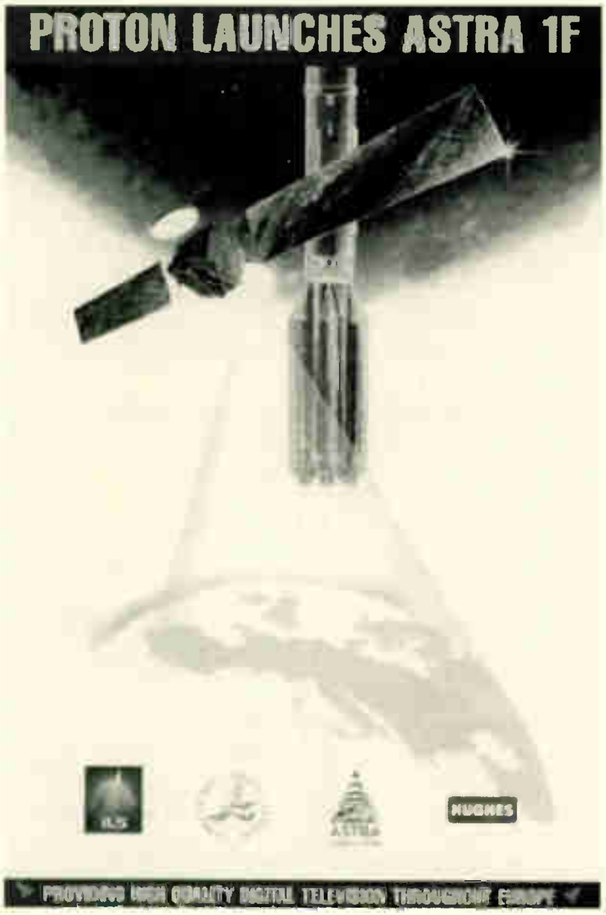
These commercial launches have introduced a new launch profile for the Proton-K with its Block DM family of fourth stages. In all cases the first burn of the Block DM variant is co-planar with the initial LEO: as previously noted, for domestic launches there is a small plane change to around 47.5°. To date all of the first burns of the commercial fourth stages have taken place during the first pass through the ascending node of the LEO.

When the fourth stage passes through the transfer orbit apogee for the first time the ullage motors fire but apparently remain attached to the fourth stage when the main engine fires. However, instead of entering a near-geosynchronous drift

TABLE 4: Orbital Data for Commercial Proton-K Launches to Geosynchronous Orbit

Satellite	Payload Mass (kg)	Incl deg	Period min	Perigee km	Apogee km	4th Stage Payload Delta-V (m/s)Delta-V (m/s)
Astra 1F	3,010	6.96	880.4	12,127	35,976	1,680/740
		0.06	1,435.8	35,772	35,790	
Proton-K third stage		51.61	88.86	213	223	
Fourth stage casing		51.61	88.64	193	222	
Fourth stage (DM3-1L)		6.95	876.19	11,966	35,940	
INMARSAT 3-2	1,144	51.59	645.48	261	36,465	2,340/20
		2.49	1,461.68	36,260	36,312	
		2.70	1,436.09	35,766	35,807	
Proton-K third stage		51.59	89.01	218	234	
Fourth stage casing		51.60	88.92	220	222	
Fourth stage (DM1-1L)		2.72	1,461.37	36,244	36,316	
Telstar 5	3,650	51.71	632.34	219	35,833	1,182/1,230
		17.55	762.06	6,690	35,827	
		0.04	1,436.12	35,731	35,843	
Proton-K third stage		51.59	88.78	209	219	
Fourth stage (DM4-1L)		17.60	757.91	6,549	35,767	
PAS 5	3,600	51.57	635.87	215	36,018	1,344/1,070
		14.61	804.98	8,572	36,001	
Proton-K third stage		51.59	88.23	149	224	
Fourth stage casing		51.59	88.49	177	223	
Fourth stage (DM3-3L)		14.61	800.73	8,434	35,938	

Orbital data taken from various issues of *Worldwide Satellite Launches* during 1996-1997. Delta-V (maneuvers) are calculated based upon an "instantaneous" orbit change over the equator, and thus might be slightly in error. The parameters for the geosynchronous transfer orbit are not available from USSPACECOM for Astra 1F, but they are believed to have been close to 51.6° and 215-36,000 km. The initial orbit for INMARSAT 3-2 and the Block DM1-1L orbit are supplied by INMARSAT in the absence of data from USSPACECOM, since the Block DM1-1L has not been catalogued by USSPACECOM.



orbit the fourth stages have placed the payloads into intermediate orbits. The reason for the variation in intermediate orbits becomes clear when the payload masses are considered.

When used for domestic launches the Block DM (series) fourth stage performs first and second burns of around 2,545 m/s and 2,270 m/s respectively, thus placing satellites with masses of 2-2.5 tons into a geosynchronous drift orbit. A mass of 2.5 tons is close to the maximum which the Proton/Block DM combination can place into geosynchronous drift orbit.

However, the western commercial satellites tend to be heavier than the Russian payloads, and thus the fourth stage cannot reach the geosynchronous drift orbit–there simply is not the propellant to do so. Therefore, the orbits used on the commercial missions are a compromise.

The first burn of the fourth stage from the LEO of 51.6° and 205-225 km to the transfer orbit at around 51.6° and 215-36,000 km totals 2,395 m/s–less than domestic missions because there is no plane change. The second burn of the fourth stage is fixed in terms of total magnitude by the amount of remaining propellant, but that orbital change can be split between changing the orbital plane and the perigee altitude. At one extreme it is possible to change the orbital inclination to one close to 0° but having very little effect on the perigee altitude; at the other the orbital inclination is changed very little but the perigee could be raised to one approaching geosynchronous altitude.

Reference to Table 4 shows how the final orbits for the fourth stage have varied from one mission to the next.

After the final fourth stage burn the satellite has to use its own propulsion system to reach geosynchronous altitude. Of course, the satellite is now in an orbit which needs less of a velocity change to reach a geosynchronous drift orbit than if it had been launched by a western launch vehicle. This is demonstrated in Table 5.

Table 5 shows the geosynchronous transfer orbits and the geosynchronous orbits for payloads in the same series as those listed in Table 4, but for launches on western vehicles–primarily Ariane-4 variants and the Atlas-2A(S) vehicles. Both of these vehicles–as well as the Delta-2 (7925 variant)–use a different launch technique then that used by the Proton-K.

The Russian vehicle has a fourth stage which maneuvers out of geosynchronous transfer orbit and, for domestic launches, will place payloads into a geosynchronous drift orbit, following which the payload only has to perform small maneuvers. The western (and also Chinese) launch vehicles will only place the payloads into geosynchronous transfer orbit from which the satellite itself has to maneuver into a geosynchronous orbit. This means a significant increase in the satellite mass to carry the propellant for the major apogee burn.

Since Ariane launches are from the near-equatorial launch site of Kourou the transfer orbit inclination is 7° or less (lower inclinations require a dog-leg maneuver during the ascent to orbit)–and changing inclination is an expensive maneuver. U.S. launches from Cape Canaveral start with a minimum inclination of 28.5°, although in-flight dog-leg maneuvers and/or in-orbit plane changes can reduce the transfer orbit inclination to some extent.

Table 5 shows that for an Ariane launch one can expect that the satellite will have to perform an apogee burn of around 1,400-1,450 m/s, while for U.S. launches (depending upon the transfer orbit incli-

TABLE 5: Western Launches of Selected Commercial Payloads

Satellite	Launch Vehicle	Mass kg	Incl deg	Period min	Perigee km	Apogee km	Delta-V m/s
Astra 1E	Ariane-42L	3,010	4.14	638.06 1,436.38	502 35,705	35,844 35,879	1,450
PAS 3R	Ariane-44L	2,918	6.92 0.03	655.07 1,435.54	256 35,666	36,959 35,886	1,410
INMARSAT 3-1	Atlas-2A	2,064	21.85 2.67	642.95 1,436.01	1,019 35,758	35,577 35,811	1,600
INMARSAT 3-4	Ariane-44L	1,999	7.02 0.27	631.37 1,436.17	207 35,770	35,795 35,806	1,500
Telstar 401	Atlas-2AS	3,375	23.87 0.05	631.13 1,436.13	190 35,784	35,800 35,791	1,738
Telstar 402R	Ariane-42R	3,410	7.10 0.20	647.03 1,435.57	259 35,754	36,546 35,830	1,436
Thor 2	Delta-2 (7925)	~1,300	19.72 0.05	666.33 1,436.12	1,314 35,781	36,471 35,794	1,536

Where possible representative U.S. and Ariane launches have been chosen for satellites owned by the same first four companies which have used the Proton-K vehicle. Astra and PAS have only used Ariane launches: Thor 2 is chosen to represent the Delta-2 launch vehicle since no company has yet used both Proton-K and a Delta-2. Orbital data taken from issues of *Worldwide Satellite Launches*: delta-V (maneuvers) are calculated based upon an "instantaneous" orbit change over the equator, and thus might be slightly in error, but the same method has been used to calculate maneuvers for the Proton-K launches.

nation) the corresponding burn is 1,600 m/s or more.

A comparison with Table 4 shows that launching via Proton-K involves the satellite performing a velocity change of 1,230 m/s or less. Indeed, in the case of the INMARSAT 3-2 launch the Proton-K was able to place the satellite virtually into a geosynchronous drift orbit, just as it does with domestic launches.

The advantage of launching with the Proton-K vehicle is that a smaller apogee burn is required for injection into a geosynchronous drift orbit, and this translates into a lower launch mass of the satellite. Satellites using a unified propellant system in which the same propellant is used for apogee burn and all other maneuvers can greatly extend their useful life by being launched with a full propellant load (or more "spare" propellant than a western launcher would permit). More propellant is then available for keeping the satellite on-station and functional.

Using Super-Synchronous Orbits

As of September 1997 the Proton-K has not used super-synchronous orbits for launching payloads to geosynchronous altitudes. The use of super-synchronous orbits calls for the launch vehicle to "over-perform" in that the payload is launched into a transfer orbit which has apogee in excess of the geosynchronous altitude. The principle is as follows: Since the magnitude of the orbital plane change maneuver is proportional to the velocity at the time of the maneuver, a lower velocity means a decrease in the plane change maneuver–and the way to reduce the orbital velocity is to perform it at a higher altitude.

Some Chinese and western launches have used the super-synchronous launch technique, although normally the transfer orbit apogee is within the range 40,000-45,000 km. The most extreme super-synchronous launch to date is that of Orion 1 aboard an Atlas-2A. Its orbital data are shown in Table 6.

With a mass of 2,340 kg, Orion 1 was much lighter than the maximum payload limit the Atlas-2A could boost to geosynchronous transfer orbit. Advantage was taken of this by using a super-synchronous transfer orbit which reached out to more than 120,000 km. After separating from the Centaur second stage, Orion 1 then maneuvered into geosynchronous orbit.

TABLE 6: Orbital Data for Orion 1 Launch

Epoch Date 1994-1995	Incl deg	Period min	Perigee km	Apogee km	Delta-V m/s
Nov 29.60	25.49	2,936,21	402	122,688	
Dec 1.81	3.43	3,766.27	25,074	122,543	620
	(3.4		25,075	65,500)*	315
Dec 7.87	0.79	2,257.05	35,742	65,496	205
Dec 14.23	0.03	1,437.85	35,621	36,021	375
Jan 7.90	0.06	1,436.16	35,775	35,801	1

Orbital data taken from *Worldwide Satellite Launches* 1994, page 38. The intermediate orbit marked * is estimated since USSPACECOM issued no data for this orbit. Delta-V (maneuvers) are calculated based upon an "instantaneous" orbit change over the equator, and thus might be slightly in error.

The velocity changes performed by the satellite amounted to about 1,515 m/s: if the Atlas-2A had used a standard 25.5° and 400-36,000 km transfer orbit then the satellite would have had to perform maneuvers totalling around 1,760 m/s to reach geosynchronous orbit.

Although the Proton-K has not used a super-synchronous launch profile yet, there is no reason why it cannot. Of course there are many factors to consider in terms of the trade-off between the payload mass and its effect on the maneuvers which can be performed by the Proton-K fourth stage and the maneuvers which remain to be performed by the satellite itself.

Using the figures previously noted, domestic launches (using a plane change at each of the two fourth stage burns) have a velocity requirement of 4,815 m/s (2,545 + 2,270 m/s); this translates into a maximum payload mass of around 2.5 tons. A possible Proton-K launch would start with a super-synchronous transfer inclination of 51.6° and perform a single plane change at the first apogee burn of the fourth stage (second burn of the stage), raising perigee to geosynchronous altitude. When passing through this altitude the fourth stage would perform a further burn to circularize the orbit at geosynchronous altitude. Thus a Block DM (variant) stage could directly inject a payload into a geosynchronous drift orbit using a super-synchronous orbit and three burns of the rocket stage: the satellite would only need to perform minor maneuvers to reach its operational orbital location.

Launching Iridium Satellites

On June 6, 1997, the launch of Cosmos 2344 (a new class of optical reconnaissance platform) is reported to have introduced the new Block DM-5 fourth stage to the Proton-K.

This launch involved yet another launch profile. Starting off in a 64.8° and 140-170 km parking orbit, the Block DM-5 first maneuvered to a 64.5°, 200 to 2,490 km transfer orbit, and then to a 63.4°, 1,510 to 2,745 km orbit, where the satellite

(Continued on page 55)

ST THE VIEW FROM ABOVE

By Lawrence Harris
lawrenceh@ndirect.co.uk

The Russian Weather Satellites

In this month's edition of *View* we will include some background material on the work of the scientists at the Space Research Institute of the Russian Academy of Sciences, which provides support to users of meteorological satellite data in the Commonwealth of Independent States.

Meteor 3-5 November 27 at 1720 UTC.

I am indebted to Dr Michael Yu Zakharov, a scientist working in the CIS with whom I have been in email contact for some years. Michael has kindly given us permission to publish information from articles written by him and his colleagues at the Space Monitoring Information Support laboratory (IKI RAN). But first let's look at some general monitoring notes from my logbook.

Current Russian APT Weather Satellites

After its absence of several weeks, I finally logged a short transmission from Meteor 3-5 in late November (see figure 1). The orbits of the Meteor weather satellites are not sun-synchronous, so their planes slowly drift with respect to the sunrise/sunset terminator. Meteor 3-5 has not been in sunlight during passes across the higher latitudes of the northern hemisphere for many weeks, so it has not been transmitting over these regions. Northbound passes occurred during the afternoon, with the satellite entering darkness (and switching off) at increasing latitudes. By late November the orbital plane had moved such that the afternoon passes occurred early enough for transmissions to continue for a few minutes after rising above the local horizon.

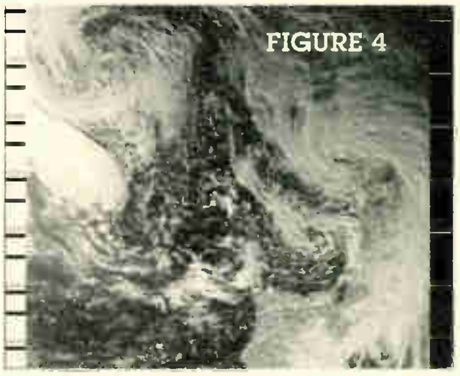
The satellite switches off when ground illumination has reduced to about half the width of the scanned view. Therefore, by using a satellite tracking program which shows footprints, one can predict the first date on which the transmission should be heard. By the middle of this month the situation should be improved (see figure 2).

Meteor 3-5 footprint for January 15

For those new to the weather satellite hobby, note that with experience, monitors of Meteor satellites can tell to within a few seconds when the satellite will switch off just by listening. Between the synchronizing tones and bars (which mark the edges of each scan line), the content and pitch of the picture can be interpreted by ear. This capability is acquired over time by watching images as they are received, and subconsciously associating the signal characteristics with the incoming image. As the land under a Meteor darkens (during the approach to the terminator) the audio pitch drops and becomes hollow (due to the lack of detail). The last few seconds of transmission sound almost empty.

Between November and early February, NOAA-12 transmits both infrared channels on APT frequencies during both south and northbound passes across the northern hemisphere, because solar illumination is so low. Only the northbound, midday NOAA-14 pass delivers a visible-light image (see figure 3) and that needs to be enhanced in order to reveal detail (see figure 4).

NOAA-14 November 28 at 1257UTC



NOAA-14 November 28 enhanced.

Sich-1 and Okean-4 Satellites

One of the most interesting aspects of weather satellite monitoring for many years has been listening for the possible reception of the Sich-1 and Okean-4 (a.k.a. Okean 1-7) oceanographic satellites operated by the Commonwealth of Independent States. The Okeans were manufactured in the Ukraine for the former Soviet Union. These two satellites can sometimes be heard transmitting APT images for short periods on 137.400 MHz.

Okean-4 was launched on October 11, 1994, and Sich-1 (carrying identical hardware) was launched on August 31, 1995. Sich-1 is the Ukraine's first oceanographic weather satellite, and like its sister Okeans, does not operate like either Meteor or

For those new to the weather satellite hobby, note that with experience, monitors of Meteor satellites can tell to within a few seconds when the satellite will switch off just by listening. Between the synchronizing tones and bars (which mark the edges of each scan line), the content and pitch of the picture can be interpreted by ear.

NOAA satellite. It carries a side-looking radar scanner (named RLS-BO) having a carrier frequency of 9.52 GHz (wavelength 3.15 cm).

Sich-1 orbits at 650 km (400 miles), and also carries thermal microwave imaging hardware as well as visible-light sensors. Its multichannel, low-resolution scanning device (named MSU-M) has two channels. The scanning microwave radiometer (RM-0.8) operates in the 36.5-36.8 GHz frequency band (8 mm). A schedule of planned transmissions from Okean-4 is published weekly on the Internet, and I plan to include this update on my own web page at URL: **http://www.ndirect.co.uk/~lawrenceh/**.

Developments in the CIS

The Commonwealth of Independent States has built an infrastructure both for the collection of digital data transmitted from meteorological satellites and for the timely dissemination of this data around the country. The simplicity of data acquisition from polar orbiting satellites has benefited various environmental tasks, and the NOAA weather satellites have produced data of the greatest interest. Low cost, high resolution picture telemetry (HRPT) data receiving stations, have started appearing all over the CIS territory.

Figure 6 shows the locations of receiving centers opened during recent years, and those planned to open in the near future. Among those currently operational are data receiving centers in the Space Research Institute of the Russian Academy of Sciences (IKI RAN) in Moscow, the Institute of Space Physics (Yakutsk), the Institute of Solar-Terrestrial Physics SO RAN (Irkutsk), and the Institute of Forestry SO RAN (Krasnoyarsk).

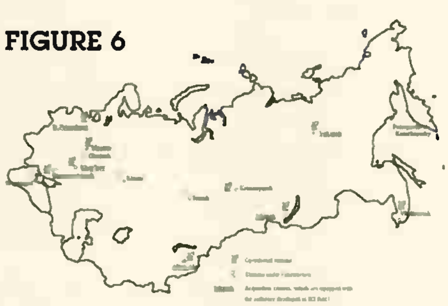
In the near future, centers in Tomsk, Sevastopol, Khar'kov, and Kazan' are scheduled to open. All can, or will soon be able to receive HRPT data from NOAA satellites. Some centers are currently working on new projects to open ground stations for the reception of high-resolution type image data from other Earth-observation satellites.

The development of these local centers has resulted in data becoming available to users over a far wider spread. The traditional method involved satellite data acquisition and distribution based on the accumulation of data in large regional centers, followed by further dissemination to end users.

The users of satellite information are scattered widely over the territory of the CIS, so an acceptable level of support can only be achieved by using the well-developed systems of wide-area computer networks, which is now rapidly growing in the CIS states. Currently, almost all the scientific centers listed have access to the global network system. In the next year or two, all will probably have a fast, reliable connection to the Internet, solving the problem of joining local acquisition centers into a single wide-area network for satellite data acquisition and processing.

Okean radar and microwave image from April 19, 1995

FIGURE 6



NOAA HRPT receiving stations within the CIS

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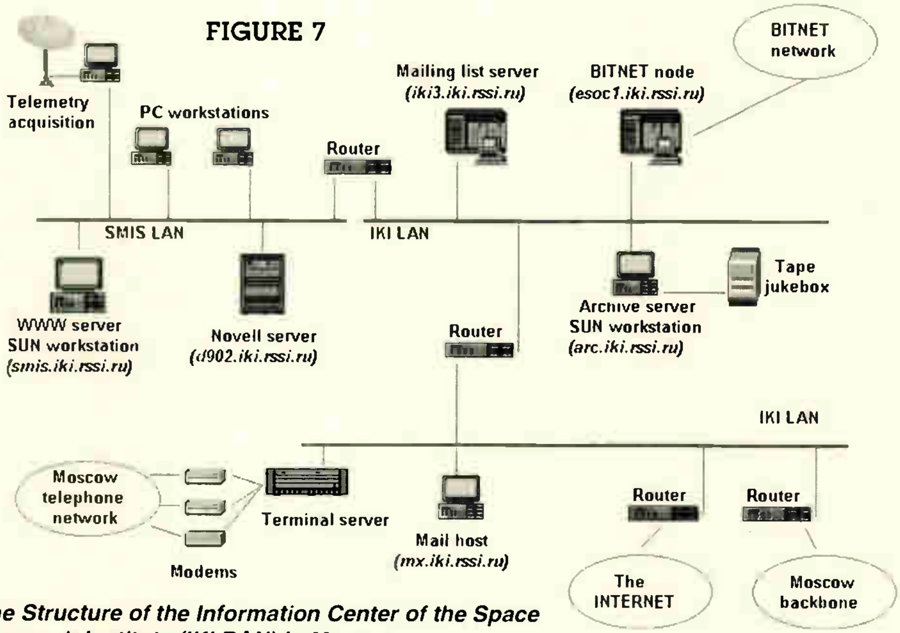
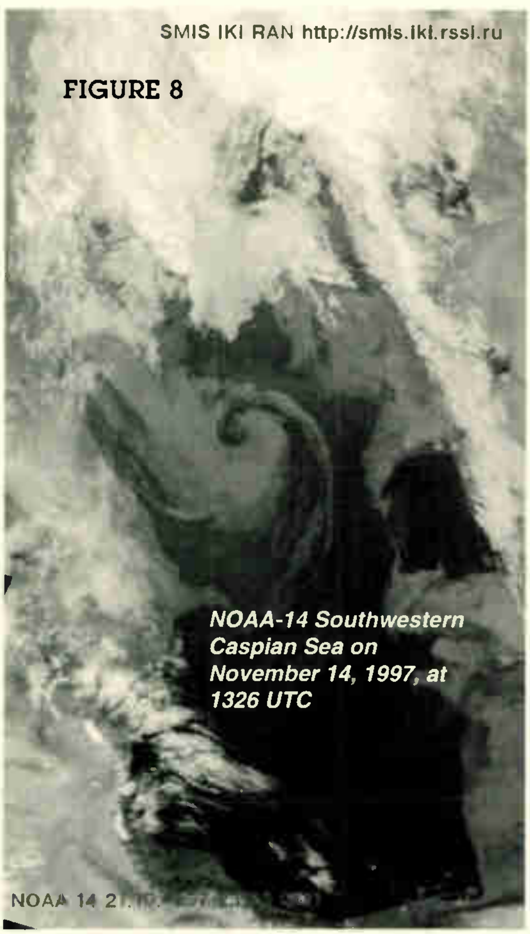
FIGURE 7



The Structure of the Information Center of the Space Research Institute (IKI RAN) in Moscow.

FIGURE 8



NOAA-14 Southwestern Caspian Sea on November 14, 1997, at 1326 UTC

Figure 8 is an HRPT image from the SMIS laboratory, courtesy of the Space Research Institute (IKI RAN). The web site address of the SMIS laboratory is: **http://smis.iki.rssi.ru/** and the Sputnik site which includes links to other sites containing information on other CIS imaging spacecraft: **http://sputnik.infospace.ru/**

There will be more information on weather satellite operations from the CIS in future editions of *The View from Above.*

An Internet Weather Satellite Website

During the last 15 years I have collected a fairly comprehensive library of reference material on polar and geostationary weather satellites, mostly publications issued by the National Oceanic and Atmospheric Administration (NOAA) and similar bodies elsewhere. During the mid-eighties I wrote to an address in Moscow (which I no longer have) asking whether there was any information available on Russian weather satellites, and much to my surprise, I received a decent-sized booklet listing the experimental packages onboard the Meteors, and tables listing the frequency bands of the sensors.

Although some of the manuals in my collection are out of date I'm reluctant to dispose of them–just in case! What I really wanted was a source of easily obtainable information on each piece of equipment used in each satellite which would be helpful when looking at images from them.

Donald Hinsman of the World Meteorological Organization has set up a web site at: **http://www.wmo.ch/** from which WMO Satellite Activities, can be selected, then Instrument Information: **http://www.wmo.ch/hinsman/index.html**

This listing includes details of almost 300 instruments which are used on a variety of imaging satellites, as well as an easy-to-use alphabetical listing. The data available for each instrument includes its name, type, sponsoring agency, wavebands, and missions on which the instrument will fly.

Satellite Tracking Programs

If you are new to the hobby of weather satellite signal image decoding and are looking for a quick way in, the first requirement must be a computer and satellite tracking program. Several of these programs are free, while some are shareware and others are commercial. Programs have been written for various platforms (IBM PC, OS/2, Windows-95, and a few less common ones), and can be obtained from shareware sources and from the Internet. A good place to start is at AMSAT–the Radio Amateur Satellite Corporation.

Although AMSAT exists basically to support the radio amateur satellite community, it carries a considerable amount of software for other satellite operations, including programs for satellite tracking. The following list is not exhaustive, and some of the programs are currently only available from the respective authors' homepages.

http://www.amsat.org/

InstantTrack is written for the IBM PC and it is one of AMSAT's main satellite tracking programs. It runs in DOS and has a database of up to 200 satellites. Anyone who has experienced problems with corruption of the display should obtain patch

[Satellite Tracking] programs have been written for various platforms (IBM PC, OS/2, Windows-95, and a few less common ones), and can be obtained from shareware sources and from the Internet. A good place to start is at AMSAT–the Radio Amateur Satellite Corporation.

four which fixes this bug.

PC Track 3.1: This is also an excellent, full-featured tracking program which runs under DOS in the protected mode (requiring an 80286 or better, and 2-Mb memory). Although the program is shareware, its author, Thomas Johnson, KF8NX, is apparently untraceable! I have attempted to locate him via the Internet but his email address and web page no longer exist.

STS Orbit Plus: The current version is 9731. This program's screen output simulates the wall map in NASA's Mission Control Center in Houston. It is a DOS program requiring an 80386 or better, with math coprocessor recommended, but not essential. The author is David Ransom, Jr, and he provides software upgrades.

Traksat 4.5: A DOS shareware program written by Paul Traufler and featuring fully-rendered 3D Earth views with full color sun/shadow. Several alternative modes of use are available, including multi-satellite and multi-station.

WST: The Weather Satellite Tracker, an excellent program written by the British software programmer Gordon Train. It is designed to run on the most basic of PCs, and is the program I recommend to people when they use old 80286 computers! Refer to my own web site for WST (**http://www.ndirect.co.uk/~lawrenceh/**).

Winorb 3.4: A Windows program which tracks up to 20 satellites simultaneously. Simple world map displays, now with orthographic view from space projection.

TrackII for Windows: A commercial program available from Spectrum International (Timestep UK representative).

This Month's Weather Satellite Frequencies

NOAA-12 transmits APT on 137.500 MHz
NOAA-14 transmits APT on 137.620 MHz
NOAA satellites transmit beacon data on 136.770 or 136.770 MHz
Meteor 3-5 transmits APT on 137.850 MHz when in sunlight.
Okean-4 and Sich-1 (occasional short transmissions) use 137.400 MHz
GOES-8 and GOES-9 use 1691 MHz for WEFAX downlinks
Mir voice can be heard on the station 143.625 MHz downlink ST

By John Magliacane, KD2BD
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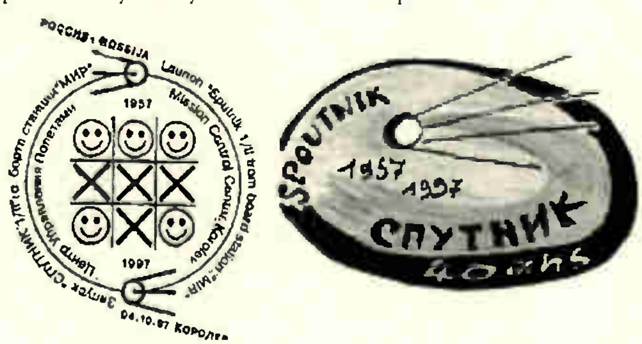
Amateur Satellites Help Celebrate Sputnik's 40th Anniversary

The 40th anniversary of the successful launch of the first man-made satellite, Sputnik-1, was commemorated late last year with the deployment of a scale model of the original Sputnik from the Russian space station Mir. The Sputnik model, known as Sputnik-40 or RS-17 after launch, is the product of efforts made by the L'Aeroclub of France, the Russian Aeronautical Federation, and students from the Jules Reydellet College in St. Denis, Reunion Island, and the Polytechnic Laboratory of Nalchik Kabaradine Balkar Republique.

3:1 scale model of Sputnik as shown at the AMSAT-UK Colloquium '97

Sputnik-40/RS-17 is a one-third scale model of the original Sputnik satellite launched 40 years ago. Photo by Reinhard, DJ1KM

Sputnik-40 was originally planned to be hand deployed from Mir by cosmonauts Pavel Vinogradov and Anatoly Solovyev during an extra vehicular activity (EVA) scheduled for October 4, 1997, the 40th anniversary of the launch of the original Sputnik spacecraft. The EVA, however, did not occur until Monday, November 3, 1997, thereby delaying the deployment of the spacecraft by nearly one month. Two Sputnik satellites were actually carried to Mir, with the second acting as a spare if the first failed to function. The second Sputnik will be brought back to earth and placed in a museum.



Two of the many logos developed for the Sputnik-40/RS-17 project.

Shortly after its successful release from Mir, Sputnik-40's low-power VHF-FM beacon transmitter was heard by countless amateurs and space enthusiasts around the world. The satellite was easily heard, even using very modest receiving equipment. Although the output power of the beacon transmitter only measured between 100 mW and 200 mW, Sputnik-40 could be heard beeping using nothing more than a handheld 2-meter transceiver a "rubber duck" antenna.

Sputnik-40's beacon transmitter is powered by a 3.5 volt, 9 ampere-hour, non-rechargeable battery pack consisting of 12 lithium cells, the same as those used to power the Mars Pathfinder rover. The beacon operates on a VHF carrier frequency of 145.820 MHz, and is frequency modulated by a pulsating audio tone whose frequency is related to the internal temperature on the spacecraft. Table 1 lists several audio frequencies and the internal spacecraft temperature with which they correspond.

Sputnik-40 not only helped to celebrate a historic achievement for mankind, but its simplicity of reception helped spark interest in the amateur space program by amateurs and non-amateurs alike. Shortly after its launch, Sputnik-40's reception times closely correlated to passes of UoSAT-OSCAR-11 and DOVE-OSCAR-17, both of which transmit only several kilohertz above Sputnik-40's beacon frequency. This provided some unexpected surprises for those listening for Sputnik-40, and inquiries began into how telemetry may be decoded and analyzed from these veteran satellites. Additional publicity was gained from the Newport News Daily Press of Newport News, Virginia, which ran a front page story on Sputnik-40, stirring interest in the project by many of its readers, including those at the Langley Research Center in Hampton, Virginia.

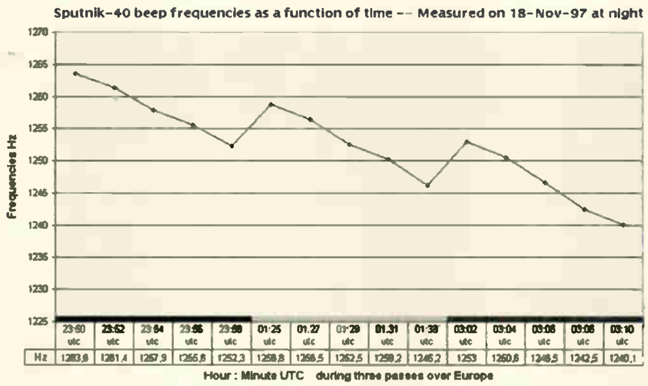
Sputnik-40's orbital lifetime is expected to greatly outlast the life of the 12 non-rechargeable lithium internal batteries being used to power the spacecraft's beacon transmitter. Those who successfully copied Sputnik-40's beacon transmissions are eligible for a QSL card and reception certificate. Those wishing to confirm their recep-

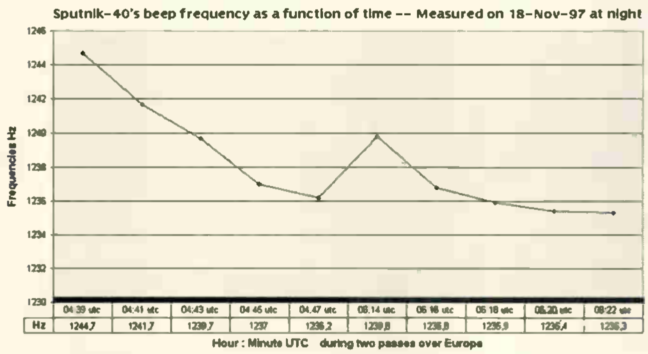
Shortly after its launch, Sputnik-40's reception times closely correlated to passes of UoSAT-OSCAR-11 and DOVE-OSCAR-17, both of which transmit only several kilohertz above Sputnik-40's beacon frequency.

tion report with a QSL card should send their reports along with an International Reply Coupon (IRC) and a self-addressed envelope to: Sergej Samburov, PO Box 73, Kaliningrad-10 City, Moscow Area, 14070, Russia

Be sure not to include any callsigns on the envelopes to insure they will not be opened or searched by anyone except those intended. International Reply Coupons are available at most post offices, and may be redeemed for return postage in many foreign countries.

In addition to QSL cards from Russia, 15 x 21 cm reception certificates are available directly from the Radio Club of Jules Reydellet school on Reunion Island. Those wishing certificates should send their reception reports along with a 6 x 9 inch self-addressed envelope and two IRCs to: FR5KJ Radio Club, 103 Rue de la Republique, 97 489 Saint Denis Cedex, Reunion Island





Sputnik beep frequencies as a function of time. Measurements taken by Claudio, IK1SLD in Italy.

New Mir Frequency Experiment

As part of on-going amateur radio communication experiments taking place from the Mir space station, the operating frequencies for FM voice and packet radio communications were moved from 145.985 MHz simplex to a 437.850 MHz uplink / 145.800 MHz downlink crossband frequency pair on December 1, 1997. This frequency change experiment was developed by the international partners in Manned Space discussions at last October's Toronto AMSAT-NA Space Symposium, and has been endorsed by the representatives present at the conference including SAFEX, SAREX, AMSAT-UK, the IARU Region 2 President, the IARU Satellite Advisor,

(ZS5AKV), ARI (Italy), and RAC (Canada). The US MIREX team, while not present at the Toronto meeting, also supports this latest Mir frequency experiment.

The Mir frequency experiment will take place in two phases. The first phase, which was expected to begin on December 1, 1997, will last for a period of three months. The second phase of the experiment will commence on March 1, 1998, and involves using a set of uplink and downlink frequencies in the 2-meter amateur band, again for a period of three months. Difficulties being experienced with the dual-band amateur radio antenna on Mir in the latter part of November, and on-going problems occurring with Mir's on-board computers, however, may delay the start of these experiments.

It is best to keep tuned to *SpaceNews* and official AMSAT bulletins for the latest information on amateur radio activity taking place from Mir.

Lighthouse Weekend Special Event

At times, amateur radio operators take their radio communications equipment to unusual places and establish radio contact with others around the globe. Such was the case last August when members of the Portland Amateur Radio Club were active as G0VOP/P during the Northern Lighthouse Weekend and the International Lighthouse and Lightship Weekend on August 23 and 24, 1997, from the Island of Portland in the county of Dorset on the South Coast of England (grid square

The launch of PANSAT, the Petite Amateur Navy Satellite, which was originally scheduled for deployment from the U.S. space shuttle on mission STS-86, has been delayed and is now expected to be deployed from the International Space Station.

Members of the Portland Amateur Radio Club who were active during the Lighthouse Weekend special event last August in England.

IO80sm). The group made contacts on the HF bands, 6-meters, 2-meters, and 70-cm, as well as several OSCAR from this very rare grid square. The photograph shown in Figure 6 was uploaded to the KITSAT-OSCAR-25 satellite by members of the group in commemoration of the Lighhouse Weekend Special Event.

PANSAT Launch Delayed

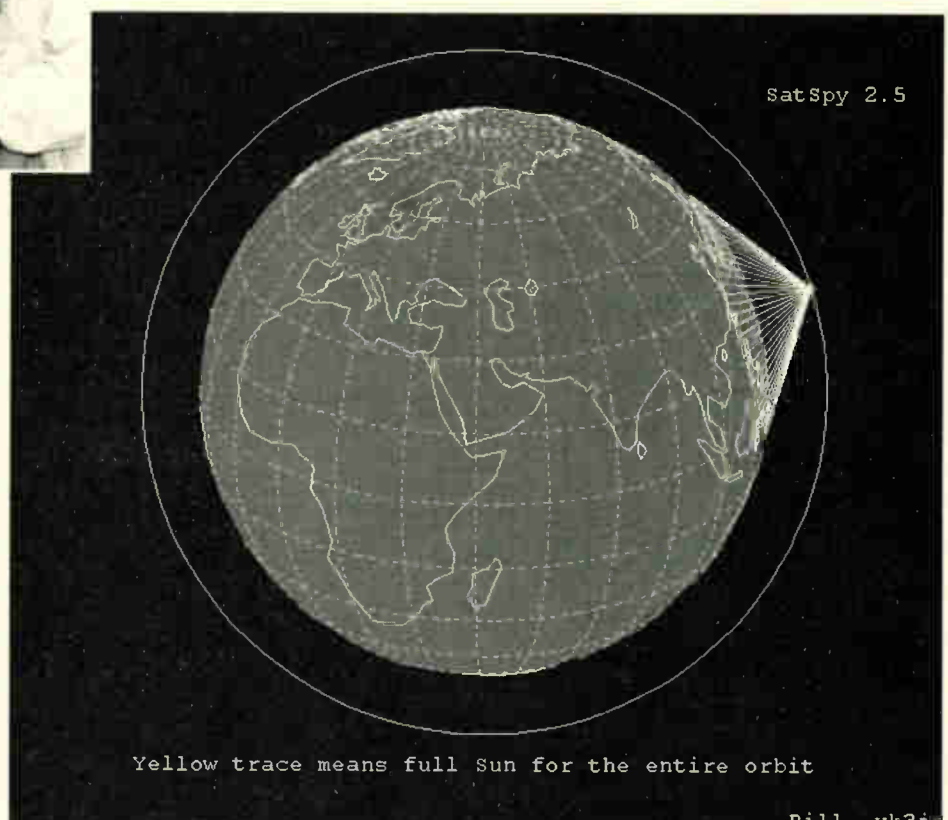
The launch of PANSAT, the Petite Amateur Navy Satellite, which was originally scheduled for deployment from the U.S. space shuttle on mission STS-86, has been delayed and is now expected to be deployed from the International Space Station. PANSAT is a spread spectrum, digital communications microsatellite designed by the Space Systems Academic Group at the Naval Postgraduate School in Monterey, California. The PANSAT group is currently filing paperwork with NASA to have their satellite deployed into low-earth orbit, and final bugs are being worked out with the spacecraft electronics.

RS-16: Still Not Operational

Nearly a year after launch, the RS-16 amateur satellite has yet to be commissioned for general use. RS-16 is an amateur communications package carried on-board a Russian Zeya military satellite that was launched last March from the Svobodnyi Cosmodrome in the Amur Oblast. It remains unclear whether the satellite's communications transponder has ever been turned on or whether the rumors indicating its sporadic use by the Russian military or commercial organizations are true. The satellite can still be heard transmitting CW telemetry on 29.408 MHz, 29.451 MHz, 435.504 MHz, or 435.548 MHz.

KITSAT-OSCAR-23 Heating Problem

Users of the KITSAT-OSCAR-23 digital communications satellite have been experiencing seasonal difficulties in uploading and downloading files to and from the satellite due to a lack of eclipses, and a corresponding temperature rise on the spacecraft. The elevated temperatures effect the spacecraft electronics and cause a change in the frequency deviation of KO-23's downlink transmitter, producing difficulty in reception and an overall decrease in data throughput. Since the condition is seasonal and is not the result of permanent



Graphic showing the KITSAT-OSCAR-23 satellite in constant sunlight late last year. The lack of eclipses causes a dramatic temperature rise on the spacecraft, thereby resulting in a distorted downlink signal and sharply reduced throughput.

Turned off by the high cost and complexity of amateur radio communications equipment? Many amateurs have found that building their own equipment to be an effective way of reducing cash outlay and an excellent method of learning more about communications technology.

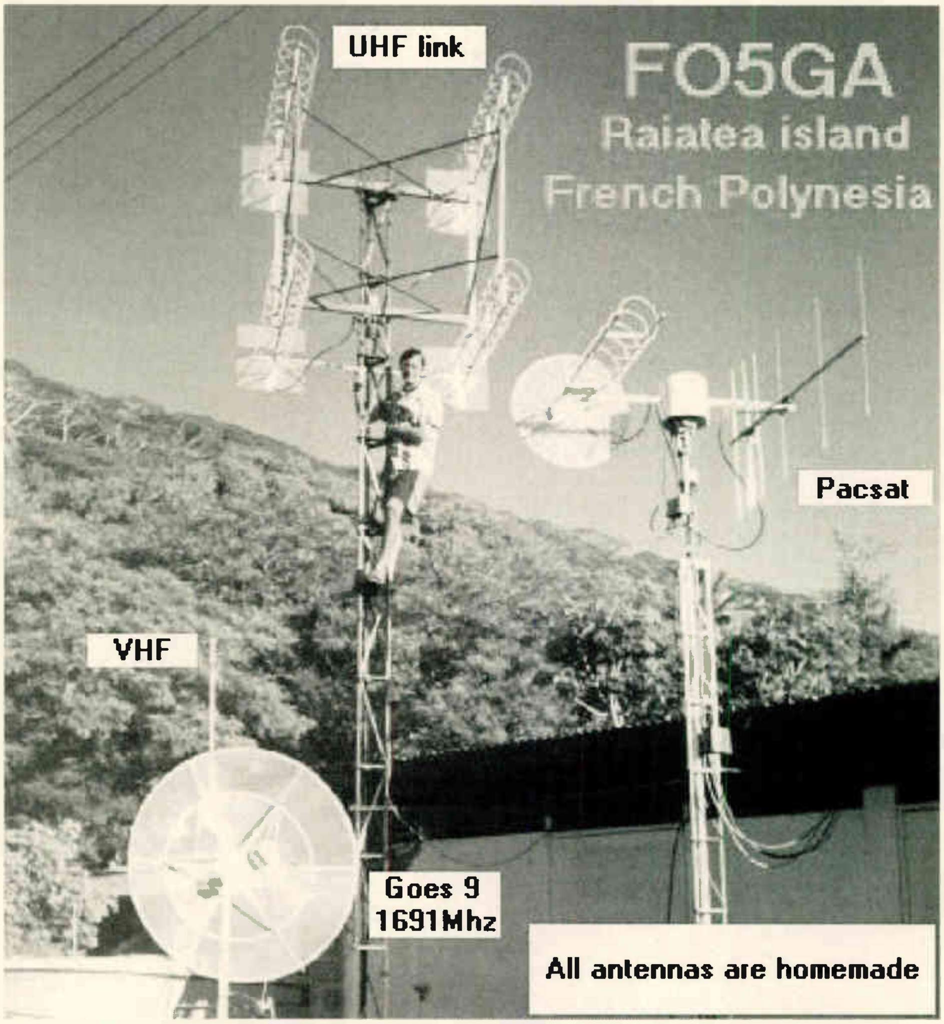
damage to the spacecraft, it only affects users on a temporary basis.

Beating the High Cost of Satellite Communications

Turned off by the high cost and complexity of amateur radio communications equipment? Many amateurs have found that building their own equipment to be an effective way of reducing cash outlay and an excellent method of learning more about communications technology. Photo at right shows an impressive amateur satellite antenna array belonging to FO5GA on Raiatea Island in French Polynesia. All antennas in the photograph were built from scratch.

In an effort to help promote the design and construction of amateur satellite communications equipment by communication hobbyists, *Satellite Times* will publish its first construction article–The KD2BD 9600 Baud Modem–in the February issue. The KD2BD 9600 baud modem is capable of high performance, 9600-bit-per-second, packet radio data communications, and is compatible with 9600 baud communications taking place through digital OSCAR satellite transponders and via terrestrial packet radio links. It uses commonly available components and offers several features not available in previous data modem designs.

Hopefully the KD2BD 9600-baud modem and future construction articles it will help increase the understanding of the technology and techniques used in the fascinating world of OSCAR amateur radio satellite communications.



Amateur satellites need not be expensive. FO5GA on Raiatea Island in French Polynesia shows off his homemade satellite antennas in this photo he recently uploaded to the KITSAT-OSCAR-25 satellite.

TABLE 1

Correlation between spacecraft temperature and audio frequency of the tone transmitted via the Sputnik-40/RS-17 FM beacon transmitter.

*50 deg C	1361 Hz
30 deg C	1290 Hz
25 deg C	1261 Hz
10 deg C	1208 Hz
0 deg C	1131 Hz
-10 deg C	1040 Hz
-20 deg C	891 Hz
-30 deg C	724 Hz
-40 deg C	541 Hz

TABLE 2: W8RVH and W8ZCF Temperature Analysis of Sputnik-40

Date/Time	Frequency	Temperature
06-Nov-97/14:26 UTC	1269.3 Hz	27.0 Deg C
07-Nov-97/13:27 UTC	1257.4 Hz	23.0 Deg C
08-Nov-97/14:06 UTC	1255.9 Hz	22.0 Deg C
09-Nov-97/13:08 UTC	1248.4 Hz	19.5 Deg C
11-Nov-97/12:49 UTC	1248.3 Hz	19.5 Deg C
12-Nov-97/11:49 UTC	1244.3 Hz	19.0 Deg C
13-Nov-97/09:12 UTC	1257.0 Hz	21.8 Deg C
13-Nov-97/14:03 UTC	1241.0 Hz	18.0 Deg C
14-Nov-97/12:05 UTC	1244.5 Hz	19.0 Deg C
14-Nov-97/16:17 UTC	1245.0 Hz	19.0 Deg C
16-Nov-97/14:19 UTC	1246.0 Hz	19.0 Deg C
17-Nov-97/13:20 UTC	1243.0 Hz	18.5 Deg C

W8RVH and W8ZCF provided this temperature analysis of Sputnik-40 beginning shortly after its launch. The decline in spacecraft temperature is probably due to increased eclipse time shortly prior to the temperature samples taken.

By Keith Stein
kstein@erols.com

Monitoring the Top End of the S-band

It's time to take a different look at amateur radio satellites for this issue, and the end of the S-band region. We're talking 2400 MHz–try putting that in your PRO-2006 scanner!

If the radio manufacturing industry would develop some receiver converter technology, maybe someday you and I would be able to pick up S-band satellite signals with a low cost receiver or scanner converter combination. But in the meantime, if you want to hear S-band transmissions, you are going to need a small satellite dish antenna and some military surplus equipment to play around in this portion of the radio spectrum (2400-2500 MHz).

Various modulation schemes and modes are used from 2390 to 2400 and 2410 to 2450 MHz, and amateur satellite operations (space-to-Earth/downlinks) are authorized from 2400-2450 MHz. The 2400-2450 MHz band is also available for use by a wide variety of unlicensed devices. M i - crowave ovens use this portion of the spectrum (approximately 2450 MHz) and as well as a variety of industrial processes (welding, etc). I can almost see it now in next month's *ST SLP Intercepts* section:

M2450 Heard the space shuttle's microwave oven at 1717. I checked to make sure mine was off. So it had to be the shuttle's because I heard it the same time the shuttle passed over. (Joe Doe-Three Mile Island)

But seriously, the Air Force also uses this band for high-power, long-range surveillance radars and air traffic control radars. However, because of the operation of tens of millions of microwave ovens and other industrial, scientific, and medical (ISM) equipment, little use is made of this band and little growth is expected.

The Navy also uses this band for scoring applications for missiles and projectiles. There is also some packet radio development by the Army going on in this band but, of course, we want to talk about satellites.

OSCAR 11

An oldie, but a goodie, is OSCAR 11 (also known as UoSAT 2, UoSAT 11, UOSAT OSCAR-11, or UO-11) catalog number 14781.

OSCAR 11 was launched for the United Kingdom on March 1, 1984, from Vandenberg Air Force Base, California, on board a Delta booster rocket. Its primary mission has been to study the magnetosphere, earth imaging, and amateur radio digital communications.

The mode-S beacon is currently on and transmitting an unmodulated carrier, but telemetry indicates that it has partially failed, and only delivering half power. This beacon is a useful space signal source for hobbyists wanting to test mode-S converters.

OSCAR 11	Downlink Frequency Assignments
VHF-band	145.826 MHz
UHF-band	435.025 MHz
S-band	2401.500 MHz

OSCAR 17

When the S-band is mentioned, the most talked about amateur satellite is OSCAR 17 (also known as DOVE, DOVE OSCAR-17, or DO-17), USSPACECOM catalog number 20440. OSCAR 17 was launched for Brazil on January 22, 1990, from the Arianespace Guiana Space Center on board an Ariane 4 booster.

DOVE, which stands for Digital Orbiting Voice Encoder, is designed to transmit digital voice messages, but due to hardware and software difficulties, it has not yet met this objective except for a few short tests. Recently, it has been transmitting telemetry in normal AX-25 AFSK packet mode.

The DOVE S-band transmitter puts out about 0.8 watts into a 1/4 wave whip mounted the spacecraft, according to a article found on AMSAT's web site at **www.amsat.org**. The article was written by Jim White, WD0E on November 5, 1997.

If you monitor DOVE from the northern hemisphere you should hear deep fades about every 30 seconds or so as the satellite rotates, and the S-band antenna is blocked by the spacecraft's body. In the southern hemisphere the signal should be pretty steady.

The data transmitted in S-band is the same as on 2-meters, telemetry with a short text broadcast about every 30-60 seconds depending upon power available. All data is ASCII text, and modulation is 1200 baud PSK.

Decoding the data from this transmitter presents an interesting challenge. For more details, ckeckout Jim's article on the AMSAT web site at **http://www.amsat.org**.

OSCAR 17	Downlink Frequency Assignments
VHF-band	145.825 MHz
S-band	2401.220 MHz

To receive a QSL for DOVE reception, send a reception report and SASE to: Dianne White N0IZO, 45777 Rampart Road, Parker, Colorado 80138-4316USA

Globalstar

Based in San Jose, California, Globalstar was formed in 1991 to develop, launch, and operate a low-earth-orbit (LEO) personal communications satellite system.

The first launch of four satellites is expected next month on February 5, 1998, according to a recent company news release. The postponement was needed to allow further testing and rehearsals of the tracking, telemetry and control (TT&C) ground equipment that will monitor the launch and deploy the Globalstar satellites.

Globalstar now expects to begin commercial service no later than in the first quarter of 1999 following the launch of 44 satellites during 1998. The remaining 12 satellites will be launched in early 1999.

The first four Globalstar satellites are at the Cape Canaveral launch site and four additional satellites for the second launch have successfully completed integration and testing. In addition, satellite and major subsystem assembly, integration, and test-

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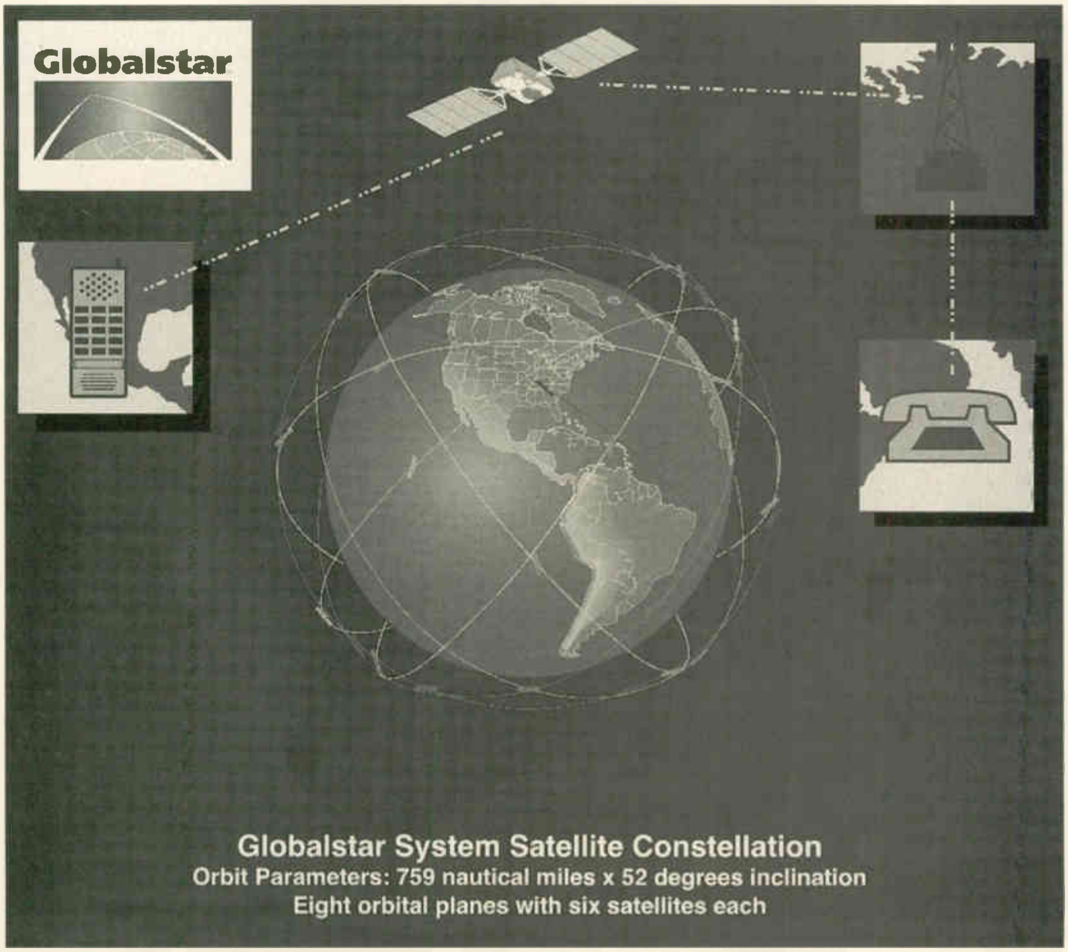

Globalstar System Satellite Constellation
Orbit Parameters: 759 nautical miles x 52 degrees inclination
Eight orbital planes with six satellites each

ing necessary for the first Zenit launch are underway.

Globalstar Launch Schedule

Date	Launch Vehicle	Number of Satellites
Feb 1998	Delta II	4
Apr 1998	Delta II	4
Jul 1998	Zenit-2	12
-	Zenit-2	12
-	Zenit-2	12
-	Soyuz	4
-	Soyuz	4
-	Soyuz	4
		56 Total

Globalstar	Downlink Frequency Assignments
S-band	2483.5-2500.0 MHz (Uplink)
	1610.0-1626.5 MHz (Downlink)
	6875.0-7075.0 MHz (Downlink)

Crew Aboard MIR Deploys Sputnik Replica

Reports from around the world indicate that the replica *Sputnik 40* satellite, deployed in November from Russia's Mir Space Station, is transmitting a readable downlink signal from its 100 milliwatt transmitter.

The satellite was built as a joint project by schools in Russia and Reunion Island, with technical assistance from AMSAT-France.

Sputink 40	Downlink Frequency Assignments
VHF-band	145.820-145.825 MHz

ATS-3 Keeps on Ticking

ATS-3 is still being used by NASA for communication links to Antarctica, mainly for the South Pole. This was reported recently on the Hearsat-L newsgroup by Elie Bonilla at the University of Puerto Rico.

Due to its inclination, it has a window of several hours which it can provide a link to the scientific community down there. A router at Malabar decides which satellite link to use (there are several) for the network links. If not implemented already, they will have TCP/IP capability through ATS-3, although at low rates, very soon.

Philip Chien wrote a very interesting article about ATS-3 in the May/June 1997 issue of *Satellite Times.*

ATS-3 was launched in 1967 and, despite losing its station-keeping ability, its C-band transponder, and its NASA funding, it is still active.

ATS-3 is now maintained by the University of Florida from a home-based control station in Florida. The VHF equipment is still active with a downlink on 135.6 MHz. Because its orbit became highly inclined after station-keeping ceased, it must now be tracked. The University of Florida uses a multi-element Yagi for communicating with the satellite.

Globalstar satellite phones

ATS-3 is now maintained by the University of Florida from a home-based control station in Florida. The VHF equipment is still active with a downlink on 135.6 MHz.Because its orbit became highly inclined after station-keeping ceased, it must now be tracked.

Satellite Listening Post Intercepts (all times in UTC)

Abbreviations and Acronyms

AFB	Air Force Base
AM	Amplitude Modulation
DoD	Department of Defense
FM	Frequency Modulation
G	Gigahertz
M	Megahertz
Milsat	Military Satellite
NASA	National Aeronautics and Space Administration
UFO	UHF Follow-On
UHF	Ultra High Frequency

M124.100 Miami Center working NASA 908 (T-38 aircraft) departure from Patrick AFB in AM mode. (Al Stern-Satellite Beach, FL)

M128.550 NASA 916 (T-38 aircraft) requesting fly-by of shuttle landing facility tower at 2113 in AM mode (Stern-FL)

M132.650 NASA 970 heard at 2247 in AM mode. (Stern-FL)

M133.750 NASA 419 (UH-1H helicopter) departure at 1600 in AM mode. (Stern-FL)

M134.950 NASA 903 (T-38 aircraft) arrival at 1328 on runway 13 at Cape Canaveral Air Station skid strip. Transmission in AM mode. (Stern-FL)

M145.825 Sputnik-40/RS-17 heard at 0446. Nice signal with approximately 14 beeps every 10 seconds (74 beeps per minute). In narrowband FM mode. (Costas Krallis, SV1XV-Athens, Greece)

M145.985 Heard voice downlink from Mir space station on 1832, narrowband FM mode. Dave Wolf heard saying "We're 500 miles out over the ocean." (John Corby-Caledon, Toronto, Canada)

M146.940 Good coverage of Delta launch from Cape Canaveral Air Station. Also safety on M165.185 and Photo Ops on M148.485. (Larry Kraus-Titusville, FL)

M147.000 Launch Net heard during Titan IV/DoD launch from Vandenberg Air Force Base, California. (Brian Webb, KD6NRP-Thousand Oaks, CA)

M251.950 U.S. Military UHF satellite comms: Radio 1 working Radio 2 with radio checks (Magnus Hammarstedt-Ostersund, Sweden)

M261.525 LEASAT Yankee bandplan channel 2: Heard Ice 14 working Ice Ops and passing weather observation for 2200. "I'll be off for an hour now. I'm going to lunch." (Dave Batcho, N5JHV-Las Cruces, NM)

M261.625 UFO milsat, Papa bandplan, channel 13 (Fleet Relay): Heard Cougar Oscar calling Cougar Base and Cougar X-ray. (Hammarstedt-Sweden)

M261.650 UFO milsat: Heard Tango Oscar calling Tango X-ray (Hammarstedt-Sweden)

M261.700 UFO milsat: Heard Dragon 1 calling Dragon 2 (Hammarstedt-Sweden)

M289.600 NASA-982 (T-38A based at Ellington AFB, TX) landed then flew on to Boise, Idaho. Female pilot in AM mode. (Sandy-Denver, CO)

M296.700 NASA 709 (ER-2 Aircraft) above 60,000 feet in AM mode (Rick-Sacramento, CA)

M335.600 Button 6 for NASA 831 (SR-71B aircraft) and NASA 852 (F/A-18B) on departure. NASA 831 did a mach 3 pass (AM mode). (Dan-West of March AFB, CA)

M364.800 NASA 831 (SR-71 aircraft) working Salt Lake Center (ARTCC). Also heard on 322.300 and 296.700 MHz in AM mode. (Jim De Witt-Sacramento, CA)

G3.9750 BBC Breakfast News on Intelsat 803 transponder 44L, left-circular polarized, in NTSC. (Nick Roman)

G12.0680 TNN backhaul feed of NASCAR race on SBS-6 transponder 15 at 1715. (Bob Lyle)

TABLE 1: RUSSIAN NAVIGATION SATELLITE

Constellation Status Report. Compiled and verified by John Corby, moderator of the Hearsat-L newsgroup

Catalog Number	Satellite Name	Operating Frequencies	Current Status
Russian Military NavSats			
Plane 1			
24953	Cosmos 2346	150.030/400.080 MHz	Active
24304	Cosmos 2334	150.030/400.080 MHz	Working standby
23773	Cosmos 2327	149.970/399.920 MHz	Failed
22888	Cosmos 2266	149.970/399.920 MHz	Working standby
Plane 2			
24772	Cosmos 2341	149.910/399.760 MHz	Active
23526	Cosmos 2310	149.910/399.760 MHz	Working standby
21937	Cosmos 2184	149.910/399.760 MHz	Working standby
20577	Cosmos 2074	149.910/399.760 MHz	Failed
Plane 3			
22207	Cosmos 2218	149.940/399.840 MHz	Active
Plane 4			
24677	Cosmos 2336	149.970/399.920 MHz	Active
22590	Cosmos 2239	149.970/399.920 MHz	Off (status unknown)
21796	Cosmos 2173	149.970/399.920 MHz	Off (status unknown)
Plane 5			
21230	Cosmos 2142	150.030/400.080 MHz	Off
22487	Cosmos 2233	150.030/400.080 MHz	Off (status unknown)
Plane 6			
23092	Cosmos 2279	149.940/399.840 MHz	Off
21875	Cosmos 2180	149.940/399.840 MHz	Off (status unknown)
Russian Civilian NavSats			
Plane 11			
23603	Cosmos 2315	150.000/400.000 MHz	Active
22307	Cosmos 2230	150.000/400.000 MHz	Off (status unknown)
21902	Cosmos 2181	150.000/400.000 MHz	Off (status unknown)
17066	Cosmos 1791	150.000/400.000 MHz	Off (status unknown)
Plane 12			
21152	Nadezhda 3	150.000/400.000/ 1544.50 MHz	Active
Plane 13			
23463	Tsikada	150.000/400.000 MHz	Active
21089	Cosmos 2123	150.000/400.000 MHz	Failed
Plane 14			
23179	Nadezhda 4	150.000/400.000/ 1544.50 MHz	Active
20508	Nadezhda 2	150.000/400.000/ 1544.50 MHz	Failed

Musson Satellite Constellation Notes

Planes 1-6 are spaced 30 degrees apart to cover one earth hemisphere. Planes 11-14 are spaced 45 degrees apart to cover the other hemisphere. Only one satellite is active in each plane.

The signal is 50 bits/sec. There are three sidebands at 3, 5, and 7 kHz either side of the carrier. A "1" data bit is transmitted by a frequency shift from 3 to 5 kHz. The 7 kHz sideband produces timing.

Nadezhda satellites carry COSPAS-SARSAT transponders with a 1544.50 MHz downlink. This downlink should only be active when the satellite is receiving a distress beacon on 121.5/243.0/406 MHz.

Two frequency sets have been used for plane 1: 149.970/399.920 MHz and 150.030/400.080 MHz. All other planes have fixed frequency assignments.

The Russian navigation satellite constellation is subject to frequent changes. Always consult the most recently posted status report on the Hearsat-L newsgroup.

This status report is posted to HearSat-L and the HearSat website at URL: **http://www.grove.net/~hearsat.**

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.

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

	Catalog #	Intl. Desig.	Epoch Year	Epoch Day .Fraction	Period Decay Rate	Not used		
1	14129U	83058B	94	254.05030619	- .0000192	00000-0	100000-30	3080

	Catalog #	Inclination	Right Asc. of Node	Eccentricity	Argument of Perigee	Mean Anomaly	Mean Motion	Revolution # at Epoch	
2	14129	26.8972	308.5366	6028238	209.9975	94.5175	2.05881264	5658	5

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 97333.64124932 -.00000024 00000-0 10000-3 0 5185
2 14129 26.4589 114.5142 6027450 172.1079 205.2863 2.05880955 80794
OSCAR 11 (UoSAT 2, UoSAT 11, UOSAT OSCAR-11, UO-11)
1 14781U 84021B 97337.97989549 .00000304 00000-0 59005-4 0 200
2 14781 97.8532 312.6041 0011119 175.3068 184.8243 14.69628616736192
Russian Mir Space Station
1 16609U 86017A 97338.18136002 .00010098 00000-0 12307-3 0 8279
2 16609 51.6560 311.1179 0007770 50.3087 309.8606 15.61149569673560
OSCAR 16 (PACSAT, AMSAT OSCAR-16, AO-16)
1 20439U 90005D 97338.20826173 .00000067 00000-0 42816-4 0 1115
2 20439 98.5284 59.4269 0012361 68.0186 292.2319 14.30030378410533
OSCAR 17 (DOVE, DOVE OSCAR-17, DO-17)
1 20440U 90005E 97338.24712855 .00000052 00000-0 36895-4 0 1093
2 20440 98.5330 60.4470 0012433 67.7837 292.4664 14.30174180410571
OSCAR 18 (WEBERSAT, WEBERSAT OSCAR-18, WO-18)
1 20441U 90005F 97337.19949308 .00000060 00000-0 39838-4 0 1169
2 20441 98.5309 59.2964 0012792 70.2205 290.0356 14.30140016410425
OSCAR 19 (LUSAT, LUSAT OSCAR-19, LO-19)
1 20442U 90005G 97337.22302525 .00000069 00000-0 43122-4 0 1146
2 20442 98.5335 60.0858 0013585 72.4223 287.8470 14.30257632410459
OSCAR 20 (JAS 1B, FUJI 2, FUJI OSCAR 20, FO-20)
1 20480U 90013C 97337.84207081 .00000001 00000-0 78875-4 0 144
2 20480 99.0668 267.6695 0540626 353.3787 6.0373 12.83241505366469
RS-12/13 (Radio Sputnik 12/13, Cosmos 2123)
1 21089U 91007A 97337.00764857 .00000074 00000-0 62090-4 0 266
2 21089 82.9234 153.4574 0028518 185.0455 175.0417 13.74089584342341
OSCAR 22 (UoSAT-F, UoSAT-5, UOSAT OSCAR 22, UO-22)
1 21575U 91050B 97335.20818281 .00000060 00000-0 34230-4 0 8184
2 21575 98.2801 29.6691 0008172 104.8743 255.3349 14.37099775334472
OSCAR 23 (KITSAT-A, KITSAT-1, KITSAT OSCAR-23, KO-23)
1 22077U 92052B 97337.86151345 -.00000037 00000-0 10000-3 0 7081
2 22077 66.0853 149.9793 0000554 26.3665 333.7381 12.86305553249575
OSCAR 27 (EYESAT-A, EYESAT-1, AMSAT OSCAR-27, AO-27
1 22825U 93061C 97337.72977707 .00000036 00000-0 31770-4 0 6036
2 22825 98.5302 48.0472 0009244 98.9093 261.3135 14.27747027218261
OSCAR 26 (ITAMSAT, ITAMSAT OSCAR-26, IO-26)
1 22826U 93061D 97338.24574763 .00000032 00000-0 30259-4 0 6004
2 22826 98.5302 48.8395 0010005 101.5512 258.6791 14.27857951218353
OSCAR 25 (KITSAT-B, KITSAT-2, KITSAT OSCAR-25, KO-25)
1 22828U 93061F 97334.24575767 .00000036 00000-0 31682-4 0 5786
2 22828 98.5273 45.0284 0010908 95.3893 264.8532 14.28203205185917
OSCAR 28 (POSAT, POSAT OSCAR-28, PO-28)
1 22829U 93061G 97336.72068864 .00000064 00000-0 42914-4 0 5957
2 22829 98.5267 47.5461 0010862 91.0980 269.1446 14.28190248218184
RS-15 (Radio Sputnik 15)
1 23439U 94085A 97338.18766682 -.00000039 00000-0 10000-3 0 2643
2 23439 64.8200 237.9471 0145580 99.3383 262.4036 11.27528790121104
OSCAR 29 (FUJI 3, FUJI OSCAR-29, FO-29)
1 24278U 96046B 97338.12291475 .00000011 00000-0 43840-4 0 1255
2 24278 98.5200 356.0169 0352367 105.7244 258.3051 13.52635668 64096
RS-16 (Radio Sputnik 16)
1 24744U 97010A 97338.24970972 .00007405 00000-0 23517-3 0 1188
2 24744 97.2631 240.0990 0005674 191.4027 168.7088 15.32922206 42120
RS-17/Sputnik 40 (Radio Sputnik 17)
1 24958U 97058C 97337.34282116 .00048029 00000-0 53096-3 0 353
2 24958 51.6586 315.2693 0007729 41.7538 318.4075 15.62508367 4637

WEATHER/IMAGING SATELLITES
Geostationary Satellites
GOES 7 (Standby Geostationary Spacecraft-USA)
1 17561U 87022A 97335.63333193 -.00000128 00000-0 10000-3 0 4257
2 17561 4.0880 65.8573 0002396 220.4345 274.3347 1.00269340 22645
GOES 8 (Operational East-USA)
1 23051U 94022A 97335.92022466 -.00000242 00000-0 10000-3 0 9449
2 23051 0.3623 92.9685 0004902 159.4388 75.0718 1.00271981 20705
GOES 9 (Operational West-USA)
1 23581U 95025A 97337.63405685 .00000095 00000-0 00000+0 0 6930
2 23581 0.0478 268.7355 0003785 5.9809 250.6731 1.00269033 9287
GOES 10 (Standby Geostationary Spacecraft-USA)
1 24786U 97019A 97335.49265137 -.00000080 00000-0 00000+0 0 1458
2 24786 0.0377 287.8271 0006388 1.1307 214.1240 1.00262715 2233
ELEKTRO (Operational-Russia)
1 23327U 94069A 97335.91149919 -.00000088 00000-0 00000+0 0 4020
2 23327 1.1260 89.6411 0002417 145.9462 239.3915 1.00271542 11346
Feng Yun 2B (Operational-China)
1 24834U 97029A 97336.75245391 -.00000318 00000-0 00000+0 0 939
2 24834 0.8806 257.9468 0001128 113.0395 75.6439 1.00265319 1754
Meteosat 5 (Operational ESA, aka MOP-2)
1 21140U 91015B 97336.12083912 -.00000068 00000-0 00000+0 0 3985
2 21140 1.6165 78.8236 0004665 161.5060 224.8892 1.00271866 26951
Meteosat 6 (Operational-ESA)
1 22912U 93073B 97323.68257757 .00000000 00000-0 10000-3 0 8947
2 22912 0.3998 305.1852 0002981 241.5531 118.1424 1.00277241 13078
Meteosat 7 (Operational ESA)
1 24932U 97049B 97335.83218171 -.00000074 00000-0 00000+0 0 742
2 24932 1.6410 290.3631 0002888 332.7913 96.8560 1.00273027 929
GMS 4 (Standby-Japan, aka Himawari 4)
1 20217U 89070A 97336.64868853 -.00000357 00000-0 10000-3 0 6797
2 20217 2.8450 72.4740 0001441 272.8897 79.3826 1.00258580 30760
GMS 5 Operational-Japan, aka Himawari 5)
1 23522U 95011B 97334.37079398 -.00000271 00000-0 10000-3 0 5229
2 23522 0.4114 354.3275 0002552 240.1684 108.3525 1.00264012 9777

Near Polar/Polar Orbiting Imaging Spacecraft
NOAA 12 (Operational morning spacecraft-USA 137.500 MHz)
1 21263U 91032A 97338.13050278 .00000145 00000-0 83343-4 0 6177
2 21263 98.5312 347.1581 0012883 155.7415 204.4371 14.22771235340522
NOAA 14 (Operational afternoon spacecraft-USA 137.620 MHz)
1 23455U 94089A 97338.06125940 .00000163 00000-0 11461-3 0 2805
2 23455 99.0128 289.9036 0008939 170.4661 189.6682 14.11717244150919
Meteor 2-21(Off at last report)
1 22782U 93055A 97336.95362733 .00000017 00000-0 20797-5 0 6073
2 22782 82.5478 284.1099 0021219 284.6310 75.2496 13.83086345214910
Meteor 3-5 (Operational-Russia 137.850 MHz)
1 21655U 91056A 97336.88238341 .00000051 00000-0 10000-3 0 255
2 21655 82.5508 303.5255 0012499 275.7810 84.1907 13.16857245302913
Meteor 3-6 (Off at last report)
1 22969U 94003A 97337.24397063 .00000051 00000-0 10000-3 0 3924
2 22969 82.5626 243.6804 0015848 348.4212 11.6546 13.16750671185336
DMSP B5D2-7 (DoD meteorological polar orbiter: downlink encrypted)
1 23233U 94057A 97338.13866618 .00000155 00000-0 10638-3 0 4703
2 23233 98.7567 33.0182 0013304 100.1310 260.1365 14.12861453168363
DMSP B5D2-8 (DoD meteorological polar orbiter: downlink encrypted)
1 23533U 95015A 97338.07104630 .00000073 00000-0 62912-4 0 2174
2 23533 98.8509 339.9851 0007410 345.6420 14.4536 14.12822545139157
DMSP B5D2-9 (DoD meteorological polar orbiter: downlink encrypted)
1 24753U 97012A 97338.12305796 .00000095 00000-0 74865-4 0 2691
2 24753 98.9142 21.8403 0008625 293.4909 66.5360 14.13018949 34385

EARTH RESOURCES IMAGING SATELLITES
OKEAN 1-7 (Okean 4-Russia 137.400 MHz)
1 23317U 94066A 97336.91365460 .00000325 00000-0 45565-4 0 2872
2 23317 82.5420 287.9756 0027110 141.7450 218.5696 14.74163005169167
SICH-1 (Oceanographic satellite-Russia 137.400 MHz)
1 23657U 95046A 97336.32518387 .00000244 00000-0 33780-4 0 2158
2 23657 82.5332 69.7932 0029569 117.4064 243.0163 14.73616379121345
IRS-1C (Remote Sensing-India)
1 23751U 95072A 97335.41549782 -.00000044 00000-0 00000+0 0 2720
2 23751 98.6908 48.1639 0001368 36.5105 323.6085 14.21637156100058
IRS-P3 (Remote Sensing-India)
1 23827U 96017A 97337.58122198 -.00000044 00000-0 00000+0 0 2395
2 23827 98.7009 54.0898 0000553 133.2146 226.7650 14.21618380 88417
TOMS-EP (Total Ozone Mapping Spectrometer-USA)
1 23940U 96037A 97335.25540105 .00007244 00000-0 30442-3 0 1908
2 23940 97.4195 240.1795 0012265 274.5754 85.4084 15.23664596 78576
IRS-1D
1 24971U 97057A 97336.87217445 .00000024 00000-0 24349-4 0 1025
2 24971 98.6201 49.8018 0061739 181.9244 178.1711 14.32772782 9329

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

OOVE (OO-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

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
Planet Connect, Planet Systems, Inc 100 kbps service	G1, 9	7.80
Skylink, Planet Systems, Inc	G1, 9	7.265
	G4, 6	7.264
Superguide	G5, 7	5.48

Contemporary Music

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

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, 10	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
CBC Radio Canada-East (French)	E2, 1	5.38/5.58 (DS)
	E2, 1	7.36
La Cadena CNN Radio Noticias (CNN Radio News in Spanish)	G5,17	7.56
KAZN-AM (1300) Pasadena, CA—Asian Radio	GE1, 22 (Ku)	6.20
RAI Satelradio Italy (Italian)	G7, 14	7.38
Radio Dubai United Arab Emirates (Arabic)	G7, 10	7.48
Radio Maria (Italian)—religious programming	G7, 10	5.80
Radio Maria	G7, 10	8.03
Radio Tropical	GE1, 4	7.60
Unidentified station-foreign language	GE-1,22 (Ku-band)	5.80
WCRP-FM (88.1) Guyama, PR (Spanish)—religious	G4, 6	6.53
XEQ-FM (92.9) Mexico City, DF 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

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
WTLT-AM (1480) Charlotte, NC—news/talk	G1R, 17	7.92

Religious Programming

Ambassasor Inspirational Radio	GE3, 15	5.96, 6.48
Brother Staire Radio	G5, 6	6.48
Christian Music Network, Lakeland, FL	GE1, 14	6.20, 7.60
KHCB-FM (105.7) Houston, TX	C1, 10	7.28
Inspirational Music (unidentified)	G4, 6	7.96
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
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 C-band Downlinks

C-SPAN Audio 1: Various shortwave broadcasters	C3, 7	5.20
C-SPAN Audio 2: British Broadcasting Corp. (BBC)	C3, 7	5.41
Deutsche Welle	GE1, 22	7.02, 7.22 , 7.38/ 7.56, 7.74
WEWN-Worldwide Catholic Radio, Vandiver, Ala.	G1R, 11	5.40 (English), 5.58 (Spanish)
WHRI/KHWR–World Harvest R., South Bend, Ind.	G4, 15	7.46/7.55, 7.64
World Radio Network: WRN1 North America	G5, 6	6.80
WRN2 North America	G5, 6	6.20 (Multi-ling.)

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, 7	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
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
Talk Radio Network—talk programs	C1, 5	5.80
United Broadcasting Network	C1, 2	7.50
WOKIE Network—tech talk	SBS6, 13B (Ku)	6.20 (network is active when Megabingo is present)
WWTN-FM (99.7) Manchester, TN—news and talk	G5, 18	7.38, 7.56

Variety Programming

CBC Radio (occasional audio)	E2, 1	5.78
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	7.38
WUSF-FM (89.7) Tampa-St. Petersburg, FL (Public Radio), ID-*Concert 90*	C4, 10	8.26 (N)

Satellite Radio Guide/SCPC Services Guide

WWRL-AM (1600) New York, NY–Am. Urban R. Network
GE3, 9
6.30/6.48 (DS)

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 and 3.750 MHz
Focus on the Family (ch. 1), .780 (ch. 2) and 1.230 MHz
Information Radio Network 3.390 MHz
International Broadcasting Network: 4.830 MHz
USA Radio Network: .330, 5.010 (ch 1) and 5.200 MHz (ch. 2)

GE-3 Transponder 17 (C-band)

Blank audio carriers: 3.570 MHz
Data Transmission: .800 MHz
Focus on the Family: 1.050 and 1.400 MHz
In-Touch—religious: 4.470 MHz
Salem Satellite Network: 4.650, 4.840, 5.010 (ch.1) and 5.200 MHz (ch. 2)
SRN News: .330 MHz
Skylight Radio Network—religious: 1.770 MHz

Galaxy 4 Transponder 3 (Ku-band)

Blank Audio Carriers: 1.150, 2.060, 3.250, 3.620, 4.340, 4.400 and 4.450 MHz
Data transmissions: 1.000, 2.950, 3.070 and 3.190 MHz
Generic News: 3.530 MHz (occasional audio)
In-Store audio network ads (various companies): .710, .810, .910, 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 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, 3.620, 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 and 2.070 MHz

Anik E1 Transponder 6 (Ku-band)

Nova Network FM Squared Services

FM CUBED (FM³) AUDIO SERVICES

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

Single Channel Per Carrier (SCPC) Services Guide

By Robert Smathers

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

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

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

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

1178.70 (81.3)	NASA space shuttle audio

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

1207.90 (52.1)	Wisconsin Voice of Christian Youth (VCY) America Radio Network—religious programming
1206.70 (53.3)	Data Transmission
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
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/Denver Bronocs NFL radio network/Colorado sports
1404.60 (55.4)	WGN-AM (720) Chicago, IL—news and talk radio/Chicago Bears NFL radio network/Northwestern 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/Green Bay Packers NFL radio network/Wisconsin Radio Network—network news feeds/Wisconsin sports
1396.90 (63.1)	Dallas Cowboys Spanish radio network
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/Green Bay Packers NFL radio network/Wisconsin Radio Network—network news feeds/Wisconsin sports
1395.60 (64.4)	WGST-AM/FM (640/105.7) Atlanta, GA ID *Planet Radio*—news and talk radio/Atlanta Falcons NFL radio network
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 Detroit Pistons NBA radio network
1394.50 (65.5)	XEPRS-AM (1090) Tijuana, Mexico—Spanish language programming
1394.30 (65.7)	Michigan News Network/Michigan State sports
1391.00 (69.0)	Occasional audio
1388.90 (71.1)	Data transmissions (burst)
1387.80 (72.2)	Data transmissions (constant)
1384.40 (75.6)	KOA-AM (850)/KTLK-AM (760) Denver, CO—news and talk radio/Denver Broncos NFL radio network/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
1383.90 (76.9)	KIRO-AM (710) Seattle, WA—news and talk radio/Seattle Seahawks NFL radio network
1382.90 (77.1)	Michigan News Network—network news feeds
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
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
1377.40 (82.6)	Data transmission (packet burst/tones)
1377.10 (82.9)	In-Touch—reading service for the blind
1376.90 (83.1)	Data Transmissions
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

Anik E2 Transponder 13-Horizontal (C-band)

1206.00 (54.0)	Canadian Broadcasting Corporation (CBC) Radio—southwestern Northwest Territories service

Anik E2 Transponder 17-Horizontal (C-band)

1126.00 (54.0)	Canadian Broadcasting Corporation (CBC) Radio—northern Northwest Territories service
1125.50 (54.5)	Canadian Broadcasting Corporation (CBC) Radio—Newfoundland and Labrador service

Anik E2 Transponder 23-Horizontal (C-band)

1006.00 (54.0)	Radio Canada International (International Shortwave Broadcaster)
1005.50 (54.5)	Canadian Broadcasting Corporation (CBC) Radio-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.ST. Louis Rams NFL radio network
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/Kansas City Chiefs NFL radio network
1386.20 (73.8)	Radio Iowa/Iowa sports
1386.00 (74.0)	United broadcasting Network—talk radio
1384.60 (75.4)	Capitol Radio Network/Washington Redskins NFL 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/Carolina Panthers NFL radio network
1382.90 (77.1)	Missourinet/Missouri sports
1382.30 (77.7)	Virginia News Network—network news feeds
1382.10 (77.9)	Learfield Communications/Missourinet

RCA C5 Transponder 21-Vertical (C-band)

1045.00 (55.0)	Blank audio carrier
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
4	11798.5-V	Data Transmissions
5	11823-H	Occ video
6	11847.5-V	Unknown user [digital video]
7	11872-H	Occ video
8	11896.5-V	Occ video/[digital video] (occ)
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
4	11817.5-V	Occ video
6	11876.5-V	Occ video
7	11906-H	Occ video
13	12083-H	Occ video
15	12142-H	GE Americom K2 ID slate

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]
10	11900-V	National Technology University (NTU) [Spectrumsaver]
11	11920-H	Data transmissions
13	11960-H	Occ video
17	12040-H	Oregon EdNet
18	12060-V	PBS leased digital services
19	12080-H	PBS leased analog services/ *The Business Channel*
20	12100-V	PBS adult learning service (ALS)
21	12120-H	PBS High Definition TV testing
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]

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 [Digicipher]
7	11910-V	Occ video
8	11923-H	Data transmissions
9	11971-V	Occ video
10	11984-H	Occ video
11	12033-V	South Carolina Educational TV [digicipher]
12	12046-H	Occ video
13	12095-V	Florida Public TV (occ)/Occ video
14	12108-H	Data transmissions-possible digital video
15	12157-V	DMX for Business [digital data-lower half transponder]
16	12170-H	Louisiana Public TV [Digicipher]

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
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

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
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	Data transmissions
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]
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)
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/Data transmissions
17	12050-V	CBS Newsnet and affiliate feeds (half-transponders)
18	12050-H	Honk Kong TVB Jade Channel (Chinese) [videocrypt]
19	12080-H	Unknown User [digital video]
20	12110-V	Data transmissions
21	12110-H	Asian-American TV Network (occ)/Occ video
22	12140-H	Data transmissions
23	12170-V	CBS Newsnet and affiliate feeds (half-transponders)
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	Georgia Public TV [Digicipher] (lower half)
24	12140-H	E.M.G. courses [Digital video] (upper half)

DBS-1 101.2° W./DBS-2 & DBS-3 100.8° W.

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

GE-1 (GE1) 103° West

1	11720-H	Qualcomm data [digital]
2	11740-V	Data transmissions
3	11760-H	NBC Eastern Time Zone programming
4	11780-V	Data transmissions
6	11820-V	Empire Sports [Wegener digital]/Kentucky Educational TV (KET) [Digicipher]
7	11840-H	NBC Pacific Time Zone programming
8	11860-V	Qualcomm data [digital]
9	11880-H	NBC Mountain Time Zone programming
10	11900-V	Qualcomm data [digital]
12	11940-V	Microspace Velocity [digital]
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 News Channel [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
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	CNN Newsource (Primary) [Leitch]
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 Newsource (secondary)/ occ video
16	12171-V	Data transmissions

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, 6-9, 14-16 on Solidaridad 2.

5	11974-H	Data Transmissions
10	11805-V	Data Transmissions
11	11866-V	Data Transmissions
12	11927-V	Data Transmissions
13	11988-V	Data Transmissions

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

This satellite rarely has any Ku-band video transmissions.

7	11900-V	Occ video

Morelos 2 (M2) 116.8° West

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

Anik C1 (C1) 118.6° West

32	12183-H	Occ video

EchoStar 1/2 & Tempo 1 119°West

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

SBS 5 (SBS5) 123° West

1	11725-H	Unknown User [digital video]
2	11780-H	SCPC services/Data transmissions
3	11823-H	Data transmissions
5	11921-H	Data transmissions
6	11970-H	Data transmissions
7	12019-H	Data transmissions
8	12068-H	Data transmissions/Unknown User [digital video]
9	12117-H	Data transmissions
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°	GE-2 (GE2) 85°	GE-3 (GE3) 87°	Telstar 4 (T4) 89°	Galaxy 7 (G7) 91°	Galaxy 3R (G3R) 95°	Telstar 5 (T5) 97°	Galaxy 4 (G4) 99°	Spacenet 4 (S4) 101°	GE-1 (GE1) 103°	Anik E2 (A1) 107.3°
1	Tokyo BS New York feeds	o/v	Associated Press TV [MPEG/DVB]	o/v	Sega Channel Interactive [digital]	TVN Theatre 1 [V2+]	Telequest DBS [Digicipher]	SCPC services	Data Transmissions	o/v	CBC-H English Eastern
2	o/v	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	o/v
3	Gospel Music Television	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 [Digicipher]	CBC feeds (occ)
4	Horse Racing [digital video]	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/Cincinnati [V2+]	Cancom [PowerVu]
5	CNN feeds (o/v)	NASA Contract Channel	Univision [V2+]	FOX feeds	fX West [V2+]	TVN Theatre 5 [V2+]	Telequest DBS [Digicipher]	4 Media Company feeds	Data Transmissions	Hero Teleport (GEMS HTV) [Digicipher]	CBS feeds
6	NHK (TV Japan) feeds	Kuwait TV	(none)	Infomercials	Game Show Network [V2+]	TVN Theatre 6/TVN Promo [V2+]	Telequest DBS [Digicipher]	Shepherd's Chapel Network (Rel)	KNBC-NBC Los Angeles (PT24W) [V2+]	WNBC-NBC New York (PT24E) [V2+]	o/v
7	Video Catalog Channel (VCC)	Data Transmissions	Data Transmissions	Adam and Eve/Spice (adult)/Hot Spice [Digicipher]	The Golf Channel [V2+]	Guthy-Renker TV (infomercials)/TVN Theatre 7 [V2+]	o/v	(none)	3BTV	Cornerstone TV (Rel)	CBC-M English
8	Horse Racing [digital video]	Data Transmissions	Data Transmissions	ABC feeds East [LEITCH]	o/v	Pandamerica Home Shopping/TVN Theatre 8 [V2+]	ABC NewsOne Channel	Telemundo Telenoticias [PowerVu]	KDMD- ABC Seattle (PT24W) [V2+]	SC Chicago [V2+]	o/v
9	MuchMusic U.S. [V2+]	NASA TV	WPIX-Ind New York [V2+]	Horse Racing [digital video]	CBS Eye on People Network [PowerVu]	TVN Theatre 9 [V2+]	FOX Feeds	WB Dom TV/Network	Data Transmissions	Fox Sports South [V2+]	CBC-B English Atlantic
10	Horse Racing [digital video]	Data Transmissions	Data Transmissions	FOX News Edge	United Arab Emirates TV Dubai	TVN Theatre 10 - adulTVision (adult) [V2+]	FOX Feed East	o/v	FOXNet (PT24E/W) [V2+]	WKRN-ABC Nashville, TN (PT24E) [V2+]	Cancom [PowerVu]
11	o/v	o/v	CNN/SI	Xxxcite (adult) [V2+]	Encore [V2+]	o/v	Exxxtasy (adult) [V2+]	o/v	STARZ! East [V2+]	Univision [digital video]	CBC-A French [Powervu]
12	TV Asia [PowerVu] Horse Racing [digital video]	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	Cancom [PowerVu]
13	RTPi (Portugal)	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/SC Alternate (occ)/o/v	CBC-C English Pacific
14	Horse Racing [digital video]	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+]	SC New England [V2+]	Cancom [PowerVu]
15	Midwest Sports Channel [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	SC Alternate/o/v	o/v
16	Horse Racing [digital video]	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	SC Pacific [V2+]	Global TV [PowerVu]
17	o/v	Data Transmissions	FM2 services	FOX feeds	(none)	Cinemax 2 East [V2+]	o/v	CBS feeds [occ VC1]	(none)	SC Alternates (occ)	CBC-D feeds
18	EWTN International Alabama Cable Network [Powervu]	o/v	o/v	PBS National Schedule	Teleport Minnesota/CBS feeds/o/v	Inforamerica TV (Informercials)	o/v	CBS feeds/ Eyemark syndicated feeds	STARZ! West [V2+]	SC New York [V2+]	Data Transmissions
19	University Network-Dr. Gene Scott (Rel)	Data Transmissions	Fox Sports Detroit [V2+]	Natl Jewish TV/Exotica Promo (adult)	CBS East [occ VC1]	HBO 3 [V2+]	America's Collectibles Network	CBS East [occ VC1]	(none)	National Empowerment TV (Net)	Telesat [PowerVu]
20	o/v	o/v	Gen Shopping Channel	(none)	FOX News Channel	HBO 2 West [V2+]	o/v	CBS East [occ VC1]	(none)	AFRTS [Powervu]	(Inactive)
21	o/v	o/v	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)	Telesat [PowerVu]
22	Horse Racing [digital video]	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	o/v
23	Worship TV/Praise TV (Rel) [MPEG2/DVB]	NHK Secondary Feeds	(none)	FOX feeds/ABC feeds	fX Movies [V2+]	3 Angels Broadcasting	o/v	SCOLA [Wegener] LDS TV (occ)	Data Transmissions	o/v	CBC-E English
24	Horse Racing [digital video]/o/v	o/v	America One	(none)	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+]	CTV [PowerVu]

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(Other rates: 6 months US, $12.95; 2 years US, $45.95; 3 years US, $67.95; 1 year Canada surface, $36.50; 1 year foreign international, $55.45. Call for other options, or see details in our magazines)

Judy Bob

Anyone who says the hobby radio market is dead wasn't listening to the telephones, fax machine, Internet terminals, and walk-in customers at Grove Enterprises over the holidays! We enjoyed a superb business season, unequalled in recent history.

While the complexion of the hobby is changing, it is by no means moribund. New shortwave listeners and scanner enthusiasts are contacting us daily, expressing their appreciation for our customer support; long-timers thank us for our representation at the scanner hearings a year ago in Washington.

At that time it was grueling, but in the long run, it was worth it. Working together, the radio community has secured the legitimacy of the hobby, and has prevented the passage of outrageous legislation which would have virtually banished radio monitoring.

And now we see once again the emergence of new products on the market, a welcome sight, some if which are breathtaking in their potential. As more unfold, you will see them reviewed in Monitoring Times, and offered for sale in the Grove Buyer's Guide and on our Web site (www.grove.net).

We look forward to a year renewed in radio vitality and, as the sunspot cycle continues to improve shortwave reception, we prepare for a new era of communications. We are glad you will be with us for that pleasure.

Bob & Judy Grove

Trade In, Trade Up!

Grove Enterprises offers liberal trade-in allowances for your used receiving equipment and accessories. 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.

NOTE: Simplfied shipping charges for all products in this Guide are shown in the chart on page "o".

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

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."

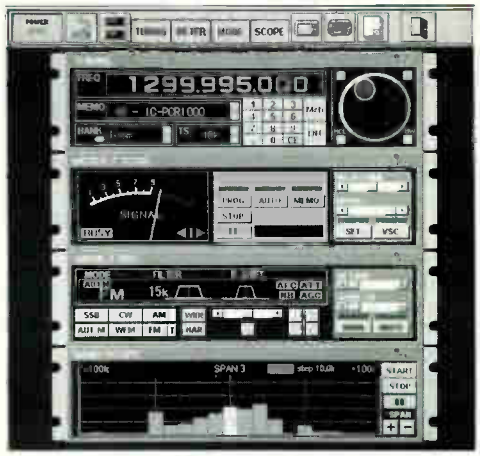
No receiver with exceptionally broad frequency range can hope to match the performance of a radio designed for a specific frequency band. If you want the best shortwave receiver, look at the top dedicated shortwave receivers of Drake, AOR and JRC.

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.**



Computer screen simulation.

ORDER RCV 21 only 499^{95}
(Includes Percon FCC Database)

The Incredible Alinco DJ-X10

Measuring only 2-1/4"W x 6"H x 1"D and weighing a mere 11 ounces, the DJ-X10 offers continuous 100 kHz through 2000 MHz coverage (less cellular) and all-mode reception (AM, WFM, NFM, USB, LSB, CW), high sensitivity, 1200 memory channel capacity in 30 banks, triple conversion superheterodyne design, 25 channel per second scan/search speed, 40 channel spectrum display, clock timer.

The feature-packed DJ-X10 also features low battery indicator, dual power (replaceable AA cells or 8-15 VDC external supply; rechargeable NiCD pack available), computer port, 100 mW audio output, overload attenuator, display contrast control, selectable on-screen help messages, alphanumeric identification of channels, automatic memorizing of search-discovered channels, illuminated dial, and up to 8 different scanning modes including linked ranges and dual VFO. See specifications on page "h".

Call for price and availability
(available pending FCC approval)

ICOM R8500

Huge $300 Discount on one of the World's Best Receivers!

Here is one of the world's best tabletop receivers with continuous 100 kHz-1999.99 MHz frequency coverage (less cellular), tunable in precise 10 Hz steps—wide and narrow FM and AM, USB, LSB, CW. Add high sensitivity, IF shift, selectable AGC timing, audio peak filter to automatically enhance modes, built-in RS232C and CI-V for direct computer control, 1000 memory channels in 20 banks, 12 VDC / 120 VAC operation. 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, ANT 2, BRK 4, BRK 5, MAN 1 beginning on page "m".**

ORDER SCN 01 only ~~1999^{95}~~ 1699^{95}

ICOM R-10!

Special Discount Price!

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, ANT 8, ANT 14, CAS 1-N, DCC 5, AND SFT 2 beginning on page "m".**

ORDER SCN 06 only ~~499^{95}~~ 399^{95}

UPS Second Day Air at Ground Rates on ALL PRODUCTS!

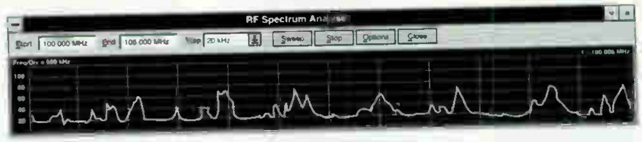
WiNRADiO WR-1000i

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.

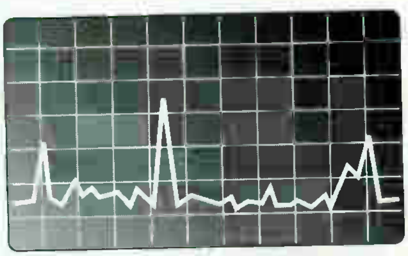
Call up a full-fledged spectrum display and see signal presence on any span between 500 kHz and 1.3 GHz! Double-click the mouse on any signal spike and the receiver immediately tunes to that frequency! Storage feature allows recall of signal traces. BNC connector allows attachment of your antenna system, 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 1, ANT 2, ANT 3, ANT 7, ANT 9, ANT 15, SPK 13, CBL 50 and CBL 100 beginning on page "m".**

ORDER RCV 16 only **$499.95**

In addition to the receivers shown on these two pages, please see specifications for the wide-band AR-3000 on page h.



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.

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-consrolled 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

Super-wide-coverage receiver

AOR has scooped the market with their new AR5000 extended-frequency coverage receiver, tunable from 10 kHz through 2600 MHz (less cellular) and offering 650 memory channels. 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, ANT 7, SDU 5000 and SFT 2 beginning on page "m".**

ORDER RCV 12 only **$1895.95**

AR-5000 PLUS 3 also available. All the features of the AR-5000 plus double and single sideband synchronous detection, 2000 memory channels, AM & FM automatic frequency control, 10 VFOs, 40 search banks, and more. Order RCV 12-P, only **$2095.95.**

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.

ORDER SCN 27 only **$599.95**

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,m ACC 15, SFT2 and DCC 3 beginning on page "m".**

ORDER SCN 09 only **$369.95**

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, BAT 5, CAS-3 and DCC-7 beginning on page "m".**

ORDER SCN 10 only **$249.95**

For superb reception, combine the TrunkTracker with the Austin Condor high gain flex antenna (ANT 14) shown elsewhere in this Buyers Guide.

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				
AR-3000	SCN-26	Mobile/base 100 kHz-2036 MHz 400 channel	$1062.95	ANT-2, ANT-1, SPK-13, SFT-2W
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

UPS Second Day Air at Ground Rates on ALL PRODUCTS!

GROVE

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, ANT 14, BAT 1, BAT 13, CAS 11, and DCC 3 beginning on page "m".**

ORDER SCN 08 only $249^95

New: RCA Scanner

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

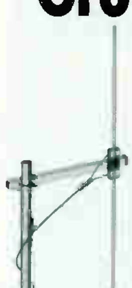
Radio Shack PRO-90 Trunk Tracking Scanner

Virtually every two-way VHF or UHF communications is at your fingertips with the new triple-conversion PRO-90, even the elusive Motorola trunking systems! 29-54, 108-174, 406-512, 806-956 MHz (less cellular) frequency coverage, 300 memory channels plus 10 priority channels. Includes NiCd battery pack, AC charger/adaptor, flex whip, trunking frequency guide. Specifications are similar to Uniden BC235XLT shown on page "h". **Accessories: ANT 14, ANT 8, ANT 22, BAT 5 replacement battery pack and and CAS 3 leather case beginning on page "m".**

ORDER SCN 11 only $269^95

REACH OUT TO THE WORLD WITH GROVE SCANNER ANTENNAS

Grove OMNI II



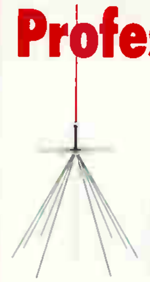
Designed by Bob Grove, this exclusive Grove product offers 25-1300 MHz coverage; lightweight, compact design, high performance, and low cost! Designed especially for wide-area metropolitan listeners, the 68" Omni can be mounted on a mast, in an attic crawl space, against a wall...just about anywhere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

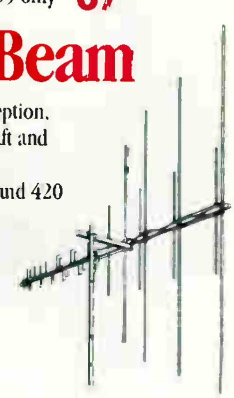
Professional Wideband Discone



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.

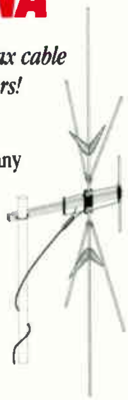
May be used with inexpensive TV antenna rotator or fixed in favored direction. Local signals still come in loud and clear from all directions.

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}

Premium Low-Loss 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!

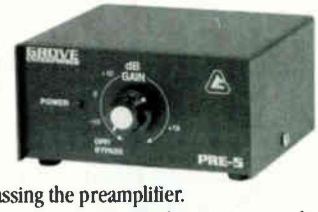
CBL 25	**25' RG 59U**	$9^{95}
CBL 50	**50'RG-6U**	$14^{95}
CBL 100	**100'RG-6U**	$19^{95}

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)
ADP 28	F female to PAL fem. Satellite700
ADP 29	3.5mm female to 2.5mm male mini plug (qnty.2)
ADP 30	Dual BNC female to BNC male T-adaptor (qnty.2)
ADP 31	BNC female to Motorola male
ADP 32	RCA female to male PL-259
ADPK 10	F female to Motorola male
ADPK 13	F male to F male 3ft.cable (qnty.3)
ADPK 14	F/Motorola cable, 3ft.(qnty.2)
ADPK 15	PL259 male to PL259 male 3ft.
ADPK 16	BNC male/ BNC male 3ft cable

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

Grove PRE-5A VHF/UHF Signal Booster



Now Grove has integrated its high-performance preamplifier and control box into one convenient unit, offering improved performance. The new PRE-5A offers wide dynamic range and low noise for weak signal boosting, and improved 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.

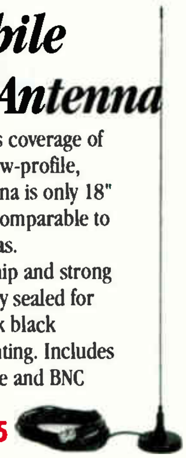
ORDER PRE 5A only $89^{95}

NEW Universal Whip!

The ANT 8 now features a spring-supported base for greater flexibility—and no increase in price! Extendable from 7 to 47-1/2 inches, the ANT-8 is made of chrome-plated brass and equipped with a standard BNC base. Transmits on 45-960 MHz; receives 25-1300 MHz. Spring-base ANT-19 adjusts from 4"-21" (transmits and receives from 144-960 MHz). ANT-8B has right-angle BNC adaptor. ANT-8N has right-angle N adaptor.

Order ANT 8 (7"-47-1/2")	$16^{95}
ANT 19 (4"-21")	$14^{95}
ANT 8B	$21^{95}
ANT-8N	$23^{95}

STEALTH *Mobile Monitoring 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

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.

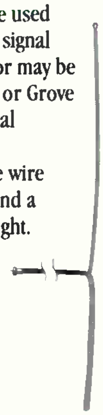
ORDER ANT 22 only $29^{95}

With straight connector for handhelds

ORDER ANT 23 only $34^{95}

With right-angle connector for desktop use (right)

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}

UPS Second Day Air at Ground Rates on ALL PRODUCTS!

SOFTWARE FOR SCANNERS/SHORTWAVE RECEIVERS

Scan Manager Pro v.1.1

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

Order SFT 13, only $68.95

Scancat-Gold for DOS

Use your 640k (or better) computer to control 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

Optoelectronics Frequency Scout

This advanced pocket frequency counter has a selectable, silent vibrator or audible beeper to alert you to signal presence. Continuous 10-2800 MHz frequency coverage, displayed on a 10-digit, backlit LCD. High sensitivity captures weak signals up to hundreds of feet.

Connected to any scanner with a CI-V interface, allows automatic reception of any intercepted signal within the scanner's frequency range. For use with the AR8000, order SAC-8000; for the R10 order ADPK-4; for R7000, R7100, R8500, R9000, use ACC-74 or ACC-157.

Relative signal strengths are displayed on a 16-segment bargraph, and up to 400 different intercepted signal frequencies may be automatically stored in memory for later recall. Continuous operation for at least 8 hours on a fast two-hour-rechargeable battery. Antennas sold separately.

ORDER CRT 8 only **$399.95**

Optoelectronics CUB

Compact, lightweight, and inexpensive, the 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 and AC charger included.

ORDER CRT 9 only **$144.95**

Incredible, 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**

NEW! LEATHERMAN TOOL 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.

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

NOTE: Cellular-Capable Scanners are available only to government agencies and cellular service providers by direct inquiry. These scanners include special versions of the SCN 27 (p. "c"), RCV 12 (p. "c"), RCV 16 (p. "c"), SCN 06 (p. "b"), SCN 01 (p. "b"), and SCN 26 (p. "l").

Grove's Wide Band-Receiver Specification Guide

Prices subject to change without notice

Scanner	Alinco DJ-X10	AR 3000A	AR 5000	AR 8000	ICOM PCR 1000	ICOM R10	ICOM R8500	WINRADIO
Grove Order #	SCN 02	SCN 26	RCV 12	SCN 27	RCV 21	SCN 6	SCN 1	RCV 16
Grove Price	Call	$1,062.95	$1,895.95	$599.95	$499.95	$399.95	$1699.95	$499.95
Frequency Range	100 kHz-2000 MHz (less cellular)	100kHz-2036 MHz (less cellular)	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	Yes, plus tuning dial	Yes, plus tuning dial	Yes	Yes	Alphanumeric	Yes	Yes
Tuning Steps	10/100 Hz/1/2.5/6.25/9/10/12.5/15/20/-25/30/50/100/125/15-0/200/250/500 kHz	Programmable 50 Hz-999 kHz	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	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	Yes	On/Off	Your monitor	On/Off	Yes	N/A
Receiving Modes	AM/NFM/WFM/LSB/USB/CW	AM/NFM/WFM/LSB/USB/CW	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	1200 channels	400 channels	1000 channels	1000 channels	Unlimited, determined by computer	1000 channels	1000 channels	Virtually unlimited
Scan	25 channels/sec.	50 channels/sec.	45 channels/sec. w/ priority	30 channels/sec.	Yes, 6 different modes	6 ch./sec.	40 chan./sec.	50 ch./sec. FM modes
Banks	30	4	20/40	20		18	20	16
Channel Lockout	1000	Yes.	Yes	Yes		Yes	Yes	
Priority	1 channel	4 channels	Any channel	Any channel		Yes	Yes	
Search	Yes	50 channels/sec.	50 channels/sec.	30 channels/sec.		17 channels	40 channels/sec.	Yes
Delay	Selectable	All channels	Programmable	Programmable		Programmable time, channel	Yes	Programmable
Clock	Clock timer	Yes	Yes	No		No	No, sleep timer	Yes
Audio Output (typical)	100 mW	1.2 W	1 W	180 mW	200 mW	120 mW	2W	200 mW
Record Audio Output	Yes	Yes	Yes	No		No	Yes	No
Recorder Activator	No	Yes	Yes	No		No	Yes	8 ohm minijack
Signal Strength Ind.	LCD bargraph	Yes	Analog S-meter	LCD bargraph	Yes	LCD bargraph	Analog S meter	On PC screen
Computer Interface	No	RS232C	RS232	RS232	RS232C	CI-V	RS232C and CI-V	Expansion slot
Conversion Scheme	Triple up (736.25/275.45, 45.05, 10.7/0.455 MHz)	Triple conv.	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)	1 uV AM, 0.25 uV SSB, 0.35 uV NFM	0.25uV	.06 uV	.03 uV	0.3 uV	0.45 uV	0.5 uV	0.35 uV
Selectable Atten.	Yes	Yes	Yes	Yes, chan. selectable	20 dB	Programmable, 20 dB	-10/-20 dB	Yes
IF Selectivity (-6/-60 dB)	(-6 dB) 4 kHz SSB/CW, 15 kHz AM/NFM, 150 kHz WFM	(-6/-60 dB): SSB 2.4/4.5 kHz; AM/NFM 12/25 kHz	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	BNC	BNC	SO-239	BNC
Dimensions (W"xH"xD")	2-1/4x6x1	5.5x3x7.9	8.5x3.5x10	6x2.75x1.5	5x1.25x7.75	2.25x5x1.25	11.25x4.5x8.25	PC expansion slot
Weight	11 oz.	2.5 lbs.	7 lb. 10.5 oz.	13 oz.	2.2 oz	11 oz	18 lbs.	N/A
Power Requirement(s)	4 AA cells or 8-15 VDC external	9-16 VDC	13.8 VDC @ 1 A or 120 VAC @ 60 Hz	4AA cells (NiCds supplied)	12 VDC @ 700 mA, AC adaptor included	4.8-16 VDC; AC adaptor included	12 VDC/120 VAC	PC bus powered
Accessories Incl.	Telescopic whip	Tele. whip/AC adapt./DC adaptor, manual	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-9000XLT	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	$369.95	$369.95	$399.95	$179.95
Frequency Range	29-54, 108-174, 406-512, 806-956 MHz (less cellular)	26-54, 110-174, 406-520, 806-960 MHz (less cellular)	29-54, 108-174, 406-512, 806-956 MHz (less cellular)	29-54, 108-174, 406-512, 806-956 MHz (less cellular)	29-54, 108-174, 216-512, 806-956 MHz (less cellular)	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, 12VDC	Rechargeable battery, 12VDC	120VAC/12 VDC	12 VDC (AC adaptor included)	6.5 VDC	12 VDC (AC adapt. incl.)	12 VDC
Accessories Incl.	DC cord/Mobile mounting bracket	Flex antenna/AC charger-adaptor/belt clip/earphone/carrying strap	Flex antenna/belt clip/earphone/extra battery/AC charger-adaptor	Flex antenna/belt clip/earphone, extra battery/AC charger-adaptor	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

New, 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, ANT 2, ANT 24, MAN 2, SPK 2, and SPK 13 beginning on page "m".**

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: ANT 2, ANT 24, CAS 10, SPK 13, and TUN 4A beginning on page "m".**

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, 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: ANT 3, ANT 32, BAT 1, BAT 2, SPK 13, WPO4, and TUN 4A beginning on page "m."**

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: ANT 21, BAT 1, SPK 11, SPK 13, and TUN 4A beginning on page "m."**

ORDER RCV 24 **$359.95**

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

NEWLY UPDATED SONY ICF-SW7600GS

Now includes an LPI Shortwave Active Antenna and AC adaptor!

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, ANT 32, BAT 1, SPK 11, and TUN 4A, beginning on page "m."**

ORDER RCV 11 only $249^{95}

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, BAT 2, SPK 13, and TUN 4A beginning on page "m."**

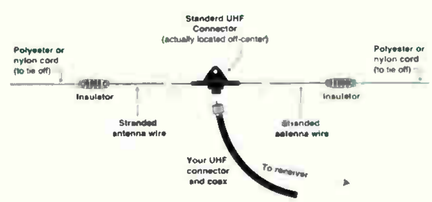
ORDER RCV 5 only $59^{95}

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, BAT 1 (4 required), SPK 11, and TUN 4A, beginning on page "m."**

ORDER RCV 8 only $259^{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.

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}

Versatile Sangeans

ATS-818CS w/cassette recorder
ORDER RCV 9 only $219^{95}

ATS-818 w/o cassette recorder
ORDER RCV 7 only $149^{95}

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

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

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

UPS Second Day Air at Ground Rates on ALL PRODUCTS!

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 2, ANT 3, ANT 25, and PWR 19 beginning on page "m."**

ORDER TUN 4A only $99⁹⁵

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 $179⁹⁵

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 $59⁹⁵

KIWA Medium Wave Air-Core Loop Antenna

Are you looking for an antenna that will improve 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 $349⁹⁵

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 $194⁹⁵

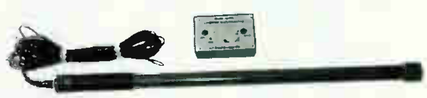
Exciting New KIWA Pocket-Loop Antenna

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 $119⁹⁵

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 $99⁹⁵

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

RECEIVER SPECIFICATIONS

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-21	JPS ANC-4 NOISE CANCELLER 100 kHz-80 MHz	$194.95
ACC-43	VHF CONVERTER, DRAKE R8A/B (33-55, 108-174 MHZ)	$219.95
ACC-50	FAX INTERFACE, O'GARA PHN-5	$95.00
ACC-51	DATA INTERFACE, O'GARA PHN-5	$295.00
ACC-53	RECHARGEABLE NIMH BATTERY, O'GARA PHN-6	$335.00
ACC-54	AC-DC CONVERTER, O'GARA PHN-6	$175.00
ACC-55	12 VDC MINI CHARGER, O'GARA PHN-6	$160.00
ACC-56	SOFT CARRYING CASE, O'GARA PHN-6	&95.00
ACC-57	HARD CARRYING CASE, O'GARA PHN-6	$325.00
ACC-58	REMOTE ANTENNA, O'GARA PHN-5A	$1395.00
ACC-59	ADDITIONAL ACCESS CARDS, O'GARA COMPACT-M, PHN-5	$85.00
ACC-60	ANTENNA WALL MOUNTING BRACKET, O'GARA PHN-6	$400.00
ACC-61	ANTENNA CABLE (10 METERS), O'GARA PHN-6	$320.00
ACC-62	ANTENNA CABLE, (20 METERS), O'GARA PHN-6	$480.00
ACC-63	INTERNAL RECHARGEABLE BAT PACK O'GARA PHN-6	$128.00
ACC-64	UNIVERSAL AC/DC CONVERTER, O'GARA PHN-6	$335.00
ACC-72	TV-R7100 TV/FM ADAPTER, ICOM R7100/8500	$339.95
ACC-74	CT-17 LEVEL CONVERTER, ICOM R7000/7100/8500	$134.95
ACC-79	AUDIO CASSETTE ADAPTER, SCANNERS/SW RECEIVERS	$9.95
ACC-94	ADHESIVE REPLACEMENT KIT, ANT-13	$4.95
ACC-96	CTCSS SQUELCH DECODER, BC-890	$59.95
ACC-101	BUDWIG CH-239 SW DIPOLE CONNECTOR	$9.95
ACC-130	CTCSS TONE BOARD, UNIDEN BC-9000&PRO-2045	$46.95
ACC-156	SAC-8000 INTERFACE CABLE, AR-8000/OPTO SCOUT	$34.95
ACC-157	OPTO'S LYNX COMPUTER INTERFACE, AR-8000	$129.95
ACC-168	WEATHER-PROOF FLEX TAPE, 22 FT ROLL	$1.95

ADAPTORS & ADAPTOR KITS

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

ANTENNAS VHF/UHF

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

ANTENNAS SHORTWAVE

ANT-12	ALPHA DELTA ANT KIT, SO-239 CONNECTOR, INSULATORS	$29.95
ANT-16	23' REEL FOR SW PORTABLES	$14.95
ANT-25	25' RANDOM WIRE W/RCA & PL-259 ADAPTORS	$7.95
ANT-32	KIWA POCKET LOOP 530 kHz - 30 MHz	$119.95

BATTERIES

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

BOOKS (See listings and displays on following pages)

BRACKETS

BRK-1	HAND-HELD RADIO MOBILE MOUNT, SINGLE	$9.95
BRK-2	MOBILE MOUNTING BRACKET FOR BC-890/9000XLT, PRO2045	$15.95
BRK-3	UNIVERSAL BELT CLIP CAN BE USED WITH BRK-6	$4.95
BRK-4	MB12 MOBILE MOUNTING BRACKET, ICOM R8500	$35.95
BRK-5	MB-23 CARRYING HANDLE, ICOM R7100/8500	$12.95
BRK-6	MOBILE HANGER FOR BELT CLIPS UP TO 1"W	$4.95
BRK-7	HAND-HELD RADIO MOBILE MOUNT, DOUBLE	$12.95
BRK-9	WINDOW ANTENNA MOUNT KIT BNC CONNECTOR	$28.95
BRK-10	DELUXE MOBILE HAND HELD SCANNER MOUNT/ORGANIZER	$14.95
BRK-12	DRAKE SW-1,2 CARRYING/TILT HANDLE	$6.95
BRK-13	DRAKE SW-1,2 MOBILE MOUNTING BRACKET	$14.95
BRK-14	AOR-5000 DOUBLE RACK MOUNT	$149.95
BRK-15	AOR-3000 RACK MOUNT	$89.95
BRK-15	AOR-3000 DOUBLE RACK MOUNT	$95.95

CARRYING CASES

CAS-1-N	ICOM R10 HEAVY-DUTY DURAS NYLON CASE	$29.95
CAS-2	LEATHER CASE FOR AR-8000	$29.95
CAS-3	LEATHER CASE FOR UNIDEN BC-230/235, PRO-90	$29.95
CAS-6	LEATHER CASE FOR UNIDEN BC-3000XLT	$29.95
CAS-7	MAGELLAN GPS-2000 CARRYING CASE	$9.95
CAS-8	OPTOELECTRONICS SCOUT	$15.10
CAS-10	DRAKE SW-8 CARRYING CASE	$49.95
CAS-11-L	RELM HS-200 LEATHER CASE	$29.95

CABLE

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

CHARTS

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

CLOCKS

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

COLLECTIBLES

COL-1	SPINNING VANE RADIOMETER	$6.95
COL-3	EDISON WALL PLAQUE	$6.95
COL-5	RADIACMETER (1960 PERSONAL RADIATION DETECTOR)	$9.95
COL-6DS	TWIN CYLINDER STEAM ENGINE, BUILT ($20.00 UPS)	$449.95
COL-7	JENSEN HOBBY STEAM ENGINE KIT	$99.95
COL-8	VICTORIAN STYLE CARBON FILAMENT BULB	$6.95
COL-9DS	TWIN CYLINDER, STEAM POWER PLANT ($25.00 UPS)	$574.95
COL-10	POST OFFICE BANK SMALL (DOOR SIZE: 3-5/8"x5"Hx3-3/4")	$39.95
COL-11	POST OFFICE BANK LARGE (DOOR SIZE: 5-3/8"x6-1/4"Hx3-3/4")	$79.95
COL-12	POST OFFICE BOX DOORS, SMALL (3-5/8"x5"Hx3-3/4")	$19.95
COL-13	POST OFFICE BOX DOORS, LARGE (5-3/8"x6-1/4"Hx3-3/4")	$24.95

COUPLERS

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

FREQUENCY COUNTERS

CTR-8	OPTOELECTRONICS SCOUT-40 (10 MHz - 2.8 GHz)	$399.95
CTR-9	OPTOELECTRONICS CUB (1 MHz - 2.8 GHz)	$144.95

CONVERTERS

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

FILTERS

FTR-6	30-2000 MHZ BANDPASS FOR SCANNERS	$29.95
FTR-7	540-1700 KHZ BAND REJECT FOR SHORTWAVE RECEIVERS	$29.95
FTR-8	118-137 MHZ BAND REJECT FOR SCANNERS	$29.95
FTR-9	30 MHZ LOW PASS FOR SHORTWAVE RECEIVERS	$29.95

GPS SATELLITE EQUIPMENT

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

HEADPHONES

HDP-3	ICOM HP-4 LIGHTWEIGHT	$22.95
HDP-4	RACETRAC CLASSIC PROFESSIONAL	$59.95
HDP-5	RACETRAC PLATINUM PROFESSIONAL W/DOUBLE HEADBAND	$88.95

LIGHTNING PROTECTORS

LAR-1B	GAS DISCHARGE LIGHTNING/SURGE PROTECTOR (BNC)	$24.95
LAR-1F	GAS DISCHARGE LIGHTNING/SURGE PROTECTOR (F)	$19.95
LAR-1M	GAS DISCHARGE LIGHTNING/SURGE PROTECTOR (MOTO)	$29.95
LAR-1P	GAS DISCHARGE LIGHTNING/SURGE PROTECTOR (PL-259)	$24.95
LAR-2	SINGLE OUTLET-SURGE PROTECTOR (120 VAC)	$3.95
LAR-03	SIX OUTLET SURGE PROTECTOR (120 VAC)	$4.95

MANUALS

MAN-1	SERVICE MANUAL, ICOM R-8500	$57.95
MAN-2	SERVICE MANUAL, DRAKE R8A	$39.95
MAN-6	SERVICE MANUAL, AR-5000	$29.95

MICROPHONES

MIC3	CLIP-ON MICROPHONE, 1/8" PLUG, 10' CORD	$4.95

PHONES

PHN-2	MAGELLAN'S MINI-M PHONE	$4000.00
PHN-4	CALLER ID AD100	$69.95
PHN-5	O'GARA COMPACT-M SATELLITE PHONE	$4995.00
PHN-5A	O'GARA COMPACT-M SATELLITE PHONE W/ REMOTE	$5145.00
PHN-6	O'GARA MOBIL-F-ONE SATELLITE PHONE	$4495.00

PREAMPLIFIERS

PRE-1	GRE SUPER PREAMPLIFIER (100-1000 MHz) HANDHELD	$49.95

POWER SUPPLIES

PWR 1	PORTABLE POWER STATION	$59.95
PWR-2	PSU-101,DESKTOP STAND/CHARGER, +12VDC	$59.95
PWR-3	DAIWA POWER SUPPLY, ADJUSTABLE 9-15 V, 5 AMPS DC	$59.95
PWR-4	+12 VDC ADAPTOR, 800 MA,2.1 mm PLUG	$14.95
PWR-9	+6VDC ADAPTOR 700 mA.SONY SW-7600G	$19.95
PWR-12	AC ADAPTOR, 500mA +/- 3/4.5/6/7.5/9/12V, 5 PLUGS	$4.95
PWR-13	SAME AS WR12 BUT UL APPROVED	$9.95
PWR-15	METRO WEST PRO-CHARGE FOR BAT-9	$49.95
PWR-19	+12VDC APAPTOR ,200mA, 2.1 mm PLUG	$7.95
PWR-21	+12VDC ADAPTOR, 500 mA, 2.1 mm PLUG	$9.95

RECORDERS

REC-2	VOICE IT POCKET RECORDER VT300 (5-MINUTE)	$69.95

ROTATORS/ANTENNA

ROT-1	HEAVY DUTY WINEGUARD MODEL RT 1000	$59.95

SOFTWARE

SFT-1	ICOM CS-R10 CLONING ONLY	$12.50
SFT-3	KLINGENFUSS GUIDE TO UTILITIES CD-ROM	$34.95

SPEAKERS

SPK-2	DRAKE EXTERNAL, DRAKE R8/8A/8B	$48.95
SPK-4	RADIO SHACK PRO-X5 OPTIMUS, 30W MAX.	$45.95
SPK-6	VALOR'S CLASSIC NOISE CANCELLER	$16.95
SPK-8	RADIO SHACK PILLOW SPEAKER	$5.95
SPK-9	RADIO SHACK CLIP-ON MINI SPEAKER	$10.95
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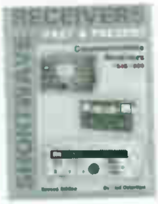

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Satellite Transponder Guide

By Robert Smathers

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°	
Data Transmissions	Data Transmissions	Data Transmissions	Data Transmissions	BBC Breakfast News/Reuters Newsfeeds 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
Data Transmissions	(Inactive)	Data Transmissions	Unknown User [digital video]	Reuters Newsfeeds o/v	Playboy (adult) [V2+]	The Learning Channel [V2+]	Univision/Galavision [PowerVu]	Request TV PPV [Digicipher]	KMGH-ABC Denver [V2+]	2
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
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
(none)	Data Transmissions	o/v	Data Transmissions	Showtime/TMC/SDC (West) [4DTV]	CNN [V2+]	Odyssey (Rel)	Classic Arts Showcase	Product Information Network	KDVR-Fox Denver [V2+]	5
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
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
Data Transmissions	(Inactive)	Data Transmissions	XHGC canal 5	General Communication [digital video]	HBO West [V2+]	QVC-2 Fashion Channel	Cartoon Network [V2+]	Prevue Guide	NBC-East	8
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
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
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 [V2+]	Eternal Word TV Network (Rel)	SpeedVision	(none)	11
(none)	o/v	(none)	Data Transmissions	General Communication [digital video]	Discovery West [V2+]	History Channel [V2+]	Valuevision	(none)	Data Transmissions	12
(none)	(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
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
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
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
o/v	(Inactive)	(none)	Unknown User [digital video]	Nickelodeon West [V2+]	TNT [V2+]	Movie Channel East [V2+]	The New Inspirational Network (Rel)	MTV East [V2+]	SSN FOX Sports (alternates) [V2+]	17
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
Data Transmissions	TV Northern Canada [PowerVu]	Data Transmissions	Unknown user [digital video]	MTV West [V2+]	USA East [V2+]	Showtime/TMC/SDC (East) [4DTV]	Cinemax East [V2+]	C-SPAN 2 [analog]/C-SPAN 3 [digital]	FOXNet [V2+]	19
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
(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)	(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
(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
Unknown User [digital video]	(Inactive)	(none)	XHDF canal 13	General Communication [digital video]	Showtime/Movie Channel [PowerVu]	Digital Music Express Radio (DMX) [digital audio]	Outdoor Channel	CMT [V2+]	SSN Sunshine Network [V2+]	24

LEGEND:

- (white) Unscrambled/non-video
- (grey) Subscription
- (black) Not available in U.S.
- o/v = occasional video

Geostationary Satellite Locator Guide

By Larry Van Horn

This guide shows the orbital locations of 259 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; Havard-Smithsonian Center for Astrophysics: Jonathan McDowell; U.S. Space Command/Public Affairs; Naval Space Command/Public Affairs; NASA NSSDC/WDC-A, Goddard Space Flight Center; and the *Satellite Times* staff.

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

Radio Frequency Band Key

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

Satellite Service Key

BSS	Broadcast Satellite Service
Dom	Domestic
DTH	Direct to Home
FSS	Fixed Satellite Service
Gov	Government
Int	International
Mar	Maritime
Met	Meteorology
Mil	Military
Mob	Mobile
Reg	Regional

OBJ NO.	INT-DESIG/COMMOM NAME	LONG (DEG)	TYPE SATELLITE
22912	1993-073B Meteosat 6 (MOP 3) (ESA)	0.6E#	Met (L)
23730	1995-067A Telecom 2C (France)	2.9E	Dom FSS/Gov-Mil (X/C/Ku)
23712	1995-060A USA 115 (Milstar-2) (US)	4.0E/i	Mil-Comm (P/S/K)
19919	1989-027A Tele X (Sweden)	5.0E#	Reg BSS (Ku)
20193	1989-067A Sirius/Marcopolo 1(BSB R-1)	5.1E	Reg BSS (Ku)
22921	1993-076A USA 98 (NATO 4B)	5.9E/i	Mil-Comm (P/S/X)
22028	1992-041B Eutelsat II F4	6.9E	Reg FSS (Ku)
21056	1991-003B Eutelsat II F2	10.0E	Reg FSS (Ku)
25049	1997-071A Sirius 2 (Sweden)	10.8E#	Reg BSS (Ku)
22269	1992-088A Cosmos 2224 (Russia)	11.7E#	Mil-Earl Warning (X)
22557	1993-013A Raduga 29 (Russia)	12.0E/i	Dom FSS/Gov-Mil (X/C)
19596	1988-095A Raduga 22 (Russia)	12.3E/i	Dom FSS/Gov-Mil (X/C)
24208	1996-044A Italsat 2 (Italy)	13.1E#	Dom-Telephone/Mob (L/S/K/Ka)
23537	1995-016B Eutelsat II F6 (Hot Bird 1)	13.1E	Reg BSS (Ku)
21055	1991-003A Italsat 1 (Italy)	13.2E#	Dom-Telephone (S/K/Ka)
20777	1990-079B Eutelsat II F1	13.3E	Reg FSS (Ku)
24665	1996-067A Eutelsat II F7 (Hot Bird 2)	13.3E	Reg BSS (Ku)
24931	1997-049A Hot Bird 3	13.6E	Reg BSS (Ku)
21803	1991-083A Eutelsat II F3	16.0E	Reg FSS (Ku)
22653	1993-031A Astra 1C	19.3E	Reg BSS (Ku)
23331	1994-070A Astra 1D	19.3E	Reg BSS (Ku)
23686	1995-055A Astra 1E	19.4E	Reg BSS (Ku)
19688	1988-109B Astra 1A	19.4E	Reg BSS (Ku)
21139	1991-015A Astra 1B	19.5E	Reg BSS (Ku)
19331	1988-063B Eutelsat 1 F5 (ECS 5)	21.5E/i	Reg FSS (VHF/Ku)
22175	1992-066A DFS 3 (Germany)	23.5E	Dom BSS (S/Ku/K)
18351	1987-078B Eutelsat 1 F4 (ECS 4)	25.4E/i	Reg FSS (VHF/Ku)
20659	1990-054A Gorizont 20 (Russia)	25.4E/i	Dom/Gov FSS (C/Ku)
23948	1996-040A Arabsat 2A (Arabsat)	26.0E	Reg FSS/BSS (C/Ku)
20706	1990-063B DFS 2/Kopernikus (Germany)	28.5E	Dom BSS (S/Ku/K)
23842	1996-021A Astra 1F	30.1E	Reg BSS (Ku)
24652	1996-062A Arabsat 2B (Arabsat)	30.6E	Reg FSS/BSS (C/Ku)
21894	1992-010B Arabsat 1C (Arabsat)	31.2E#	Reg FSS/BSS (S/C)
23200	1994-049B Turksat 1B (Turkey)	31.3E	Reg FSS (Ku)
25045	1997-070A Kupon 1 (CIS)	32.1E	Dom FSS (Ku)
15629	1985-025A Intelsat 510	32.8E/i	Int FSS (C/Ku)
20263	1989-081A Gorizont 19 (Russia)	33.5E/i	Dom/Gov FSS (C/Ku)
21821	1991-087A Raduga 28 (Russia)	34.5E/i	Dom FSS/Gov-Mil (X/C)
23717	1995-063A Gals 2 (Russia)	35.9E	Dom BSS (Ku)
22963	1993-002A Gals 1 (Russia)	35.9E	Dom BSS (Ku)
20929	1990-095A USA 65 (DSP F15) (US)	37.4E#	Mil-Early Warning (S/X)
23775	1996-005A Gorizont 31 (Russia)	39.9E#	Dom/Gov FSS (C/Ku)
23949	1996-040B Turksat 1C (Turkey)	42.0E	Reg FSS (Ku)
19874	1989-020A JCSAT 1 (Japan)	45.7E#/d	Dom FSS (Ku)
22981	1994-008A Raduga 1-3 (Russia)	49.0E#	Dom FSS/Gov-Mil (X/C)
23880	1996-034A Gorizont 32 (Russia)	52.7E#	Dom/Gov FSS (C/Ku)
19687	1988-109A Skynet 4B (UK)	52.8E/i	Mil-Comm (P/S/X/Ka)
13040	1982-006A DSCS II E15 (US)	57.0E/i	Mil-IOR reserve operational (S/X)
20203	1989-069B USA 44 (DSCS III A2) (US)	57.0E/i	Mil-IOR primary operational (P/S/X)
23305	1994-064A Intelsat 703	56.9E	Int FSS (C/Ku)
20667	1990-056A Intelsat 604	60.1E	Int FSS (C/Ku)
22913	1993-074A USA 97 (DSCS III B10) (US)	60.0E/i	Mil-IOR primary operational (P/S/X)
24742	1997-009A Intelsat 801	61.9E	Int FSS (C/Ku)
20315	1989-087A Intelsat 602	61.9E	Int FSS (C/Ku)
23839	1996-020A Inmarsat 3 F1	63.9E#	Int Mar (L/C)
21814	1991-084B Inmarsat 2 F3	64.9E#	Int Mar-POR (L/C)
23461	1995-001A Intelsat 704	65.9E	Int FSS (C/Ku)
23636	1995-040A PanAmSat 4 (PAS 4)	68.4E	Int FSS (C/Ku)
23448	1994-087A Raduga 32 (Russia)	70.2E#	Dom FSS/Gov-Mil (X/C)
22787	1993-056A USA 95 (UFO-2) (US)	71.0E/i	Mil-IOR primary (P/S)
10669	1978-016A Ops 6391 (FltSatCom 1) (US)	72.5E/i	Mil-IOR Reserve (P-Alpha/S/X)
23589	1995-027A USA 111 (UFO-5) (US)	72.5E/i	Mil-IOR reserve (P/S/K)
08882	1976-053A Marisat 2 (US)	72.9E/i	Int Mar-IOR (P/L/C)
13595	1982-097A Intelsat 505	73.5E/i	Int FSS/Mar (L/C/Ku)
22027	1992-041A Insat 2A (India)	73.7E	Dom FSS/BSS/Met (S/C)
24820	1997-027B Insat 2D (India)	73.9E	Dom FSS/BSS/Met (S/C)
23327	1994-069A Elektro 1 (Russia)	75.9E#	Met (L)
25010	1997-062A Apstar 2R (China)	76.4E	Dom FSS (C/Ku)
23680	1995-054A Luch 1-1 (Russia)	77.3E#	Tracking & Relay SDRN-2 (Ku)
24768	1997-016A Thaicom 3 (Thailand)	78.3E	Reg FSS (C/Ku)
23314	1994-065B Thaicom 2 (Thailand)	78.4E	Reg FSS (C/Ku)
21759	1991-074A Gorizont 24 (Russia)	79.7/i	Dom/Gov FSS (C/Ku)
23653	1995-045A Cosmos 2319 (Russia)	79.9E#	Data Relay (C)
24435	1996-058A Express 2 (Russia)	79.9E	Int FSS (C/Ku)
20643	1990-051A Insat 1D (India)	82.6E	Dom FSS/BSS/Met (S/C)
18922	1988-014A Zhongxing 1 (DFH2A-1/PRC-22) (China)	85.0E/i	Dom FSS (C)
22836	1993-062A Raduga 30 (Russia)	85.3E#	Dom FSS/Gov-Mil (X/C)
19548	1988-091B TDRS F3 (US)	84.6E/i	Gov-Tracking & Relay (C/S/Ku)
22880	1993-069A Gorizont 28 (Russia)	89.9E#	Dom/Gov FSS (C/Ku)
23765	1995-003A Measat 1 (Malaysia)	91.2E	Dom FSS/BSS (C/Ku)
23731	1995-067B Insat 2C (India)	93.1E	Dom FSS/BSS/Met (S/C/Ku)
22724	1993-048B Insat 2B (India)	93.2E	Dom FSS/BSS/Met (S/C)
22245	1992-082A Gorizont 27 (Russia)	95.9E/i	Dom/Gov FSS (C/Ku)
20473	1990-011A Zhongxing 3 (DFH2A-3/PRC-26) (China)	98.4E#	Dom FSS (C)
22210	1992-074A Ekran 20 (Russia)	99.3E/i	Dom BSS (P)
23723	1995-064A AsiaSat 2	100.4E	Reg FSS (C/Ku)
21922	1992-017A Gorizont 25 (Russia)	103.1E/i	Dom/Gov FSS (C/Ku)
24834	1997-029A Fengyun 2B (China)	103.6E#	Met (L)
20558	1990-030A Asiasat 1	105.6E	Reg FSS (C/Ku)
20570	1990-034A Palapa B2R (Indonesia)	108.0E	Reg FSS (C)
25050	1997-071B Indostar 1 (Indonesia)	108.2E	Dom (L/S)
23176	1994-040B BS-3N (Japan)	108.8E	Dom BSS (Ku)
24769	1997-016B BSAT-1A (Japan)	109.6E	Dom BSS (Ku)
20771	1990-077A BS-3A (Yuri 3A)(Japan)	109.6E	Dom BSS (Ku)
21668	1991-060A BS-3B (Yuri 3B)(Japan)	110.1E	Dom BSS (Ku)
19710	1988-111A Zhongxing 2 (DFH2A-2/PRC-25) (China)	110.8E/i	Dom FSS (C)
23864	1996-030A Palapa C2 (Indonesia)	112.7E	Reg FSS (C/Ku)
14985	1984-049A Zhongxing 5 (Chnsat 5/Spcnet 1)	115.3E#	Dom FSS (C/Ku)
23639	1995-041A Koreasat 1 (Mugunghwa 1)	115.6E	Dom FSS/BSS (Ku)
23768	1996-003A Koreasat 2 (Mugunghwa 2)	115.6E	Dom FSS/BSS (Ku)
21964	1992-027A Palapa B4 (Indonesia)	117.6E	Reg FSS (C)
20217	1989-070A GMS-4 (Himawari 4) (Japan)	119.7E/i	Met (P/L)
22931	1993-078B Thaicom 1 (Thailand)	119.9E	Reg FSS (C/Ku)
23108	1994-030A Gorizont 30 (Rimsat 2)	122.0E#/d	Reg FSS (C/Ku)
24798	1997-021A Zhongxing 8 (DFH 3-2) (China)	125.0E	Dom (C)
21132	1991-014A Raduga 27 (Russia)	127.4E/i	Dom FSS/Gov-Mil (X/C)
23649	1995-043A JCSAT 3 (Japan)	127.9E	Dom FSS (Ku)
23651	1995-044A N-Star 1 (Japan)	131.9E	Dom/Mob FSS (S/C/Ku/Ka)
23943	1996-039A Apstar 1A (China)	134.0E	Reg FSS (C)
23781	1996-007A N-Star 2 (Japan)	135.9E	Dom/Mob FSS (S/C/Ku/Ka)
23185	1994-043A Apstar I (China)	137.9E	Dom BSS (C)
23522	1995-011B GMS-5 (Himawari 5) (Japan)	140.0E#	Met (P/L)
20953	1990-102A Gorizont 22 (Russia)	140.1E/i	Dom/Gov FSS (C/Ku)
17706	1987-029A Palapa B2P (Indonesia)	142.4E#	Reg FSS (C)

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OBJ NO.	INT-DESIG/COMMOM NAME	LONG (DEG)	TYPE SATELLITE
24880	1997-036A Superbird C (Japan)	143.8E	Dom FSS (Ku/K)
20923	1990-094A Gorizont 21 (Russia)	144.5E/i	Dom/Gov FSS (C/Ku)
20066	1989-046A USA 39 (DSP F14) (US)	145.4E/i	Mil-Early Warning (S/X)
24901	1997-042A Agila 2 (Mabuhay 1) (Philippines)	145.9E	Dom FSS (C/Ku)
24653	1996-063B Measat-2 (Malaysia)	147.9E	Dom FSS/BSS (C/Ku)
24732	1997-007A JCSAT 4 (Japan)	150.0E#	Dom FSS (Ku)
23779	1996-006A Palapa C1 (Indonesia)	150.4E	Reg FSS (C/Ku)
18350	1987-078A Optus A3 (Aussat K3)	152.0E#	Dom FSS/BSS (Ku)
19508	1988-086A CS 3B (Sakura 3B) (Japan)	153.8E	Dom FSS (C/K)
20402	1990-001B JCSAT 2 (Japan)	153.9E	Dom FSS (Ku)
23227	1994-055A Optus B3 (Australia)	155.9E	Dom BSS/Mob (L/Ku)
12994	1981-119A Intelsat 503	157.0E/i	Int FSS (C/Ku)
22253	1992-084A Superbird A1 (Japan)	157.9E	Dom FSS (Ku/K)
22087	1992-054A Optus B1 (Aussat B1)	160.0E	Dom BSS/Mob (L/Ku)
22907	1993-072A Gorizont 29 (Rimsat 1)	160.6E#	Reg FSS (C/Ku)
21893	1992-010A Superbird B1 (Japan)	161.9E	Dom FSS (Ku/K)
16275	1985-109C Optus A2 (Aussat 2)	164.0E/i	Dom BSS (Ku)
23175	1994-040A PanAmSat 2 (PAS-2)	168.9E	Int FSS (C/Ku)
12046	1980-087A OPS 6394 (FltSatCom F4)(US)	171.3E/i	Mil-POR reserve (P-Bravo/S/X)
24846	1997-031A Intelsat 802	173.9E	Int FSS (C/Ku)
22719	1993-046A USA 93 (DSCS III B9) (US)	175.0E/i	Mil-WPAC primary operational (P/S/X)
23124	1994-034A Intelsat 702	177.0E	Int FSS (C/Ku)
24674	1996-070A Inmarsat 3 F3	178.3E#	Int Mar (L/C)
20918	1990-093A Inmarsat 2 F1	178.9E#	Int Mar-IOR (L/C)
16117	1985-092C USA 12 (DSCS III B5) (US)	180.0E/i	Mil-WPAC reserve operational (P/S/X)
22871	1993-066A Intelsat 701	179.9W	Int FSS (C/Ku)
19121	1988-040A Intelsat 513	177.1W#	Int FSS (C/Ku)
23467	1995-003A USA 108 (UFO-4) (US)	177.1W/i	Mil-POR (P/S/K)
21639	1991-054B TDRS F5 (US)	174.4W	Int FSS/Gov-Tracking & Relay (C/S/Ku)
23613	1995-035B TDRS F7 (US)	170.9W#	Int FSS/Gov-Tracking & Relay (C/S/Ku)
18631	1987-100A Raduga 21 (Russia)	170.6W/i	Dom FSS/Gov-Mil (X/C)
20499	1990-016A Raduga 25 (Russia)	170.5W/i	Dom FSS/Gov-Mil (X/C)
21392	1991-037A Satcom C5 (Aurora II)(US)	139.0W	Dom FSS (C)
20945	1990-100A Satcom C1 (US)	137.0W	Dom FSS (C)
23581	1995-025A GOES 9 (US)	135.4W	Met (P/L/S)
21873	1992-006A USA 78 (DSCS III B14) (US)	135.0W/i	Mil-EPAC primary operational (P/S/X)
22096	1992-057A Satcom C4 (US)	134.5W	Dom FSS (C)
23016	1994-013A Galaxy 1R (US)	132.9W	Dom FSS (C)
22117	1992-060B Satcom C3 (US)	131.0W	Dom FSS (C)
13637	1982-106B DSCS III A1 (US)	130.2W/i	Mil-EPAC reserve operational (P/S/X)
21906	1992-013A Galaxy 5 (US)	125.1W	Dom FSS (C)
19484	1988-081B SBS 5 (US)	123.0W	Dom FSS (Ku)
23877	1996-033A Galaxy 9 (US)	122.9W	Dom FSS (C)
22988	1994-009A USA 99 (Milstar 1) (US)	120.0W	Mil-Comm (P/S/K)
15826	1985-048D Telestar 3D (303) (US)	120.0W#	Dom FSS (C)
24313	1996-055A Echostar 2 (US)	119.2W	Dom BSS (Ku)
23754	1995-073A EchoStar 1 (US)	119.0W	Dom BSS (Ku)
24748	1997-011A Tempo 2 (US)	118.8W	Dom BSS (Ku)
16274	1985-109B Morelos 2 (Mexico)	116.8W	Dom FSS (C/Ku)
14133	1983-059B Anik C2 (Canada)	115.0W	Dom (Ku)
23313	1994-065A Solidarida 2 (Mexico)	113.0W	Dom FSS (L/C/Ku)
21726	1991-067A Anik E1 (Canada)	111.1W	Dom FSS (C/Ku)
22911	1993-073A Solidaridad 1 (Mexico)	109.2W	Dom FSS (L/C/Ku)
21222	1991-026A Anik E2 (Canada)	107.3W	Dom FSS (C/Ku)
23846	1996-022A MSAT M1 (Canada)	106.5W	Dom Mobile (L/X)
08747	1976-023B LES 9 (US)	106.4W/i	Mil-Experimental (P/Ka)
15677	1985-035A Gstar 1 (US)	105.0W#	Dom FSS (Ku)
20946	1990-100B Gstar 4 (US)	105.0W	Dom FSS (Ku)
19483	1988-081A Gstar 3 (US)	105.0W/i	Dom FSS/Mob (L/Ku)
24786	1997-019A GOES 10 (USA)	104.7W	Met (P/L/S)
03029	1967-111A ATS 3 (US)	104.5W/i	Experimental (VHF/C)
23696	1995-057A USA 114 (UFO-6) (US)	104.5W/i	Mil-CONUS (P/S/K)
24315	1996-054A GE-1 (US)	103.1W	DOM FSS (C/Ku)
23435	1994-084A USA 107 (DSP F17) (US)	103.0W#	Mil-Early Warning (S/X)
22930	1993-078A DBS 1 (US)	101.3W	Dom BSS (Ku)
21227	1991-028A Spacenet 4 (US)	101.2W	Dom FSS (C/Ku)
23553	1995-019A AMSC 1 (US)	100.9W	Dom Mobile (L/X)
23598	1995-029A DBS 3 (US)	100.9W	Dom BSS (Ku)
23192	1994-047A DBS 2 (US)	100.8W	Dom BSS (Ku)
22796	1993-058B ACTS (US)	100.3W	Experimental (C/K/Ka)
17181	1986-096A USA 20 (FltSatCom F7)(US)	99.2W/i	Mil-CONUS (P/S/X/K)
22694	1993-039A Galaxy 4 (US)	99.0W	Dom FSS (C/Ku)
17561	1987-022A GOES 7 (US)	97.9W/i	Met (P/L/S)
24812	1997-026A Telstar 5 (US)	97.0W	Dom FSS (C/Ku)
08746	1976-023A LES 8 (US)	95.7W/i	Mil-Experimental (P/Ka)
23741	1995-069A Galaxy 3R (US)	95.1W	Dom/BSS (C/Ku)
16650	1986-026B SBTS 2 (Brazil)	92.0W#	Dom FSS (C)
22205	1992-072A Galaxy 7 (US)	91.0W	Dom FSS (C/Ku)
23670	1995-049A Telstar 402R (US)	89.0W	Dom FSS (C/Ku)
24936	1997-050A GE-3 (US)	87.2W	Dom FSS (C/Ku)
24713	1997-002A GE-2 (US)	84.9W	Dom FSS (C/Ku)
18951	1988-018A Spacenet 3R (US)	83.2W	Dom FSS (C/Ku)
16276	1985-109D Satcom K2 (US)	81.0W#	Dom FSS (Ku)
15561	1985-015B SBTS 1 (Brazil)	79.0W/i	Dom FSS (C)
15235	1984-093B SBS 4 (US)	77.0W/i	Dom FSS (Ku)
12309	1981-018A Comstar D4 (US)	75.7W/i	Dom FSS (C)
23051	1994-022A GOES 8 (US)	74.6W#	Met (P/L/S)
20873	1990-091B Galaxy 6 (US)	74.3W	Dom FSS ©
20872	1990-091A SBS 6 (US)	74.1W	Dom FSS (Ku)
24714	1997-002B Nahuel 1A (Argentina)	71.9W	Dom FSS (Ku)
23199	1994-049A Brazilsat B1 (Brazil)	70.1W	Dom FSS (C)
21805	1991-080B USA 75 (DSP F16) (US)	70.0W#	Mil-Early Warning (S/X)
23536	1995-016A Brasilsat B2 (Brazil)	65.4W	Dom FSS (C/X)
25004	1997-059A Echostar III (US)	61.5W/d	Dom BSS (Ku)
24916	1997-046A PanAmSat 5 (PAS 5)	58.4W	Reg BSS ©
16101	1985-087A Intelsat 512	55.5W/i	Int FSS (C/Ku)
21149	1991-018A Inmarsat 2 F2	55.2W/i	Int Mar-AOR-W (L/C)
24819	1997-027A Inmarsat 3 F4	54.0W	Int Mar-AOR-W (L/C)
23571	1995-023A Intelsat 706	53.1W	Int FSS (C/Ku)
23628	1995-038A USA 113 (DSCS III B4) (US)	52.5W/i	Mil-WLANT primary operational (P/S/X)
23915	1996-035A Intelsat 709	50.1W	Intl FSS (C/Ku)
22314	1993-003B TDRS F6 (US)	47.1W	Int FSS/Gov-Tracking & Relay (C/S/Ku)
19217	1988-051C PanAmSat 1 (PAS 1)	45.1W	Int FSS (C/Ku)
24891	1997-040A PanAmSat 6 (PAS 6)	43.4W	Int FSS (C/Ku)
23764	1996-002A PanAmSat 3R (PAS 3R)	43.1W	Int FSS (C/Ku)
16116	1985-092B USA 11 (DSCS III B7) (US)	42.5W/i	Mil-ATL reserve operational (P/S/X)
19883	1989-021B TDRS F4 (US)	41.0W#	Int FSS/Gov-Tracking & Relay (C/S/Ku)
12089	1980-098A Intelsat 502	40.4W/i	Int FSS (C/Ku)
23413	1994-079A Orion 1 (US)	37.6W	Int FSS (Ku)
21765	1991-075A Intelsat 601	34.6W	Int FSS (C/Ku)
20401	1990-001A Skynet 4A (UK)	34.2W/i	Mil-comm (P/S/X/Ka)
14077	1983-047A Intelsat 506	31.3/i	Int FSS/Mar (L/C/Ku)
22723	1993-048A Hispasat 1B (Spain)	30.1W	Dom BSS/FSS (Ku)
22116	1992-060A Hispasat 1A (Spain)	30.0W	Dom BSS/FSS (Ku)
20391	1989-101A Cosmos 2054 (Russia)	27.8W/i/d	Tracking & Relay WSDRN (Ku)
24957	1997-053A Intelsat 803	27.7W	Int FSS (C/Ku)
21653	1991-055A Intelsat 605	26.6W	Int FSS (C/Ku)
15386	1984-114B Marecs B2	26.2W/i	Int Mar-AOR (L)
20523	1990-021A Intelsat 603	24.5W	Int FSS (C/Ku)
20253	1989-077A USA 46 (FltSatCom 8) (US)	23.7W/i	Mil-AOR (P-Charlie/S/X/K)
23967	1996-042A USA 127 (UFO-7) (US)	22.8W/i	Mil-AOR (P/S/K)
19772	1989-006A Intelsat 515	21.7W	Int FSS (C/Ku)
21989	1992-032A Intelsat K	21.6W	Int FSS (Ku)
15391	1984-115A NATO III D	18.3W/i	Mil-Comm (P/S/X)
23528	1995-013A Intelsat 705	18.0W	Int FSS (C/Ku)
21047	1991-001A NATO IV A	17.9W/i	Mil-Comm (P/S/X)
21940	1992-021B Inmarsat 2 F4	17.2W/i	Int Mar-AOR-W (L/C)
23426	1994-082A Luch 1 (Russia)	16.1W#	Tracking & Relay CSDRN (Ku)
24307	1996-053A Inmarsat 3 F2	15.5W/i	Int Mar (L/C)
23132	1994-035A USA-104 (UFO-3)(US)	14.3W/i	Mil-AOR primary (P/S)
23319	1994-067A Express 1 (Russia)	14.0W	Int FSS (C/Ku)
23267	1994-060A Cosmos 2291 (Russia)	13.4W#	Dom Data Relay (C)
22009	1992-037A USA 82 (DSCS III B12) (US)	12.0W	Mil-ELANT primary operational (P/S/X)
22041	1992-043A Gorizont 26 (Russia)	11.5W/i	Dom/Gov FSS (C/Ku)
24932	1997-049B Meteosat 7 (MOP-4) (ESA)	10.3W#	Met (P/L/S)
21140	1991-015B Meteosat 5 (MOP 2) (ESA)	9.4E#	Met (L)
21813	1991-084A Telecom 2A (France)	8.0W	Dom FSS/Gov-Mil (X/C/Ku)
21939	1992-021A Telecom 2B (France)	5.1W	Dom FSS/Gov-Mil (X/C/Ku)
24209	1996-044B Telecom 2D (France)	5.0W	Dom-FSS/Gov-Mil (C/X/Ku)
23865	1996-030B Amos 1 (Israel)	4.1W	Dom FSS (C)
23816	1996-015A Intelsat 707	1.1W	Int FSS (C/Ku)
20776	1990-079A Skynet 4C (UK)	1.0W#	Mil-comm (P/S/X/Ka)
24808	1997-025A Thor 2A	0.8W	Reg BSS (Ku)
20168	1989-062A TV Sat 2 (Germany)	0.6W	Dom BSS (Ku)
20762	1990-074A Thor 1/Marcopolo 2 (BSB R-2)	0.6W	Reg BSS (Ku)

Satellite Launch Schedules

By Keith Stein

Space Transportation System (STS-NASA)

Mission Number	Launch Date/ Orbiter	Inclination Altitude	Mission Duration	Mission/Cargo Bay/Payloads
STS-89	Jan 1998 Endeavour*	51.6/213	10+1 days	S/MM-08**

Space shuttles are launched from the Kennedy Space Center in Florida.
*Crew Assignment: CDR: Terrence Wilcutt, PLT: Joe Edwards, MS: Bonnie Dunbar, MS: Michael Anderson, MS: James Reilly, MS: Andrew Thomas (U), MS: David Wolf (D).
**Crew Assignment: Russian Cosmonauts; Anatoly Solovyov, Pavel Vinogradov, and U.S. astronaut David Wolf (D).

Space Shuttle	Downlink Frequency Assignments:
VHF Voice	130.1625 MHz (during Mir docking operations)
UHF Voice	243.0, 259.7, 279.0 and 296.8 MHz (all are AM mode)
UHF Boosters	240.0 and 242.0 MHz (recovery beacons)
S-band TLM	2217.5, 2250.0 and 2287.5 MHz.
C-band TRK	5400-5900.0 MHz

Mir Space Station	Downlink Frequency Assignments:
VHF Voice	121.750 and 143.625 MHz
VHF Voice	145.985 MHz (Amateur radio)
UHF Voice	437.925, 437.950 and 437.975 MHz (Amateur radio)

U.S. Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
Jan 1998	Athena-2	CCAS	Lunar Prospector
Jan 1998	Delta II	CCAS	Skynet-4D
Jan 1998	Pegasus XL	VAFB	SNOE & BATSAT
Jan 1998	Sounding Rock	Puerto Rico	Coqui II
Jan 1998	Atlas	CCAS	NRO
Feb 1998	Delta II	VAFB	Iridium #7 (5)
Feb 1998	Delta II	CCAS	Globalstar-1
Feb 1998	Atlas II	CCAS	Eutelsat W1
Feb 1998	MSLS	VAFB	JawSat-1
Feb 1998	Pegasus XL	WFF	Orbcomm-2
Feb 1998	Delta II	CCAS	GPS IIR-5
Feb 1998	Taurus	VAFB	STEX
Feb 1998	Delta II	CCAS	Globalstar-2

Athena-2	Downlink Frequency Assignments
S-band	2208.5 and 2210.5 MHz
C-band	5756.0 MHz

Lunar Prospector	Downlink Frequency Assignments
S-band	2273.0 MHz

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

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

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

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

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

Globalstar	Downlink Frequency Assignments
S-band	2483.5-2500.0 MHz

Orbcomm	Downlink Frequency Assignments
VHF-band	137.680 and 137.710 MHz

GPS IIR-5	Downlink Frequency Assignments
L-band	1227.6, 1381.05 and 1575.42 MHz
S-band	2227.5 MHz

Taurus	Downlink Frequency Assignments
S-band TLM	2269.5 and 2288.5 MHz
C-band TRK	5765.0 MHz

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

Russian Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
Jan 1998	Proton	Baikonur	Gorizont-33
Jan 1998	Soyuz-U	Baikonur	Soyuz TM-27
Jan 1998	Proton-K	Baikonur	Raduga-1
Jan 1998	Soyuz-U	Baikonur	Cosmos
Feb 1998	Start 1	Svobodnyy	Odin
Feb 1998	Soyuz-U	Baikonur	Progress M-38

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

Soyuz TM-27	Downlink Frequency Assignments
VHF-band	121.75 (WBFM) and 166.0 MHz
L-band	922.750 and 926.100 MHz

Start 1	Downlink Frequency Assignments
VHF-band	75.670 MHz
UHF-band	203.270 and 219.700 MHz

Progress M-38	Downlink Frequency Assignments
VHF-band	166.000 MHz

Satellite Launch Schedules

By Keith Stein

European Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
Jan 1998	Ariane 44LP	Guiana	Brazilsat B-3 & Inmarsat
Feb 1998	Ariane 44L	Guiana	Hot Bird-4 & BSAT-1B

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

Inmarsat	Downlink Frequency Assignments
L-band	1530-1545.0 MHz
C-band	3600-3620 MHz

Japanese Expendable Launch Vehicles

Launch Date	Launch Vehicle	Launch Site	Payload
Jan 1998	H-II	Tanegashima	COMETS

List of Abbreviations and Acronyms

BATSAT — The BATSAT satellite incorporates small satellite design principles to provide a simple, low-cost design ideal for university production and testing.
Brazilsat — Brazilian geostationary communications satellite launched for Embratel.
C-band — 3700 to 6500 MHz.
CCAS — Cape Canaveral Air Station, FL
CDR — Commander
COMETS — Japanese Communications & Broadcast Engineering Test Satellite designed to demonstrate new high quality mobile, inter-satellite & broadcasting.
(D) — Crew member coming down from Russian Space Station MIR.
Eutelsat — European commercial telecommunications satellite.
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.
Gorizont — Russian telecommunications satellite.
GPS — U.S. Air Force global positioning satellite for military and civilian navigation services.
Hot Bird — Will provide direct TV programming to 45 cm dishes across Europe.
Inmarsat — International Maritime Satellite, a commercial satellite series providing global maritime and aviation communications.
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 provide global communications services through portable handsets.
JawSat — An educational project with the major goal of developing a 3-axis control system. It will also demonstrate a Pulsed Plasma Thruster for stationkeeping by using ionized Teflon.
L-band — 500 - 1549 MHz
Lunar Pro — The Lunar Prospector is designed for a low polar orbit investigation of the Moon, including mapping of surface composition and possible polar ice deposits, measurements of magnetic and gravity fields, and study of lunar outgassing events.
MHz — Megahertz
MS — Mission Specialist, a member of Shuttle flight crew primarily responsible for Orbiter subsystem and payload activities.
NRO — Classified National Reconnaissance Office satellite.
Odin — A small Swedish Space Corporation (SSC) astronomical and atmospheric satellite.
ORBCOMM — Orbcomm will provide low-cost alpha numeric data communications and position determination for emergency assistance, data acquisition and messaging services using pocket portable and mobile subscriber terminals.
PLT — Pilot, a member of the Shuttle crew whose primary responsibility is to pilot the Orbiter.
Progress — A unmanned supply ship used to bring food, fuel, water, and oxygen to the current crew aboard Russia's Mir Space Station.
Raduga — Russian telecommunications satellite.
S-band — 2000 to 2300 MHz
Skynet-4D — Geostationary communications satellite for the United Kingdom.
S/MM-08 — Shuttle mission to the Russian Space Station MIR to support design and assembly of the International Space Station.
SNOE — Student Nitric Oxide Explorer, University of Colorado payload; first in series of low-cost university small research/science payloads.
Soyuz TM — A manned spacecraft used to carry crews to and from Russia's Mir Space Station.
STEX — Sensor Technology Experiment, demonstrates radiation measurement technology.
TLM — Telemetry
TRK — Tracking
(U) — Crew member going up to Russian Space Station MIR.
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 and 10,999 MHz
XL — Extra Large

Launch Date/Time Epoch	Int Des Incl	Satellite Period	Perigee	Mass Apogee 1997
Sep 26/0234	1997-055A	Atlantis (STS-86)		114,184 kg
1997 Sep 26.14	51.66 deg	90.05 min	256 km	298 km
1997 Sep 28.58	51.65 deg	92.29 min	384 km	390 km
1997 Oct 3.93	51.65 deg	91.89 min	355 km	380 km

Seventh shuttle-Mir mission (SMM-7) and the final visit of the Atlantis orbiter to the Mir Complex. Carried seven astronauts into orbit: J D Wetherbee (commander), M J Bloomfield (pilot), V G Titov (Russian cosmonaut, mission specialist, MS-1 and EVA astronaut, EV-2), S E Parazynski (MS-2, EV-1), J-L J M Chretien (French spationaut, MS-3), W B Lawrence (MS-4) and D A Wolf (MS-5). Lawrence was originally scheduled to become the next NASA astronaut resident on board Mir, but she was excluded because her height prevented her from undertaking any EVAs which might be added to the flight program using the Russian suits: she remained a shuttle crew member, but Wolf was added to the crew to become the next NASA resident on board Mir. He replaced Foale who had flown to Mir aboard the STS-84/SMM-5 mission: for the return to Earth Foale became MS-5. Shuttle's payload bay carried Spacehab module (mass 6,553 kg) and the orbiter docking system (mass 1,822 kg). Mass quoted is that projected for the time of landing. Atlantis docked with the docking module attached to Kristall Sep 27, 1997, at 1958 UTC; undocking came on Oct 3, 1997 at 1728; and landing was at the Kennedy Space Center three days later at 2155 UTC.

1997 Sep 26/0123	1997-056A	Iridium 19		657 kg
1997 Sep 27.16	86.69 deg	95.65 min	542 km	558 km
1997 Oct 22.12	86.39 deg	100.39 min	775 km	779 km
1997 Sep 26/0123	1997-056B	Iridium 37		657 kg
1997 Sep 27.29	86.68 deg	95.66 min	542 km	559 km
1997 Oct 18.09	86.40 deg	100.38 min	774 km	779 km
1997 Sep 26/0123	1997-056C	Iridium 36		657 kg
1997 Sep 27.76	86.69 deg	95.68 min	546 km	557 km
1997 Oct 31.27	86.62 deg	97.66 min	641 km	652 km
1997 Sep 26/0123	1997-056D	Iridium 35		657 kg
1997 Sep 27.29	86.68 deg	95.66 min	542 km	558 km
1997 Oct 17.16	86.40 deg	100.39 min	774 km	781 km
1997 Sep 26/0123	1997-056E	Iridium 34		657 kg
1997 Sep 28.29	86.69 deg	95.66 min	542 km	558 km
1997 Oct 17.59	86.40 deg	100.40 min	775 km	780 km

Sixth launch of Iridium satellites, fourth to use the Delta-2 (7920) from Vandenburg. See the discussion later in this issue for details of the Iridium orbital planes.

1997 Sep 28/0447	1997-057A	IRS 1D		1,250 kg?
1997 Sep 29.90	98.64 deg	95.96 min	308 km	822 km
1997 Oct 18.41	98.62 deg	100.50 min	739 km	826 km

Indian Remote Sensing (IRS) satellite, to be operated by ISRO. Following a malfunction of the fourth stage, the satellite was left in an eccentric orbit rather than the circular 820 km one planned. Spacecraft used its own propellant to gradually raise the perigee of the orbit as shown above, thus reducing its operating lifetime below the planned three years. Launched from Sriharikota using PSLV.

1997 Oct 4/1508	1997-058A	Progress M-36		7,250 kg?
1997 Oct 5.68	51.66 deg	88.56 min	197 km	210 km
1997 Oct 11.77	51.65 deg	92.29 min	382 km	391 km
1997 Oct 4/1508	1997-058C	Sputnik 1 Model		50 kg?
1997 Nov 3.76	51.67 deg	92.30 min	385 km	389 km

Progress-M 36 is an unmanned cargo freighter, launched from Baikonur using a Soyuz-U and carrying supplies to the crew on board the Mir Complex: docked at the -X (Kvant 1) rear port Oct 8, 1997 at 1707 UTC. Sputnik 1 model (also called "Sputnik 40") was launched aboard Progress-M 36 and deployed in orbit on Nov 3, 1997 during an EVA by the two resident Russian cosmonauts on board Mir.

Launch Date/Time Epoch	Int Des Incl	Satellite Period	Perigee	Mass Apogee 1997
1997 Oct 4/2101	1997-059A	EchoStar 3		2,900 kg?
1997 Oct 5.97	25.21 deg	684.12 min	165 km	38,516 km
1997 Oct 18.70	0.04 deg	1,436.06 min	35,712 km	35,860 km

Direct broadcast telecommunications satellite, launched for the EchoStar Communications Corporation. Mass quoted at launch: in geosynchronous orbit approximately 1,700 kg and the dry mass is approximately 1,325 kg. Satellite located over 298 deg E. Launched using an Atlas-2AS from Cape Canaveral.

1997 Oct 9/1800?	1997-060A	Foton 8 (Flight 11)		5,800 kg?
1997 Oct 9.86	62.81 deg	90.45 min	218 km	375 km

Eleventh Foton microgravity research satellite to be launched, eighth to be named Foton. Launch time is estimated since the launch announcement did not give a time: launched from Plesetsk using a Soyuz-U. Descent module landed 170 km northeast of Orsk in the Orenberg Region at Oct 23, 1997, at 1012 UTC. The German MIRCA (MIcro Re-entry CApsule, mass 150 kg) for reentry experiments was mounted outside the Foton descent module and remained attached until after the main spacecraft's de-orbit maneuver took place. It then separated and landed 110 km southeast of Orsk Oct 23, 1997, at 1015 UTC.

1997 Oct 15/0843	1997-061A	Cassini + Huygens		5,712 kg
	Heliocentric orbit			

Cassini/Huygens is the last of the large planetary explorers currently planned and is to explore the Saturn system. Spacecraft managed by Jet Propulsion Laboratory. The unfuelled Cassini spacecraft on its own is 2,125 kg: Huygens probe mass 320 kg. Combined spacecraft will make multiple planetary fly-bys to gain energy to reach Saturn, although the science instruments will not be switched on until approaching the Saturn system. Mission schedule is as follows:

Apr 25, 1998	First fly-by of Venus (300 km)
Jun 23, 1999	Second fly-by of Venus (1,530 km)
Aug 17, 1999	Earth fly-by (minimum 800 km)
Dec 30, 2000	Jupiter fly-by (10 million km)
Jun 12, 2004	Phoebe fly-by (52,000 km)
Jul 1, 2004	Saturn arrival–orbital injection: incl–17 deg, period–147 days, 78,000-10,600,000 km
Sep 12, 2004	Orbital manoeuvre to raise minimum distance from Saturn to 490,000 km
Nov 6, 2004	Huygens separates from Cassini
Nov 27, 2004	Huygens descends into Titan atmosphere while Cassini flies past satellite at 1,500 km

Multiple fly-bys of the major satellites in the Saturn system will be performed, with the prime Cassini mission planned to end four years after orbital injection around the planet. Launched from Cape Canaveral using a Titan-4B/Centaur.

1997 Oct 16/1913	1997-062A	APStar 2R		3,747 kg
1997 Oct 17.16	24.59 deg	874.53 min	170 km	47,660 km
1997 Oct 24.93	0.10 deg	1,442.81 min	35,818 km	36,018 km

Replacement for APStar 2 which is believed to have exploded shortly after launch (destroying the launch vehicle) on January 25, 1995. Launched from Xi Chang using CZ-3B for APT Satellite Co Ltd. Mass quoted at launch: the dry mass is 1,415 kg. Satellite located over 76 deg E.

1997 Oct 22/1315	1997-063A	STEP M-4		395 kg
1997 Oct 22.79	44.96 deg	93.95 min	434 km	501 km

STEP 4 (Space Test Experiment Platform) was launched as part of the U.S. Air Force Space Test Program series of flights. Satellite carries three instruments: Digital Ion Drift Meter (DIDM), Electromagnetic Propagation Experiment (EMPE), and Orbiting Ozone and Aerosol Measurement (OOAM). After launch from Wallops Island using L-1011/Pegasus-XL, no telemetry was picked up from the satellite and it is believed that the solar panels failed to deploy.

Launch Date/Time Epoch	Int Des Incl	Satellite Period	Perigee	Mass Apogee
1997 Oct 24/0232	1997-064A	USA 133 (Lacrosse 3)		14,500 kg?
1997 Nov 11.23	57.00 deg	98.22 min	673 km	674 km

Third launch of a Lacrosse/Vega high-resolution radar imaging satellite: previous launches were Lacrosse 1/USA 34 (1988-106B) and Lacrosse 2/USA 69 (1991-017A). Lacrosse 1 is believed to have been de-orbited in late March 1997, while Lacrosse 2 is still in orbit. No orbital data has been issued for the satellite and the orbit shown above is based upon unofficial visual observations. Launched from Vandenberg using Titan-4A.

1997 Oct 25/0046	1997-065A	DSCS 3B-5 (USA 134?)		1,040 kg?
	Geosynchronous orbit			

Improved DSCS-3 (Defense Satellite Communications System) satellite. Mass quoted includes propellant. No orbital data have been issued for the satellite. Launched from Cape Canaveral using Atlas-2A with IABS apogee boost motor.

1997 Oct 30/1343	1997-066A	MAQSAT H+TEAMSAT		2,650 kg
1997 Oct 31.75	7.79 deg	467.80 min	533 km	26,635 km
1997 Oct 30/1343	1997-066B	EPS+MAQSAT-B		4,100 kg
1997 Nov 1.05	7.78 deg	466.64 min	533 km	26,569 km
1997 Oct 30/1343	1997-066C	Young Engineers' Satellite		60 kg?
1997 Nov 2.67	7.79 deg	467.77 min	540 km	26,626 km

Second launch of an Ariane-5 vehicle from Kourou, the first to reach orbit: the maiden flight on June 4, 1996, exploded shortly after launch. Second flight carried two instrument platforms MAQSAT H ("haut"=high) and MAQSAT B ("bas"=lower) which measured the Ariane-5 launch environment. MAQSAT H mass was 2,300 kg: MAQSAT B mass 1,400 kg and remained attached to the Ariane-5 second stage (EPS, mass 1,200 kg) and Vehicle Equipment Bay (VEB, mass 1,500 kg). TEAMSAT (Technology, science, and Education Added to MaqSAT) had a total mass of 350 kg: the major part of the satellite remained attached to MAQSAT H in orbit. TEAMSAT carried the following instruments: Orbiting Debris Device (ODD), Autonomous Vision System (AVS), Visual Telemetry System (VTS), Flux Probe Experiment (FPE) and Young Engineers' Satellite (YES). Originally YES had been planned for deployment from TEAMSAT on a tether, but the tether was deleted and YES became an independent satellite. It had been intended that the launch would place the payloads into eccentric orbits reaching out to geosynchronous altitude (~36,000 km) at apogee, but a launch vehicle malfunction prevented this, and the apogees were around 9,000 km lower than planned.

Updates for Previous Launches

1984-093D Telstar 303 was maneuvered off-station over 262 deg E approximately Sep 3, 1997.

1984-114A Spacenet 2 was relocated over 115 deg E approximately Sep 2, 1997.

1987-070A Kiku 5 was maneuvered off-station over 150 deg E in early October 1997.

1988-018A Spacenet 3R was relocated from 272-273 deg E to 277 deg E during Sep 29 and Oct 9, 1997.

1989-020A JCSat 1 was maneuvered off-station over 147 deg E in early October 1997.

1989-062A The orbital data issued in May 1997 suggesting that TVSat 2 had maneuvered off-station were in error: the satellite is still located over 359 deg E.

1991-075A INTELSAT 601 was maneuvered off-station over 332 deg E approximately Oct 8 and was relocated over 325-326 deg E approximately Oct 20, 1997.

1992-021B INMARSAT 2-4 was relocated over 343 deg E in the second half of September 1997.

1993-066A INTELSAT 701 had its longitude restabilized over 179-180 deg E during the first half of September 1997.

1994-030A Gorizont 30 was maneuvered off-station over 141-142 deg E approximately Oct 12 and was relocated over 121 deg E Oct 26, 1997.

1995-071A Cosmos 2326 manoeuvred off-station Oct 10, 1997. Add the following orbital data:

1997 Oct 10.17	65.01 deg	92.78 minutes	402 km	420 km
1997 Oct 10.50	65.01 deg	90.95 minutes	228 km	414 km

The first orbit listed is the last one to show the satellite in its operational orbit. This leaves Cosmos 2335 (1996-069A) as the sole operating EORSAT.

1996-021A According to the two-line orbital elements Astra 1F was maneuvered off-station over 19 deg E approximately Sep 5, 1997. However, it is believed that the data might be in error since the satellite appears to be still operating with the other Astra 1 satellites close to 19 deg E.

1996-031A MSTI 3 was the target of a test using the U.S. Army's Mid-Infrared Advanced Chemical Laser, based at the White Sands Missile Range. On Oct 17, 1997, two laser firings took place, lasting for 1 and 10 seconds, "illuminating" the satellite: the laser was operating at a low power since a full-power, longer burst would have destroyed the satellite.

1997-024A Cosmos 2343 was intentionally destroyed in orbit Sep 16, 1997, at 2208 UTC. The main piece following the explosion decayed from orbit Sep 18, 1997. No additional pieces of debris were officially catalogued following the satellite's explosion.

1997-033A The undocking of Progress M-35 from the Mir Complex planned for Oct 6, 1997, was cancelled because crew on board Mir had omitted to remove a clamp attaching the freighter to the Kvant 1 module.Undocking finally came Oct 7, 1997, at 1203 UTC, the de-orbit burn took place at 1641 UTC and debris came down in the Pacific Ocean at 1723 UTC.

1997-043A	Add the following orbital data for Iridium 26:			
1997 Sep 12.56	86.42 deg	100.39 minutes	774 km	780 km
1997-043B	Add the following orbital data for Iridium 25:			
1997 Sep 7.91	86.40 deg	100.38 minutes	774 km	779 km
1997-043C	Add the following orbital data for Iridium 24:			
1997 Sep 9.16	86.39 deg	100.39 minutes	776 km	779 km
1997-043D	Add the following orbital data for Iridium 23:			
1997 Sep 9.15	86.38 deg	100.39 minutes	775 km	780 km
1997-043E	Add the following orbital data for Iridium 22:			
1997 Sep 9.15	86.39 deg	100.40 minutes	776 km	779 km
1997-044A	Lewis (SSTI) decayed from orbit Sep 28.			

Close Encounter Between MSTI-2 and the Mir Complex

U.S. satellite MSTI 2 (1994-028A) made a close pass to the Mir Complex (1986-017A) Sep 15, 1997, at 1729 UTC. Russian reports suggested that the minimum distance was about 470 meters, but USSPACECOM states that the minimum distance was close to 900 meters.

Orbital Planes of Iridium Satellites

From the last issue of *Satellite Times* we continue the orbital plane listing for the Iridium satellites. The planes used by the first seven Iridium launches were as follows:

11.1 deg	1997-043	Cluster 4		
42.7 deg	1997-051	Cluster 5		
74.3 deg	1997-020	Cluster 1	1997-056	Cluster 6
105.9 deg	1997-030	Cluster 2		
137.4 deg	1997-034	Cluster 3	1997-069	Cluster 7

These deployments still leave one orbital plane to be initiated.

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By Ken Reitz, KS4ZR
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How to Get Started in Satellite Monitoring

I don't want to think about the thousands of dollars I've spent over the last 13 years on this hobby. And I also don't want to think about the countless hours I've spent putting stuff together and taking it apart when I might have been improving my mind or even just sleeping! My objective here is to help save three of your most precious personal commodities: your sleep, your money, and your mind. In order to do that I'm presenting my top five biggest tips in pursuit of this hobby.

1. Buying Used Equipment

The first reason to not buy new equipment is a monetary one. New equipment is expensive and used equipment is cheap. For every person just getting into a particular hobby, there's at least one getting out. They have their reasons. Sometimes it has to do with their sanity, or their shaky marriage, or dwindling financial reserves. Whatever the reason, be assured that you may be similarly afflicted, but that it's likely years down the road. Meanwhile, don't be afraid to buy used equipment. If a receiver or antenna has been taken care of and is in reasonably good condition, it could easily have years of use left in it. The savings can be substantial. If you decide, shortly after toying with the hobby that it's not for you, you don't have that much invested.

There are several sources for used equipment. First, buy from individuals you know and trust, or on the recommendation of people you can believe in. Second, buy from reputable dealers. Dealers are constantly getting equipment in trade for new gear and are happy to sell it to newcomers to the hobby. They know that if you're satisfied with the used stuff and you get seriously hooked on the hobby, you'll come to them when you want the new gear. Some dealers will give you a 30 day warranty if you ask. And that's the key to getting used

What's wrong with this picture? For one thing, there aren't nearly enough shims to keep the dish from spinning like a top in a heavy wind. Try mounting the dish on the proper sized pole! (Photo by Ken Reitz)

equipment: always ask, "Can you give me a 30 day warranty?" "Does this price include the power supply, remote control, or other accessories?" "Will you take 20,30 or 50 dollars less?" Typically, dealers won't give you anything, but, if you ask, they might budge a little to make a sale.

Shop for used equipment. By doing a little self-education you can determine for yourself if what's being presented is a good deal or not. Don't buy the first thing you see or pay the first price you hear. If you're looking for used satellite TV equipment call every dealer in your area. You will be amazed at the discrepancies in the various prices. If you're buying amateur related equipment, price the same gear from several sources. Most new amateur equipment dealers have used equipment, often in list form. Ask them to mail or fax such a list. Take your time. Even if a particular item you were looking for has been sold, you may be assured that another will be on the market shortly.

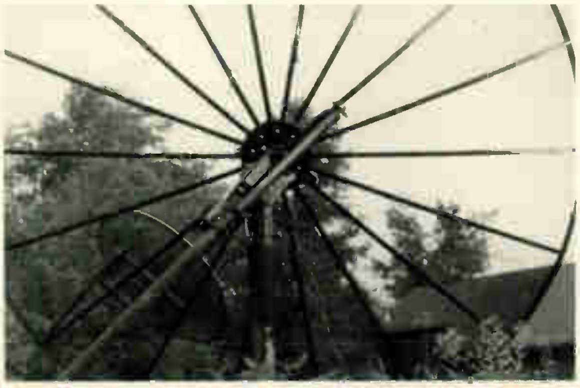
If you've purchased used equipment without owner's manuals, you can get a replacement from the company for just a few dollars. There's nothing more frustrating than not knowing what all the buttons on a remote control or front panel are for. Call or write the company and ask for a replacement manual. They're used to this and often have extras ready to ship. If the company is no longer in business, some dealers many have manuals which they might copy for a minimal charge. Some receiver functions can be accessed only by remote control. If your used gear has no remote control, ask if one is available; find out if a "universal" remote will work in its place. If there is one but it's broken, there are companies which repair them, however; infra-red remotes are much easier to repair than UHF remotes.

2. Buying New Equipment

There is a down side to buying used gear. The old adage is that if you buy used equipment you're just taking on someone else's headaches and paying for the privilege! This is particularly true when it comes to buying at hamfests or flea markets. At these markets there's usually no way to test a piece of equipment to ascertain if it's working at all, and often it's on a cash-only, all-sales-final basis. This might be all right if you're just paying $10 or $20 for an item, but if you're putting down some real money, you need to have some recourse in the event things turn sour.

Electronic equipment design is in a constant state of improvement. New, better designs with more features, and often the same or lower price than a previous model, are always being introduced in the market. Why pay just a little less for a used product with fewer features and less capability?

Most dealers have a "no questions asked" return policy. As long as the product has not been abused, most dealers will allow new equipment to be returned for refund or credit. All manufacturers have warranties which cover virtually any problem you might encounter. In addition, most retailers offer extended warranty policies. These can be critical reasons for buying new equipment. It's almost impossible to "get stuck" with a bad product if you buy new. Making your purchase with a credit card is another safety feature which could protect you if the dealer refuses to make good on a warranty or other purchase promise. Withholding payment on your credit card bill, and explaining the problem, causes your credit card company to go to bat for you. You'll be amazed at how quickly dealers come around when the credit card company calls.



Looking through the back of this dish reveals that it's trying to see through trees and a second dish planted right in front of it, as well. Better do a site survey next time! (Photo by Ken Reitz)

3. Always Follow Instructions.

Raise your hand if you've ever ripped open a carton containing a new gizmo and plugged it in right away without putting so much as a fingerprint on the instruction manual. Yeah, me too. I once installed an actuator motor upside down so that the drain holes did just the opposite: they held in the rain and when I took the cover off the motor housing to find out why it wasn't working, a cup of rainwater came gushing out. What a genius!

Engineers put a lot of effort into making products and designing instruction manuals for their proper operation. You can save yourself untold heartache and frustration by taking the time to read these manuals. When you first open a product carton, find the owner's manual and grab a cup of coffee, a glass of ice tea, a beer, a martini–Anything. Just sit down and read the manual. You might learn something.

When it comes to assembling antennas, whether it's a satellite dish or amateur satellite antenna, it's most important to put it together just right. In the case of a dish, you can lose several dB of gain just by not being careful. With antennas the whole game is gain: You can't afford to lose any. Taking your time reading, re-reading, carefully assembling, measuring your work, and re-doing it, if necessary, will pay big dividends when it comes to operating the equipment. Sloppy assembly of a satellite dish can turn sparkle free pictures into snow on Ku-band.

4. Plan Ahead

If you're planning to put any type of satellite antenna at your home, you'd better plan ahead. Go outside and look around for an optimum site. You may find that trees or other buildings prohibit even doing an installation. That would be nice to know before you buy the gear. Try to look into the future. How about that tree in front of the dish, will it grow to block the signal in another two or three years? If someone builds a house on the lot next door, will it take out most of your view of the sky for satellite viewing? If a big wind storm comes up, are there trees which could easily fall on the dish and crush it? If you bury cable to the dish, will you have to cut or go across existing utility, water, or gas lines? Will your antenna be in a place where it would become a tempting target for vandals?

Find out if there are any local ordinances, home owner's association rules, or other covenants and restrictions against putting up such antennas. Even if you are in the right legally, you may end up spending a lot of time and effort in defending your rights. Be prepared to take on the local government or group of busy-bodies intent on telling you what you can and can't do with your property. If you rent property you may still be able to do an installation. Some landlords will approve your idea, and even help, if you come right out and explain what it is you're doing.

5. Read

There's no substitute for a good education. And, in the field of satellite communications, there's no substitute for accurate, current information. Unfortunately, very few libraries have the kind of current information you're seeking. So you're on your own. You could spend hundreds of dollars on thick industry books on this subject, but you'd be better off spending that money on equipment. First, subscribe to this magazine. I know, I have a vested interest in your doing so but, believe me, this is the best and cheapest source of accurate, current information on the subject of satellite technology, not written for the industry professional, on the market today. In just a few issues you'll learn more than you ever thought you could about every aspect of satellite communications.

Another good place to start is the *Satellite & TV Handbook* published by Billboard books and available through the Grove catalog (800-438-8155). At $25, it's the single cheapest book with the most useful information you will find. With a certain amount of introductory content and an extensive list of the world's satellites and what's on them, this is a great beginner's book. The best book to get started in weather satellites is Ralph Taggart's *Weather Satellite Handbook*. The best book on getting started in amateur radio satellite communications is Davidoff's *The Satellite Experimenter's Handbook*. Both books are available from Grove.

A relatively cheap way to learn about this hobby, if you have access to the Internet, is to checkout the various websites you see mentioned in the articles and advertisements of this magazine. You can spend countless hours cruising the net and collecting information for little expense. Don't forget "snail mail." Send off for catalogs.

Skyvision is a company with a very large catalog of satellite TV equipment. Call their toll free number (800-543-3025) for a copy. Baylin Publications has the most extensive catalog of satellite related books on the market. Get their catalog, too (303-449-4551).

The smallest amount of self-education will make you a savvy shopper capable of making the right decision when it comes to spending money in a hobby which knows no financial boundaries.

By Dr. T.S. Kelso

Frequently Asked Questions: Two-Line Element Set Format

As I sat in my hotel room answering e-mail on a recent trip to Washington, D.C., I realized that a column of this nature was probably long overdue. Most of the questions I receive are the result of the lack of publicly available documentation on the NORAD SGP4/SDP4 orbital model and the two-line orbital element sets, although a few deal with issues involved in the administration of the orbital data maintained on the Celestial worldwide web site (**http://www.grove.net/~tkelso**).

In this column, I hope to provide a single source of answers to what I've seen to be the top dozen or so questions on this topic. Here is a summary of the questions I'll answer in this and the next column:

1. What is the format for the two-line element sets?
2. How is the epoch time format interpreted?
3. What time units are used (mean solar or sidereal)?
4. How will the Year 2000 be handled?
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. What is the reference frame of the resulting coordinates?
8. How often are element sets generated?
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?

I'll answer the first four questions in this column and the remainder in the next one.

FIGURE 1: Two-Line Element Set Format

```
1 NNNNNC NNNNNAAA NNNNN.NNNNNNNN +.NNNNNNNN +NNNNN-N +NNNNN-N N NNNNN
2 NNNNN NNN.NNNN NNN.NNNN NNNNNNN NNN.NNNN NNN.NNNN NN.NNNNNNNNNNNNNN
```

What is the format for the two-line element sets?

A NORAD two-line element set consists of two 69-character lines of data which can be used together with NORAD's SGP4/SDP4 orbital model to determine the position and velocity of the associated satellite. The only valid characters in a two-line element set are the numbers 0–9, the capital letters A–Z, the period, the space, and the plus and minus signs—no other characters are valid. Of course, not all valid characters can be used in all columns within the element set. Figure 1 shows what type of character is valid for each column.

Columns with a space or period can have no other character. Columns with an 'N' can have any number 0–9 or, in some cases, a space. Columns with an 'A' can have any character A–Z or a space. The column with a 'C' can only have a character representing the classification of the element set—normally either a 'U' for unclassified data or an 'S' for secret data (of course, only unclassified data are publicly available). Columns with a '+' can have either a plus sign or a space and columns with a '-' can have either a plus or minus sign.

Further restrictions are placed upon the values in each column as the individual fields of data are defined. Tables 1 and 2 define each of the individual fields for lines 1 and 2, respectively. Many of these bear additional explanation.

Column 1 of each line of the two-line element set indicates the line number (and hence the format) for that line. The next field on each line (fields 1.2 and 2.2) indicates the satellite number—actually, the NORAD Catalog Number—of the object the data is for. The NORAD Catalog Number is a unique identifier assigned by NORAD for each earth-orbiting artificial satellite in their SATCAT (Satellite Catalog). For a valid two-line element set, fields 1.2 and 2.2 must be identical. As mentioned above, field 1.3 indicates the security classification of the data—all publicly available data will have a 'U' in this field to indicate unclassified data.

The next three fields—fields 1.4 through 1.6—define the International Designator of the object. This identifier is an additional unique designation assigned by the *World Data Center-A for Rockets and Satellites* (WDC-A-R&S) in accordance with international treaty (1975 Convention on Registration of Objects Launched into Outer Space). The WDC-A-R&S works together with NORAD and NASA's National Space Science Data

TABLE 1: Two-Line Element Set Format Definition, Line 1

Field	Column	Description
1.1	01	Line Number of Element Data
1.2	03-07	Satellite Number
1.3	08	Classification
1.4	10-11	International Designator (Last two digits of launch year)
1.5	12-14	International Designator (Launch number of the year)
1.6	15-17	International Designator (Piece of the launch)
1.7	19-20	Epoch Year (Last two digits of year)
1.8	21-32	Epoch (Day of the year and fractional portion of the day)
1.9	34-43	First Time Derivative of the Mean Motion
1.10	45-52	Second Time Derivative of Mean Motion (decimal point assumed)
1.11	54-61	BSTAR drag term (decimal point assumed)
1.12	63	Ephemeris type
1.13	65-68	Element number
1.14	69	Checksum (Modulo 10)(Letters, blanks, periods, plus signs = 0; minus signs = 1)

Unfortunately, this reasoning is severely flawed. While changing the format would involve changing large numbers of software packages to accommodate the format changes, not changing the format does not remove the need to modify this software. Instead of incorporating a format change along with the software modifications, modifications must be made now to change the epoch interpretation and later when the format is finally changed. Too bad that when Aerospace Defense Command proposed going from the old five-line to the current two-line format in November 1972 they didn't recommend a four-digit year (they did, however, at least change from a one-digit to a two-digit year).

Field 1.9 represents the first derivative of the mean motion divided by two, in units of revolutions per day^2, and field 1.10 represents the second derivative of the mean motion divided by six, in units of revolutions per day^3. Together, these two fields give a second-order picture of how the mean motion is changing with time. However, these two fields are not used by the SGP4/SDP4 orbital models (only by the simpler SGP model) and, therefore, serve no real purpose.

Field 1.11 represents something called B^* (BSTAR), which is an SGP4-type drag coefficient. In aerodynamic theory, every object has a ballistic coefficient, B, that is the product of its coefficient of drag, C_D, and its cross-sectional area, A, divided by its mass, m.

$$B = C_D A/m$$

The ballistic coefficient represents how susceptible an object is to drag—the higher the number, the more susceptible. *BB* using the reference value of atmospheric density, r_o.

$$B^* = B\,r_o/2$$

B^* has units of (earth radii)$^{-1}$.

Fields 1.10 and 1.11 have a somewhat different format that the other fields. In particular, they use a modified exponential notation with an implied leading decimal point. This convention is inherited from FORTRAN where all such numbers range from 0 to less than 1. The first six columns of each field represent the mantissa and the last two represent the exponent. For example, the value –12345-6 corresponds to –0.12345x10^{-6}. Each of these two fields can be blank, corresponding to a value of zero.

Field 1.12 represents the ephemeris type (i.e., orbital model) used to generate the data. *Spacetrack Report Number 3* suggests the following assignments: 1=SGP, 2=SGP4, 3=SDP4, 4=SGP8, 5=SDP8. However, this value is used for internal analysis only—all distributed element sets have a value of zero and are generated using the SGP4/SDP4 orbital model (as appropriate).

TABLE 2:
Two-Line Element Set Format Definition, Line 2

Field	Column	Description
2.1	01	Line Number of Element Data
2.2	03-07	Satellite Number
2.3	09-16	Inclination [Degrees]
2.4	18-25	Right Ascension of the Ascending Node [Degrees]
2.5	27-33	Eccentricity (decimal point assumed)
2.6	35-42	Argument of Perigee [Degrees]
2.7	44-51	Mean Anomaly [Degrees]
2.8	53-63	Mean Motion [Revs per day]
2.9	64-68	Revolution number at epoch [Revs]
2.10	69	Checksum (Modulo 10)

Field 1.13 represents the element set number. Normally, this number is incremented each time a new element set is generated. In practice, however, this doesn't always happen. When operations switch between the primary and backup Space Control Centers, sometimes the element set numbers get out of sync, with some numbers being reused and others skipped. Unfortunately, this makes it difficult to tell if you have all the element sets for a particular object.

The last column on each line (fields 1.14 and 2.10) represents a module-10 checksum of the data on that line. To calculate the checksum, simply add the values of all the numbers on each line—ignoring all letters, spaces, periods, and plus signs—and assigning a value of 1 to all minus signs. The checksum is the last digit of that sum. Although this is a very simple error-checking procedure, it should catch 90 percent of all errors. However, many errors can still sneak through. To eliminate these, all data posted on the Celestial WWW site not only pass the checksum test, but must also pass both format and range-checking tests (as described in this article).

Line 2 consists primarily of mean elements calculated using the SGP4/SDP4 orbital model. The definitions for fields 2.3 through 2.8 can be seen in table 2 below. Fields 2.3, 2.4, 2.6, and 2.7 all have units of degrees and can range from 0 up to 360 degrees—field 2.3 (inclination) only goes up to 180 degrees. The eccentricity (field 2.5) is a unitless value with an assumed leading decimal point. For example, a value of 1234567 corresponds to an eccentricity of 0.1234567. The mean motion (field 2.8) is measured in revolutions per day.

The final field on line 2, prior to the checksum, is the revnumber. Since there are several conventions for determining rev numbers, this field also bears some clarification. In NORAD's convention, a revolution begins when the satellite is at the ascending node of its orbit and a revolution is the period between successive ascending nodes. The period from launch to the first ascending node is considered to be Rev 0 and Rev 1 begins when the first ascending node is reached. Since many element sets are generated with epochs that place the satellite near its ascending node, it is important to note whether the satellite has reached the ascending node when calculating subsequent rev numbers.

In general, any number smaller than the maximum field size can be padded with either leading spaces or leading zeros. In other words, an epoch can be represented as either 98001.12345678 or 98 1.12345678 or an inclination can be represented as 28.1234 or 028.1234. Convention uses leading zeros for fields 1.5 and 1.8 and leading spaces elsewhere, but either is valid.

Obviously, there are a few limitations with the current two-line format. First and foremost is the need for a four-digit year in fields 1.4 and 1.7. Next, there is a need for a more robust form of error checking—perhaps a 16-bit CRC. Such a checksum could be applied to both lines together, not only detecting errors within the data but also mismatched lines 1 and 2. If such changes were made, it might also be wise to increase the field size for the Catalog Number to six or seven digits to support the eventual cataloging of smaller debris.

The International Designator format seems to suffice for the foreseeable future, with a four-digit year, up to 999 launches (the most we've had to date in any one year was 129 in 1984), and up to 13,824 pieces (the record holder today is 1994-029 with 672 pieces). Of course, the cataloging of smaller debris—which we may be unable to correlate with the original launch—still presents potential problems.

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!

Russian Proton Rocket Program (continued from p. 21)

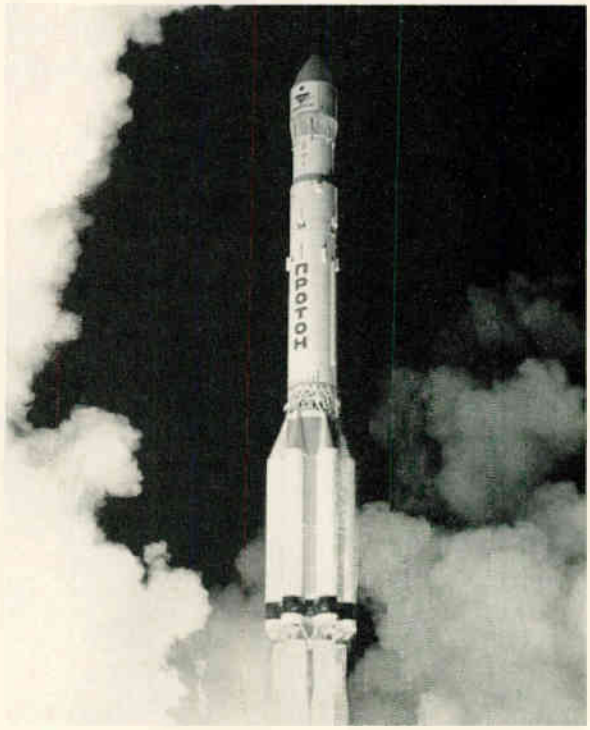
separated. This orbit had never been used before.

The first commercial launch of a group of Iridium satellites using a Proton-K vehicle (June 18, 1997) used another new launch profile. Whereas the United States Delta-2 (7920) launch vehicle could only carry five Iridium satellites on each mission, the greater lifting power of the Proton-K with a Block DM2 fourth stage allowed for seven satellites to be carried at once. As previously noted, a modification of the Block DM-5 fourth stage was used for the Iridium launches. The orbital data is given in Table 7.

After launch into LEO at an inclination of approximately 73°, the Proton-K third stage and fourth stage shroud were separated and decayed from orbit before being catalogued. (Most probably the non-cataloguing of these pieces on the first launch was because USSPACECOM was not ready to follow the new profile.) The first Block DM2 burn placed the stage and its satellites into a transfer orbit reaching out to ~516 km (planned apogee) and the second burn circularized the orbit at ~516 km but shifted the orbital inclination to approximately 86.4°: it was into this orbit that the seven Iridium satellites were deployed.

Once the satellite deployment was done the Block DM2 performed a third maneuver to de-orbit itself. This ensured that the Iridium orbital regime will not become cluttered with discarded rocket stages. When Iridium launches use the Delta-2 (7920) vehicle, the Delta-2 second stage performs a post-deployment burn to take it out of the Iridium orbital regime, and the Chinese-launched Smart Dispenser (carried on the CZ-2C as a third stage when launching pairs of Iridium satellites) will do the same.

In the future, a modification of the Iridium launch profile could be used by the Proton-K for launching payloads to Sun-synchronous orbits. Although a detailed launch profile has not been published for such launches, based upon the Iridium profile a Proton-K could place a fully-fuelled Block DM class fourth stage and payloads into a 73° LEO. The fourth stage would perform one burn (over the equator?) to a (co-planar?) orbit with an apogee at the planned altitude. When passing through that apogee (over the equator) a second burn could circularize that orbit, at the same time performing an orbital plane change to 97-99°. The Russians have suggested launches to 97°/400 km, 98°/600 km and 99°/900 km orbits (in truly Sun-synchronous orbits the altitude is a function of the inclination), and this suggests payload masses of 2.5 tons or more.



In Conclusion

Over the last few years the demonstrated launch profiles of the Proton-K launch vehicle with its various Block DM fourth stages have increased in number, and thus show that the vehicle is more flexible than previously believed. In the future we might see other new profiles introduced for super-synchronous transfers orbits used as routes to geosynchronous orbit or launches to Sun-synchronous orbits, thus extending the Proton-K's capability even further.

The variation in launch profiles to geosynchronous orbits means that when launched on a Proton-K, the satellite itself has to perform smaller maneuvers to reach its operational orbit compared with western launches. In turn this means that a larger mass can be launched to geosynchronous orbit using the Proton-K. That increased mass can be translated into either an increase in station-keeping propellant or an increase in the useful payload mass (or a combination of both).

And finally, when the planned Proton-KM launch vehicle is introduced using more powerful upper stages, observers can expect to see even greater variety in the launch profiles used by this vehicle. ST

TABLE 7: Orbital Data for Launching Iridium Satellites

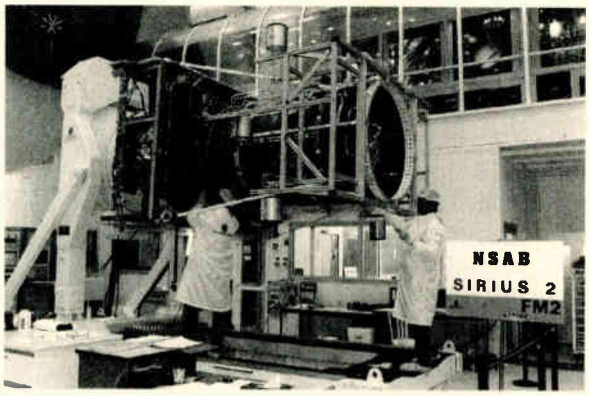
Object	Incl deg	Period min	Perigee km	Apogee km
Iridium 14	86.35	94.86	501	523
Iridium 12	86.41	94.87	504	521
Iridium 10	86.42	94.84	501	521
Iridium 9	86.33	94.86	496	527
Iridium 13	86.41	94.86	503	521
Iridium 16	86.40	94.85	500	522
Iridium 11	86.40	94.85	502	521
Proton-K third stage	~73	~87.9	~170	~170
Fourth stage casing	~73	~87.9	~170	~170
Fourth stage (DM2)	~73	~91.4	~170	~516
	~86.4	~94.9	~516	~516

Orbital data taken from *Worldwide Satellite Launches*, July 9, 1997, pages 35-36. The initial orbits for each of the satellites (in the order that they were catalogued by USSPACECOM) are shown: for the Proton-K third stage, fourth stage casing and fourth stage itself estimated orbital data (based upon pre-launch planned data) are given because these objects re-entered the atmosphere before being catalogued.

By George Wood
wood@rs.sr.se

Digital Scandinavia

Digital broadcasting is finally arriving in the Nordic region, via satellite, cable, and through the airwaves, so this time I want to focus on Scandinavia.



Sweden's Sirius 2 satellite under construction.

Months delayed, Sweden's Sirius 2 TV satellite was finally launched on an Ariane rocket November 12, 1997. At 5 degrees east, it joins Sirius 1 and replaces Tele-X, Sweden's first TV satellite, which is already several years past its expected lifespan.

The new satellite is an Aerospatiale Spacebus 3000, and at 2900 kg, is the largest telecommunications satellite ever built in Europe. Sirius 2 carries 32 transponders, with an estimated life of around 15 years.

There are three downlink configurations. The Nordic beam is 52 watts per transponder, and covers Scandinavia, the Baltic republics, and parts of eastern and western Europe. The European beam is 72 watts per transponder, and covers western and central Europe. The north/central European beam, intended for digital data and video, with 88 watts for each of the 6 transponders.

Nordic beam	13 transponders, 11.7-12.5 GHz V
Euro beam	13 transponders, 11.7-12.5 GHz H
North/Central	6 transponders, 12.5-12.75 GHz

Most of the transponders will be carrying digital signals, greatly expanding the capacity at 5 degrees east. Among the channels distributed by NSAB, the Nordic satellite company, are three moving from Tele-X: ABC/Disney's Kanal Five (PAL), the Danish sports channel TVS (D2-MAC), and the new Swedish business station TV8 (MPEG-2). In addition there will be broadcasts from the Danish parliament, called Star TV, and Swedish Television's new SVT Europe, which will also relay Swedish Radio and Radio Sweden. The telephone and cable-TV operator Telia has also booked 6 transponders.

Half of the transponders on Sirius 2 will be distributed by GE Americom, broadcasting primarily on the european beam. GE Americom's first contact for Sirius 2 was with the government of Cyprus to relay Greek-language programming to Europe. In its press releases after the launch, General Electric has started calling the satellite GE-1E/Sirius 2.

Sirius 2 didn't make it into orbit a moment too soon. On November 17, Kanal 5's transponder on Tele-X on 12.476 GHz finally died. Fortunately, the channel had been broadcasting in parallel from 1 degree west, just in case, and transmissions also switched to 12.207 GHz, apparently the last working analog transponders on Tele-X. Four days later, Kanal 5 was the first channel reported from Sirius 2, on its old frequency of 12.476 GHz.

TV8, a new Swedish business channel, started broadcasting on October 15, even before Sirius 2 was launched, in MPEG-2 on Tele-X on 12.676 GHz. Unfortunately, since there were no digital satellite receivers for sale in Sweden in October, no one could watch the channel directly. Sweden's largest cable operator, Telia, put TV8 out on its information channel for several hours a day, which must have provided its largest audience. TV8 will reportedly take over 12.207 GHz on Tele-X with clear PAL trnasmissions when Kanal 5 leaves that transponder.

The final new station on Tele-X was Denmark's new DK4, which started on 12.722 GHz in clear MPEG-2. Star Channel also broadcast a text card on the old satellite, on 12.715 GHz, in preparation for the switch to Sirius 2.

The Swedish satellites at 5 degrees east compete with Norway's Telenor, which is distributing channels on Thor 1 and 2, TV-Sat 2, and Intelsat 707 at 1 degree west.

Canal Plus and Telenor unveiled their Canal Digital this fall at the Sound and Image Show in Oslo. The new service includes 35 digital TV channels, 24 pay-per-view channels, and 20 themed radio channels from Music Choice Europe. all in Conax encoded MPEG-2.

The TV channels are: The pay-film Canal Plus (individual channels for Sweden, Norway, Denmark, and Finland, along with the Pan-Nordic "Gul", or "Yellow", channel), Hallmark, Cartoon Network, TNT, BBC Prime, NBC, CNBC, Discovery, Animal Planet, Travel, Eurosport, TVS, MTV, VH-1, Nickelodeon, Sci-Fi, CNN, Adult Channel, Eurotica, Denmark's TV Danmark, Sweden's Kanal 5, Norway's TV Norge (the last three all owned by ABC/ Disney), and Norway's public broadcaster NRK.

The PPV service, called Kiosk, is on Thor 2 on 11.372 (Kiosk 1-12) and 11.403 (Kiosk 13-24) GHz. The twenty Music Choice Europe radio channels use 11.309 GHz.

According to Frank Oestergren of the newspaper *Aftonbladet*, Canal Digital chose to skip the Christmas season, delaying the official launch until this Spring. Since the channels have been in place, presumeably the decision to forego the opportunity to make a digital set-top box the Christmas present of 1997 was made because of a digital decoder shortage. Canal Digital has reportedly advertised in Finland, home of Nokia, Europe's foremost digital receiver manufacturer.

But while the Swedes have been waiting for digital satellite television, digital cable has caught up. In late November, Telia, Sweden's largest cable operator, started rolling out its digital networks, beginning in Stockholm, followed by 15 other communities. The service is to cover all of Telia's 1.3 million households across the country by the middle of 1998. Satellite access may also be possible for those outside the reach of cable, as Telia is one of the major users of Sirius 2, with 6 transponders.

But Telia's new digital decoders have come in for criticism from Gunnel Faerm, who's been planning the introduction of digital terrestrial television (DTT) in Sweden. Telia's Eurobox set-top boxes won't work with DTT (or, for that matter, with digital satellite broadcasts), which means viewers will have to choose between separate boxes for cable, satellite, and DTT.

The same day in late November that Telia announced the roll-out of its digital cable network, the Swedish government formally approved digital terrestial channels, and allocated extra funds to Swedish public broadcasting for both DTT and Digital Audio Broadcasting.

The new DTT offerings will include a 24 hour news and sports channel (SVT 24 Nyhetskanalen), regional channels, and possibly widescreen versions of the existing SVT1 and SVT2 channels. Also proposed is a channel combining the best from the BBC and the Franco-German cultural channel Arte. Transmissions would begin by January 1, 1999. According to Kjell Kullberg, head of Swedish Television's Corporate Development Department, the new channels may also use satellite, presumably to reach the 10,000 Swedish households forced to pay TV license fees, but outside the reach of transmitters. (Sirius 2 would be the logical choice.)

Kjell Kullberg is also hopeful a combined digital decoder for terrestrial, satellite, and cable TV will eventually be developed.

On the "bizarre news" front comes the report that an Estonian company plans to start pirate TV broadcasts from a ship in the Baltic Sea, aimed at Estonia and Finland. TV Zoom is to begin programming via satellite in Estonian in May, and in Finnish in the fall, says Kaur Hanson, managing director of the Zoom advertising agency in the Estonian capital Tallinn.

Hanson wants to register the ship in a country that has not signed the Bern Convention on copyright laws. It also plans to carry commercials for alcohol and tobacco products, which cannot be advertised on television in Finland. The station plans to broadcast old Hollywood films in the mornings, with soap operas later in the day, and action films and adult movies at night.

British Interactive Broadcasting

I've just been in Britain, where satellite broadcaster British Sky Broadcasting is preparing to launch a 200 channel digital service from the upcoming Astra 2A satellite, which will be placed at 28.2 degrees east. The satellite will carry 32 transponders, 14 of which have been reserved by Sky and 4 by Flextech (TCI's British subsidiary). Sky has also gotten together with several partners, including British Telecom, Midland Bank, and Matsushita (Panasonic), in a venture called British Interactive Broadcasting, which will be offering special non-TV digital offerings.

I visited BIB, a block from St. Pauls' Cathedral in the City of London, the capital's financial district. Managing Director Peter van Gelder told me the service will focus on home shopping and banking. Users will have to use a particular BIB decoder box, rather than just any MPEG-2 receiver. BSkyB and BIB are basing their set-top boxes on Open TV, a joint venture between Sun Microsystems and France's Thomson (which owns RCA). Since Matsushita is one of the BIB partners, presumeably there will also be Panasonic BIB receivers.

While the service will initially start in Britain during the Summer ("possibly Indian Summer") of 1998, Peter van Gelder sees no obstacle to offering access to other parts of Europe.

BIB will allow very fast access to parts of the Internet, but not to the entire World Wide Web. Peter van Gelder refers to it as the World Wide Web "Walled Garden". The fast downlink would be via satellite, with the return via ordinary telephone lines using a modem in the BIB box. While he wouldn't tell me why BIB isn't providing the entire Web, it seems one reason is because fast Internet access would make it possible for subscribers to watch video from stations outside BSkyB's domain. (Ironically, BSkyB owner Rupert Murdoch has used the Internet to relay his Fox News around the world, using RealVideo, after it was kept off Time-Warner's cable systems in the US.)

Meanwhile, Sun's rival Bill Gates, often accused of trying to take over virtually everything, may be helping to break up Murdoch's British satellite TV monopoly. Gates' Microsoft is to test new television technology with Britain's Independent Television as well as leading cable operators, and possibly even the BBC. Microsoft has been in talks with Carlton and Granada, partners in British Digital Broadcasting, which plans to launch 20 DTT channels. (BSkyB was originally part of the BDB venture, but was forced to withdraw because participation would have given it far too much power over British television.) The pilot project will use a Microsoft set-top box to give TV viewers separate access to interactive services on the Internet, and "enhanced TV" based on Microsoft's WebTV.

Murdoch's BSkyB is coming under attack on another front. The *Financial Times* reports that four British cable TV companies are planning to create pay-per-view movie channels under a proposed agreement with Murdoch's American rival Time-Warner.

This would allow them to compete with BSkyB's new PPV service Sky Box Office, which started in analog form on Astra on December 1 (after a few earlier trials with PPV boxing matches). The analog schedule is:

Sky Box Office 1	transponder 26	2200-0600
Sky Box Office 2	transponder 60	1800-0600 (Sundays from 1100)
Sky Box Office 3	transponder 59	2000-1800
Sky Box Office 4	transponder 58	2000-0600

BSkyB and Cable and Wireless Communications have announced they've reached agreement on providing digital PPV TV in Britain, as part of Sky Box Office. Under the deal, CWC says it will offer PPV movies, sports, and other events on analog and digital platforms starting this Spring.

Sky insiders have told *What Satellite TV* magazine that there will be 60 to 100 digital PPV channels, offering multi-schedule films, concerts, and sports events, around the clock. The magazine also reports that Sky's new digital service will carry multiple versions of the Sky 1 entertainment channel and the Granada Sky Broadcasting channels, time-shifted, to give viewers more flexibility. The basic digital multi-channel package will include around 60 channels, and viewers will also have access to unencrypted services, including TNT, Cartoon Network, and Eurosport.

Flextech will be using one of its transponders for Discovery, Animal Planet, Discovery Home and Leisure, and possibly newcomers Discovery Kids Channel and Science and Technology, neither of which are in Europe yet. A second transponder will be used for the channels jointly owned by Flextech and the BBC: UK Style, UK Horizons, UK Arena, and UK Gold. *What Satellite TV* reports that it's possible the People and Arts Network, which the BBC and Discovery launched to Latin America in October, will be added as well.

Flextech's two remaining transponders will be used for its other channels Living, Bravo, The Children's Channel, the youth-sitcom Trouble, game channel Challenge TV, Playboy TV. The Parliamentary Channel, European Business News, and Screenshop.

What Satellite also says Rupert Murdoch's Fox News from the States will be included in the Sky digital package alongside Sky News.

The Welsh broadcaster S4C has also acquired capacity on Astra 2A. S4C says it plans to launch its digital service early next autumn, independent of Sky's digital package.

The *National Geographic* Channel will expand from its current six hours a day (2000-0200), sharing an Astra analog transponders with Fox Kids, to a daily 12 hour service when Sky launches its digital service. The Hallmark Entertainment Network is holding off its UK launch until the start of Sky's digital service.

There have been some changes in Sky's analog channels. Sky changed all its logos on November 1, and Sky Movies became Sky Movies Screen 1, and the Movie Channel became Sky Movies Screen 2.

November 9 saw the start of BBC News 24, a new, round-the-clock, news channel. Currently the channel is primarily on cable (downlinked to cableheads in encoded MPEG-2 from Orion 1 at 37.5 degrees west on 11.534 GHz), but is also relayed during the night on the terrestrial BBC 1 TV channel. There are plans for digital satellite relays. The BBC says the service will be available "on all digital platforms as they become available," which could mean the network gets carried on the upcoming BSkyB digital satellite service in addition to Britain's planned DTT service.

At the same time that it launched BBC News 24, the BBC started a news-based Web site: **http://news.bbc.co.uk.** Every evening's "Nine O'Clock News" from BBC 1 is also carried live and archived in RealVideo at: **http://www.bbc.co.uk/newsa/9news.ram.** The latest newscast from BBC World Service radio in RealAudio is at: **http://news.bbc.co.uk/olmedia/audio/world_summary.ram.** BBC Radio 5 Live, which features news and sports, can be heard live most of the day at: **http://www.bbc.co.uk/radio5/live/stub/output.ram**

While BBC News 24 is directed only to British viewers, the BBC World Service's 24 hour news channel BBC World continues in clear PAL on Eutelsat II-F1. The situation here parallels BBC Prime/UK Gold, which carry virtually identical classic entertainment programming from the BBC archives, the former available by subscription outside Britain, the latter by subscription as part of Sky Multichannels, only within the British Isles.

The BBC has also started three other new channels–UK Arena, UK Style, and UK Horizons–which, like BBC News 24, are ultimately intended for DTT. They are running in coded MPEG-2 (intended for cable relays only) on 11.058 GHz on Intelsat 803 (which has replaced Intelsat 601 at 27.5 degrees west). There is a combined version called the UKTV Preview Channel on Astra transponder 56. This is in soft Videocrypt 1 (which means anyone with a decoder can watch, whether or not he has a BSkyB subscription card), with the following schedule (British time):

0700-1400	UK Horizons
1400-1800	UK Style
1800-2200	UK Horizons
2200-0000	UK Arena (Fridays to Sundays from 2100)
0000-0100	UK Horizons

BBC Prime has left 10.995 GHz on Intelsat 803, and can now only be found in D2-MAC on Intelsat 707, and in MPEG-2 on Eutelsat II-F1 (sharing the same transponder as the clear PAL BBC World).

Fashion TV has taken over 11.055 GHz on Eutelsat II-F1, and Discovery's Animal Planet is now on 11.304 GHz, both in clear PAL. Discovery is to transmit in MPEG-2, sharing the Animal Planet transponder, following the mixed analog/digital lead of the shared BBC World/BBC Prime transponder on this same satellite.

Radio Netherlands' TV channel for Dutch tourists in Europe, Zomer TV, changed its name to Wereldomroep TV when it was given permission to continue on its Astra transponder after Summer ended. It's now switched from Astra to Hot Bird 1, in clear PAL, on 11.283 GHz. Radio Netherlands is also using the audio subcarriers at 7.38 and 7.56 MHz to relay its radio programming.

RTL has moved its digital transmissions from Astra transponder 75 to 89 (12.188 GHz). The package includes: RTL, RTL Austria, RTL Switzerland, RTL Plus (sent on cable in Hamburg), and RTL Radio. The German Premiere package (which is absorbing DF-1) in MPEG-2 has left 12.110 GHz.

All Spanish language analog channels on Astra were replaced on January 1, 1998 by German channels. The documentary channel Phoenix replaces Minimax/Documania on transponder 36. The new ORB takes over from Cineclassics on transponder 40. Bildungskanal replaces Cinemania on transponder 30, with Hessen 3 instead of Sportmania on transponder 32. The German channels are all in clear PAL.

There will be ADR (Astra Digital Radio) channels accompanying each service. BSkyB's Promo Channel in clear PAL has now replaced Mexico's Galavision on transponder 44 (which otherwise is Sky Travel and Sky Movies Gold).

Europeans are also getting more 24 hour news channels. Even before BBC News 24 started, the Spanish public broadcaster TVE launched Canal 24 Horas, in clear PAL, on Eutelsat II-F1, on 11.658 GHz.

In the digital realm, the Spanish weather channel Meteo is on Astra transponder 74 (11.895 GHz), along with Mosaico, Andalucia TV, and TVC Internacional, all in clear MPEG-2. Spanish radio stations are available in clear MPEG-2 on Astra transponder 78. On October 30, all Radio Nacional de Espana radio stations ended analog transmissions from Hispasat on 12.226 GHz, and are now only available in digital SCPC on the same satellite, but not for public access. The digital relays of Spanish radio stations R1, R3, R5, and REE have also switched from Hot Bird 1 to Hot Bird 3.

The French MCM Africa has started 15 new, themed radio stations in MPEG-2 on Astra transponder 100 (12.402 GHz).

Eutelsat continues to try to block Astra's plans to put its second series of satellites at 28.5 degrees east. On its way to its final position at 36 degrees east, Eutelsat's newly-bought TDF 2 satellite carried out tests at 29 degrees east. Hot Bird 3 tested briefly at 29 degrees east as well on September 14-15, before moving to 13 degrees east. The tests are Eutelsat's attempt to establish a prior use of the location in an effort to stop Astra. (Astra is trying to establish its second orbital position. Rival Eutelsat already operates satellites at no less than 6 positions in the Clarke Belt.)

Only 2 of the transponders on the new Hot Bird 3 are being used for analog transmissions: Hungary's MTV2 is on 12.130 GHz, and the Greek ERT International is moving to 12.284 GHz from Eutelsat II-F2.

Here are the digital transponder allocations on Hot Bird 3 (all frequencies in GHz):

12.149	TPS (France)
12.168	Canal Plus Hellas (Greece)
12.188	British Telecom
12.207	CME
12.226	German digital package
12.245	MCM
12.264	German digital package
12.303	Digital package for Slovenia and Croatia
12.322	Digital platform for Poland
12.341	Tele Plus (Italy–formerly Telepiu)
12.360	Digital Platform for Poland
12.379	Digital Platform for France
12.398	SRG (Switzerland)
12.417	Tele Plus
12.437	British Telecom
12.465	Tele Plus

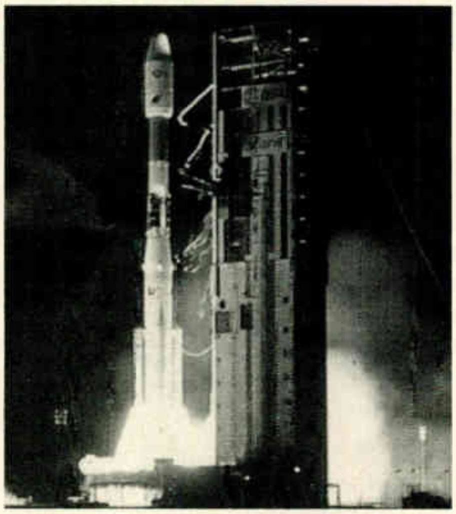
The first Italian hard-core-porn channel, Satisfaction Club Television, has announced it is starting a digital package. The channel will continue in analog on Eutelsat II-F2 (11.163 GHz), while the new digital service will be on Hot Bird 3 on 12.149 GHz (apparently part of the TPS package). There will be three thematic channels: classic porn, gays and lesbians, and bizarre porn. All three will be on the air for three hours every night.

The French digital satellite service TPS has denied a report in *Le Monde* that it is negotiating a merger with competitor AB Sat. AB Sat says the two having been talking, but admits only that "all negotiations aimed at the comfort of the television viewer, such as decoder compatibility, would be welcome." *Le Monde* says the talks could lead to more than simply decoder compatibility. Culture Minister Catherine Trautman said on October 22 the French government may force all digital TV operators to reach agreement on decoder compatibility. AB Sat has already such an agreement with its much larger rival Canalsatellite, operated by Canal Plus.

Eutelsat has signed a contract with Aerospatiale for the fourth satellite in the W series. Called W4, and equipped with 32 transponders, it will be operational at 36 degrees east in early 1999. A private broadcaster will use the satellite for analog and digital transmissions to Russia. W4 will be one of a number of Eutelsat satellites at that position, including TDF2, and the upcoming SESAT satellite which will also go into service in early 1999.

The Rest of the Planet

The recent World Radiocommunication Conference has reserved five satellite TV channels for a future Palestinian state, according to a spokeswoman for the International Telecommunications Union. This is the first time that a future independent



Hot Bird 3 launches aboard an Ariane V99 rocket.

Palestine has been included in the share-out of radio-frequencies for broadcast satellite services, last set by ITU members in 1977. Some 2000 government and ministry officials, representing 134 of the ITU's 188 member states, attended the Geneva conference. Israel and the Palestinian Authority will decide jointly when use of the allocated channels is possible, subject to their interim agreement of 1995. Israel's share was also increased from four to five channels.

A private international satellite TV service from Nigeria reportedly started on November 3. African Independent Television is to be available via Intelsat in Africa, Europe, the Caribbean, the US, and Asia. The channel promises a mixture of news, feature films, and locally made light entertainment, similar to the line-up on AIT's domestic channel. Initally, broadcasts will be in English only, although plans call for an expansion to French, Spanish, Portuguese, Swahili and Hausa. AIT and its radio station, Ray Power, which is also being carried by satellite, sprang up after the partial deregulation of Nigerian broadcasting, which began in 1992. Broadcasts are supposed to be via Intelsat 601 (this could actually be Intelsat 803, which replaced 601).

Nigeria's NTA, which was previously on Intelsat 601, has started on Intelsat 515 (which shares 21.5 degrees west with Intelsat-K) on 4.092 GHz in PAL.

South Africa's SABC says it plans to become a major supplier of news from Africa, using new satellites such as a PanAmSat to be launched this year. While the world press can overwhelm trouble spots for short periods, the SABC says there is little ongoing coverage of African issues, and it wants to fill this void.

China's Apstar 2R satellite was successfully launched with a Long March on October 16. It has 16 Ku- and 28 C-band transponders, and has been positioned at 77 degrees east.

The same Ariane rocket that put Sirius 2 into orbit also carried Indonesia's Cakrawarta 1 (previously known as Indostar-1). This satellite carries five transponders in the S-band, and has been placed at 107.7 degrees east. It will transmit 40 digital TV channels to Indonesia.

On October 31, Japan's Posts and Telecommunications Ministry gave final permission for (Hughes') digital satellite broadcaster DirecTV Japan to start its 90 channel package. Twenty-six of the 90 channels will be used for movies, 10 for drama and animation programs, and nine for music.

The international satellite TV channel Australia Television, which was privatized last June, has changed its programming format. The new lineup features a number of programs from the channel's new owner, Seven Network, including news and current affairs, sports and Australian drama.

Thanks to the usual stalwarts: Curt Swinehart, Richard Karlsson, James Robinson, Frank Oestergren, *SATCO DX*, *Tele-satellit News*, and *What Satellite TV*, along with newcomer *SatNytt*.

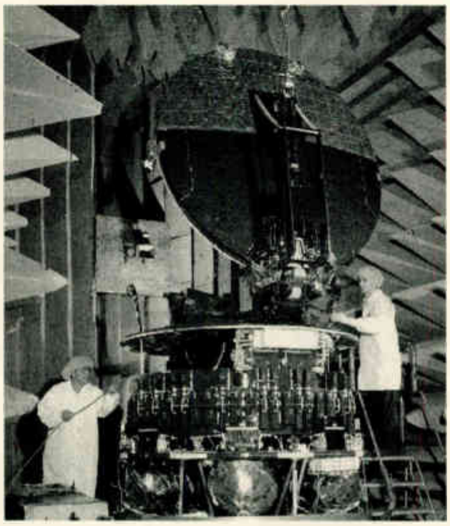
Originally airing on CBS in 1969 as *Scooby-Doo Where Are You?*, Scooby-Doo and its descendants comprise the longest continually running cartoon series in television history. The series has changed a number of times along the way, and included *The New Scooby-Doo Movies*, *The Scooby and Scrappy-Doo Show*, and *The New Scooby-Doo Mysteries*. According to the Cartoon Network, one of the stations airing the program, there have been 310 episodes in 19 program versions over 22 years. Among the voices heard on Scooby-Doo is that of Casey Kasem, who was the voice of Shaggy.

Third Place, But First Rate

My third place award goes to Rocky and Bullwinkle. Originally aired in the fall of 1959 as *Rocky and His Friends* on ABC, the show switched networks to NBC in the fall of 1961 and became *The Bullwinkle Show* where it continued until 1964. Rocky and Bullwinkle presented leading-edge wit and entertainment. It hasn't lost much in almost forty years since its debut; it's still one of the wittiest shows to grace the airwaves.

The late 1950s and the decade of the 60s were a scary time for children. It was the age of the cold war and the red menace, when communists stood ready to conquer and dominate the world. Then along came our two lovable heros, Rocket "Rocky" J. Squirrel and Bullwinkle the moose. And what could be more American than our heros' home town of Frostbite Falls, Minnesota.

It was no coincidence that the two villains in this series were named Boris Badenov and Natasha Fatale. Two more sinister Russian sounding names would be hard to find. Yes, it was our true red, white, and blue American heros, Rocky and Bullwinkle, against the Russian forces of darkness, Boris and Natasha. And truth and goodness always prevailed.



Hughes Galaxy I, home of the Cartoon Network, prepares for launch. (Credit: Hughes Aircraft Company, Space and Communications Group)

Rocky and Bullwinkle played out on two different levels: The cartoon itself dished up an enjoyable and entertaining story for kids. It also staged a satire, a higher level story and social commentary for adults. No topic was safe as the show poked fun at America's institutions and culture.

The adventures of Rocky and Bullwinkle were told in episodes which aired at the beginning and end of each half-hour program. Sandwiched in between were several gem-packed cartoons such as Dudley Do-Right. Dudley was a member of the Mounties and always stood for right and goodness. He continually pulled his girlfriend, Nell Fenwick, from the clutches of that evil-doer, Snidely Whiplash. Another of the cartoons, *Peabody's Improbable History*, taught history by punctuating a dose of education with humor and puns.

A Future Classic

Arthur, based on the book series written by Marc Brown is a modern day series that I think is headed for classicdom. The program's hero is Arthur, an adorable, human-like Aardvark. All of the children and adults on the program are cute and, although they act and stand like humans, they seem to have features from various members of the animal family.

Each *Arthur* program deals with a problem or situation that a child is likely to encounter. By watching the show and viewing how Arthur and his pals resolve their problems, children can learn by example. If my children's tastes are any measure of popularity, this show is destined to head toward the cartoon hall of fame.

Where Do You Find Them?

The list below includes some of the times and channels you may find these cartoon shows (All times Eastern Standard Time). Some channels may start their programming at 5 minutes after the hour or half hour. Consult your television programming guide for up to date listings. ST

The Flintstones			
Weekdays			
9:00-10:00 a.m.	TNT	Galaxy 5	channel 17
11:00-Noon	Cartoon Network	Galaxy 1	channel 8
8:30-9:00 p.m.	Cartoon Network	Galaxy 1	channel 8
11:30-Midnight	Cartoon Network	Galaxy 1	channel 8
Saturday			
7:30-8:30 a.m.	TBS	Galaxy 5	channel 6
8:00-8:30 a.m.	Cartoon Network	Galaxy 1	channel 8
3:30-4:00 p.m.	Cartoon Network	Galaxy 1	channel 8
6:00-6:30 p.m.	TNT	Galaxy 5	channel 17
Sunday			
8:00-8:30 p.m.	Cartoon Network	Galaxy 1	channel 8
Scooby-Doo			
Weekdays			
6:30-7:30 a.m.	TBS	Galaxy 5	channel 6
8:00-9:00 a.m.	TNT	Galaxy 5	channel 17
7:00-7:30 p.m.	Cartoon Network	Galaxy 1	channel 8
10:30-11:00 p.m.	Cartoon Network	Galaxy 1	channel 8
Saturday			
9:00-10:30 a.m.	Cartoon Network	Galaxy 1	channel 8
5:00-5:30 p.m.	TNT	Galaxy 5	channel 17
Sunday			
7:30-8:30 a.m.	TBS	Galaxy 5	channel 6

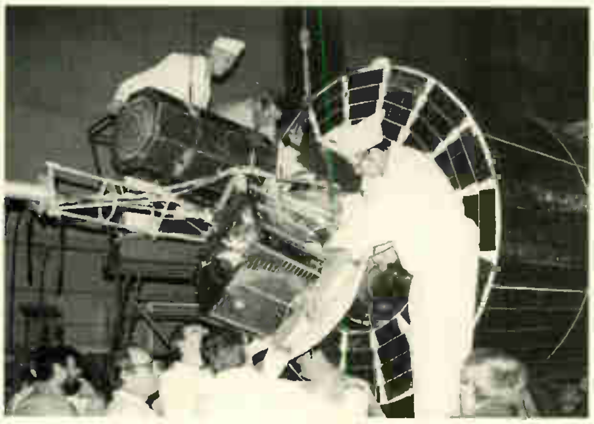
8:30-9:00 a.m.	Cartoon Network	Galaxy 1	channel 8
1:00-2:00 p.m.	Cartoon Network	Galaxy 1	channel 8
7:00-8:00 p.m.	Cartoon Network	Galaxy 1	channel 8
Rocky and Bullwinkle			
Monday			
5:00-5:30 a.m.	Cartoon Network	Galaxy 1	channel 8
Saturday			
11:00-11:30 p.m.	Cartoon Network	Galaxy 1	channel 8
Sunday			
11:00-11:30 p.m.	Cartoon Network	Galaxy 1	channel 8
Arthur			
Weekdays			
8:30-9:00 a.m.	PBS	Telstar T-4	channel 18
1:00-1:30 p.m.	PBS	Telstar T-4	channel 18
10:00-10:30 a.m.	KRMA	Satcom C-1	channel 3
2:00-2:30 p.m.	KRMA	Satcom C-1	channel 3
Saturday			
8:30-9:00 a.m.	PBS	Telstar T-4	channel 18
Sunday			
7:30-8:00 a.m.	PBS	Telstar T-4	channel 18
11:30- Noon		PBS	Telstar T-4
channel 18			
1:30-2:00 p.m.	KRMA	Satcom C-1	channel 3

By Donald E. Dickerson

Final Analysis FAISAT and Secondary Payloads

Final Analysis Inc. of Lanham, Maryland,recently announced that the FCC has granted a Section 319d waiver which allows them to construct the first two commercial satellites, at their own risk. The first two Faisats will be launched on a Russian Cosmos launch vehicle from the Plesetsk cosmodrome, 600 miles north of Moscow.

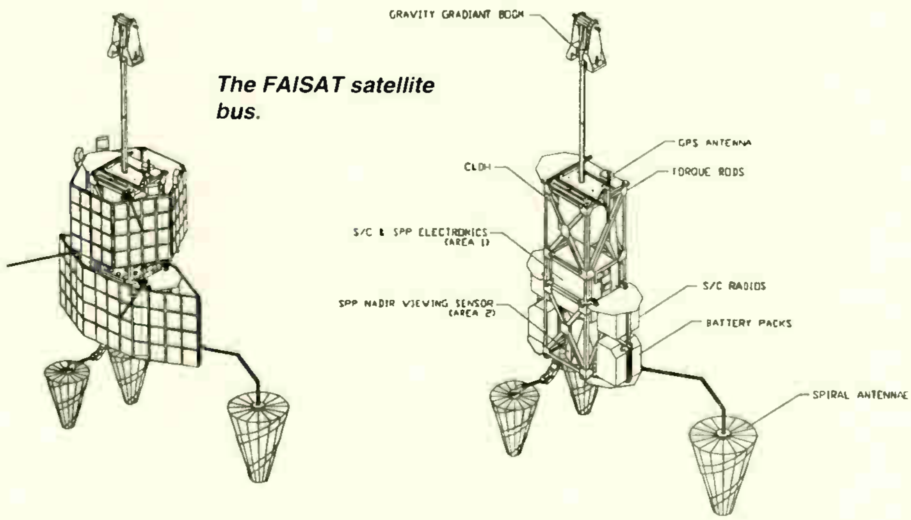
The Russian Cosmos launch vehicle is the world's most reliable rocket and Final Analysis. using it, plans to have a constellation of 30 satellites in orbit between 1998 and 2002. This constellation of satellites will support their low Earth orbit (LEO) data, paging, messaging and information system.



The FAISAT-1 (upper left cylinder) is integrated with the Russian Tsikada satellite prior to launch.

Final Analysis and the Russian company, Polyot, have signed an agreement which stipulates that Polyot provide the Cosmos launch vehicles for the 30 Faisat spacecraft. In return Final Analysis will build and provide support for a Russian ground station for the system. Polyot will be the only service provider for Final Analysis services in Russia.

The first two Faisat spacecraft will be launched with a Russian communication satellite. The next 28 satellites will be launched on four dedicated Cosmos missions which will each carry seven Faisat spacecraft.



The FAISAT satellite bus.

Final Analysis will launch two bus types:

1) a piggyback bus version designed to fly with the Russian satellite in the faring of the Cosmos launch vehicle, and
2) a dedicated bus version whereby seven Faisat satellites will complete the payload for each Cosmos launch vehicle.

The satellite will weigh in at 100 kg, have a gravity gradient boom, and deployable antennas. The spacecraft will use passive thermal controls (blankets, paint and insulation). It will be 1.8m in diameter and 6.8m in length. The version two model will be approximately twice the size of the first two Faisats which will be piggybacked on the Russian communications satellite.

Secondary Payloads

Final Analysis has also just announced plans for a low cost, low risk, secondary payload program. This program targets universities and scientists, NASA, DoD technology, and commercial space products industries as well as international space programs involved in space flight experiments.

The secondary payload program will be headed by Dr. Sam Durrance, former astronaut-payload specialist and long-time advocate of space commercialization. Dr. Durrance serves as director of science and technology at Final Analysis. Previously he served as research scientist at Johns Hopkins University.

Dr. Nader Modanlon, president and founder of Final Analysis, said, "Our success-on-orbit rate structure will achieve a new cost and risk paradigm to benefit NASA, DoD and American taxpayers. At the same time we are supporting commercial space development–an approach called for in the Administration's national space policy. We are delighted that Sam Durrance, a veteran of two space shuttle missions, will lead this innovative space program."

Investigators seeking to conduct science experiments with space-based sensors are provided with a turnkey mission capability, including integration into the satellite launch and mission operations and data acquisitions services. This service fits well with NASA's programs: Small Explorers (SMEX), University Explorers (UNEX), Earth Systems Science Pathfinder (ESSP), and Medium Explorer (MIDEX). Faisat offers a very high return-versus-cost ratio.

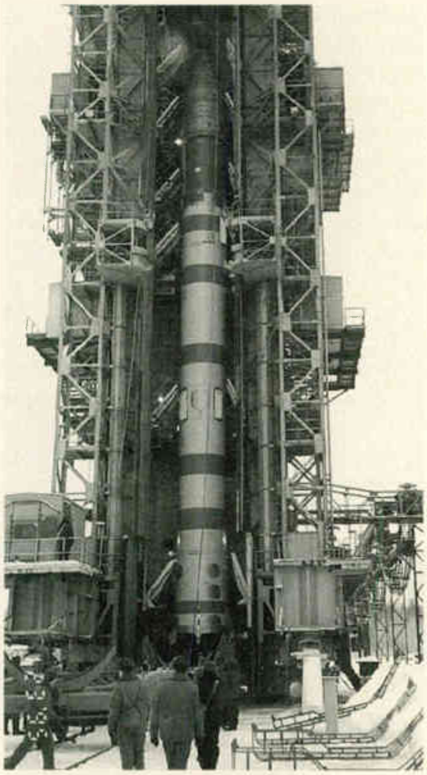
Developers of flight components and

systems are provided with an opportunity to flight-validate new components and systems in support of commercial sales, thereby reducing the risk for the first buyers of these components and systems. The program also allows the developers to collect long tern flight trends on the components and systems. Technology demonstrations on an operational mission is quick with rapid results and rewards. Final Analysis offers single or multiple flight opportunities structured to accommodate a wide range of missions.

The secondary payload program offers a complete set of services, including satellite, ground systems, and mission operations. Final Analysis integrates the delivered payload or design and builds the entire experiment to the developer's specifications. Standard services include; payload accommodations, satellite buss, launch and orbital placement, ground systems support, and one year operations and data acquisitions support.

Ground Segments

The Faisat satellites are controlled by and extensive ground segment operations team. Three initial ground stations are located at Lanham, Maryland; Logan, Utah; and Andoya Rocket Range, Norway. Additional stations will be established around



Russian Cosmos launch vehicle.

the world as the commercial services operation is expanded. Final Analysis provides basic mission operations and data acquisition services as part of its standard service for secondary payloads.

Experiment data can be downlinked to any of Final Analysis' ground stations, or low cost, remotely operated, customer-unique downlink sites can be provided. Data will be collected, level-zero processed, and be made available for the user via Internet or dial-in modem.

The mission operations room in Lanham, Maryland, houses the systems used to perform planning, scheduling, real-time satellite command and control, health and safety monitoring, performance trending, and flight software maintenance.

Real-time and stored-command capability is provided to secondary payloads at the rate of up to 25 stored commands per day, and up to four real-time command opportunities (approximately 10 commands per opportunity). Mission planning is provided with basic ephemeris, orbital event, and station acquisition information.

Secondary payloads on the version one spacecraft can weight up to 10 kg, consume 10 watts of power, and downlink 10 Mbytes of information per day. The version two spacecraft has the same downlink speed, but double the power consumption and weight limits are set at 25 kg.

The command and data handling system uses a RISC 6000 32-bit processor, 160 Mbytes onboard memory, LAN using packet data protocol, real-time and stored command capability, and uses GPS for time reference.

Attitude control system consists of gravity gradient stabilization, sun-pointed vertical solar arrays, magnetometers and torquers for attitude control, and gas jets for inplace orbit phasing for constellation adjustment.

The RF package consists of UHF/VHF, multi-channel, digital composite transceivers. Using the 150 and 400 MHz satellite bands. The uplink data rate is 19.2 kbps and downlink is 128 kbps (256 kbps on version 2 spacecraft. The spacecraft uses spiral and composite whip antennas and GMSK modulation.

Final Analysis has put together a comprehensive and diverse support program for both primary and secondary payload customers at very competitive prices. For more information on the Final Analysis secondary payload program services, call Dr. Durrance at (301) 459-0100 Ext.237 or via email at: **sdurrance@finalanalysis.com.**

TABLE 1

PCS Constellations Update, By Larry Van Horn

Ecco
Type: Big LEO;
Owners: Constellation Communications, Inc.
Launch Mass: 12 satellites total at 280 kg eachOperational: 2000
Orbital Configuration:Eleven equally spaced operational satellites and one spare in a circular (2000 km) 128 minute period equatorial orbit.

Ellipso
Type: Big Leo
Owners: Mobile Communications Holdings, Inc
Launch Mass: 17 satellites total at 700-800 kg each Operational: 2000
Orbitlal Configuration:Ellipso-Borealis constellation: Consist of two inclined (116°) planes. Each satellite will be in an elliptical orbit (7500 x 670 km, 178 minute period) with four operational satellites and one spare per plane.
Ellipso-Concordia constellation: Consist of six operational satellites and one spare in a circular (8060 km) 289 minute period equatorial orbit.

Globalstar
Type: Big LEO
Owners: Globalstar L.P. (Loral Space and Communications and QUALCOMM)
Launch Mass: 56 satellites total at 450 kg eachOperational: 1998
Orbital Configuration:Eight planes with six operational and one spare satellite per plane. Each satellite will be in a 1400 km circular orbit inclined 52° with a 114 minute orbital period.

ICO
Type: MEO
Owners: ICO Global Telecommunications
Launch Mass: 24 satellites total at 2450 kg eachOperational 2000
Orbital Configuration:Two planes with 10 operational satellites and two spares per plane. Each satellite will be in a 10300 km circular orbit inclined 45° with a 360 minute orbital period.

Iridium
Type: Big LEO
Owners: Iridium LLC (spacecraft built by Motorola)
Launch Mass:72 satelllites total at 689 kg each Operational 1998
Orbital Configuration:Six planes with 11 operational satellites plus one spare per plane. Each satellite will be in a 780 km circular orbit inclined 86° with a 101 minute orbital period.

Odyssey
Type: MEO
Owners: Odyssey Telecommunications Internationa, Inc. (TRW and Teleglobe, Inc)
Launch Mass: 18 satellites total at 2200 kg eachOperational 2001
Orbital Configuration:Three planes with four operational satellites and two spares per plane. Each satellite will be in a 10300 km circular orbit inclined 50° with a 360 minute orbital period.

ORBCOMM
Type: Little LEO
Owners: ORBCOMM (Orbital Sciences Corp and Teleglobe, Inc)
Launch Mass: 24 satellites total at 40 kg eachOperational: 1998
Orbital Configuration:Three planes with eight operational satellites per plane. Each satellite will be in a 770 km circular orbit inclined 45° with a 101 minute orbital period.

Teledisc
Type: Broadband LEOOwners: Teledisc Corp (Bill Gates and Craig McCaw)
Launch Mass: 288 plus satellites at less than 1500 kg each Operational: 2002
Orbital Configuration:12 planes with 24 operational satellites plus many spares in each plane. Each satellite will be in a 1350 km circular orbit inclined near 90° with a 113 minute orbital period.

SPECIAL REPORT

Dan Veeneman
dan@decode.com

PCS Takes Shape in 1998

The global satellite constellation Iridium took another step forward on November 8th with the launch of five additional satellites from Vandenberg Air Force Base in California. As of this writing 39 space vehicles are in orbit, although Motorola Satellite Communications reports that one of the previously launched satellites experienced an attitude control problem and is not expected to be included in the operational constellation. Since each of the six orbital planes envisioned by Iridium planners will contain a spare, this loss should not delay commercial service rollout scheduled for the third quarter of 1998.

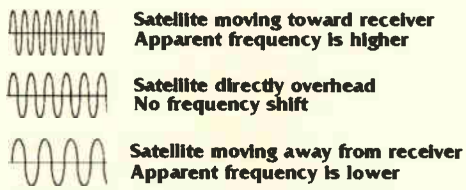
The Iridium satellite telephone network will operate using a slightly modified Global System for Mobiles (GSM) standard, incorporating their 1600 MHz transceiver into a multiband GSM handset. Customers will use the handset over 900, 1800, and 1900 MHz GSM terrestrial networks, switching to the Iridium satellites when no such local system is available. Subscribers will contract with their local GSM carrier to automatically roam on the Iridium system, which is expected to cost in the range of $3 per minute.

Globalstar, another satellite-based voice service provider, announced their first launch is now scheduled for February of 1998, eight weeks later than previously expected. The postponement is apparently to allow additional time for testing and rehearsals of the ground equipment that will provide tracking, telemetry, and control (TT&C) for the 56 low earth orbit (LEO) satellites.

Little LEOs

While Iridium and other voice service Big LEO satellite systems gather headlines, they may soon be sharing the spotlight with their less expensive counterparts. Termed Non-Voice Non-Geosynchronous (NVNG) systems by the Federal Communications Commission, these Little LEOs utilize constellations of smaller, less costly satellites to

Doppler Frequency Shift



provide low speed, low volume digital wireless links. Using small, inexpensive user terminals, little LEOs are poised to provide such services as vehicle tracking, two-way data messaging and electronic mail, routine and emergency position location, remote environmental monitoring, and security warnings.

A Report and Order released by the FCC in October specifies a number of operational rules and frequencies for five Little LEO systems, all of which will transmit and receive on VHF and UHF frequencies. Of the five, Orbcomm and VITA are already licensed and operating, Orbcomm with two satellites in orbit and VITA with one launched last September. Three newer entrants, LEO One, Final Analysis, and E-Sat, are preparing for construction and launch.

All five will share the same slice of spectrum, 148 MHz to 150 MHz for the uplink (Earth to space) as well as 137 MHz to 138 MHz and 400 MHz to 401 MHz for the downlink (space to Earth). This band of frequencies is already fairly crowded, with National Oceanic and Atmospheric Administration (NOAA) and Department of Defense (DoD) weather satellites transmitting in the 137 MHz and 400 MHz bands, respectively. Russian and French satellites also use this part of the spectrum, adding to complexity of frequency coordination.

Because geosynchronous satellites orbit 22,000 miles above the Earth and make one rotation every 24 hours, they appear to be stationary in the sky, "hanging" above a particular spot. Low earth orbiting satellites operate much closer to the earth, at altitudes from a few hundred to several thousand miles and complete an orbit many times each day. Because these satellites are moving so quickly, spectrum allocations must also take into account an effect called Doppler, which is the apparent change of transmitted frequency due to the motion of the satellite. A stationary receiver listening to a satellite moving overhead will experience a change in frequency, higher as the satellite approaches and lower as the satellite moves away. Doppler for a single beam from a Little LEO is expected to be on the order of 5 to 10 kHz, requiring a shift up or down in receiver tuning depending on the location of the receiver and the motion of the satellite.

A comprehensive plan proposed by the participants and ordered by the FCC distributes the available spectrum among each Little LEO and requires each operator to avoid interfering with the transmissions of government satellites. Accurate orbital locations and movement information ("ephemeris" data) will be collected and processed to predict their coverage areas ("footprints" in satellite parlance) up to week in advance, and where overlaps occur the Little LEO satellite must change operating frequencies or not transmit at all. In addition, to insure a failure will not create havoc, each satellite must have a fail-safe mechanism by which it will cease transmitting if a "reset" signal is not received from the ground every 72 hours.

TABLE 1: Little Low Earth Orbit (LEO) systems

SYSTEM	SATELLITES (Planned)	MODULATION METHOD	EXPECTED COST ($ millions)
E-Sat	6	CDMA	50
Final Analysis	26	FDMA/TDMA	250
LEO One	48	FDMA/TDMA	250
Orbcomm	28	FDMA/TDMA	350
VITA	2	FDMA/TDMA	10

by Wayne Mishler, KG5BI

New Astronomy Telescopes Debut

What? You didn't get that new telescope for Christmas? And it's 12 whole months until Santa's next visit? Is that's what's bothering you, Bunky?

Well, cheer up and check out *Sky & Telescope's* web site: **http://www.skypub.com/**, which lists seven new models of telescopes, and more accessories than you can count on your fingers and toes.

For example, check out the specs on an Orion VX GP refractor. The optics are housed in a seamless aluminum tube fitted with a large dew cap on one end, and a smooth, 1.25 inch, rack-and-pinion focuser on the other. The tube assembly attaches to the GP equatorial mount in seconds via a meshed dovetail fitting. This advanced German-type mount is a masterwork of precision engineering. Its cast-aluminum construction provides rigid stability, yet it moves smoothly on both axes.

The aluminum tripod provides solid support. It has adjustable legs and comes with a deluxe accessory tray. Optional right ascension and declination motors and controller can be added for automatic tracking and guiding. If the $1,049 price tag is too astronomical for your budget, there are six other new models to tempt you.

And if buying a new factory-made telescope is out of the question this year, why not build your own? You can, you know, with some help from books you'll find listed in Sky Publishing Corporation's 1998 catalog.

Those are only a few of the astronomy books, videos, globes, posters, software, CD-ROMs, slide sets, star atlases, and planispheres listed in this year's catalog. You can get your copy by calling *Sky and Telescope* at 800-253-0245. Outside the U.S. and Canada, call 1-617-864-7360.

Radio Shack Offers Satellite TV Systems and Accessories

RadioShack now offers private-label, direct-to-home satellite products including Optimus and RCA brands. Its DSS product line includes the new Optimus 5100 digital satellite system known for its CD-quality sound and laserdisc-quality reception. Programming options include access to premium channels, pay-per-view movies, sports, and specials. Parental channel lockout and StarSight direct tuning to a desired channel by program title are also available.

The user-installable Optimus DSS System 5100 is capable of receiving DirecTV and USSB programming with more than 200 channels. RadioShack's suggested retail price for the complete system, including 18-inch mini-dish, set-top receiver and remote, is $299.99.

RadioShack also offers instructional material including a booklet entitled, *Installing TV/Video Systems* which gives you tips on mini-dish satellite systems, TV antennas, and multi-room installations. The 128-page booklet is fully illustrated with specific hookup examples and is available from RadioShack for $7.99.

Looking for a direct TV antenna for your recreational vehicle or van? RadioShack's got 18-inch dishes that crank up and down from within the vehicle.

Tired of snow and ice covering your dish and ruining your signal? Forget slipping and sliding around on your roof. Try RadioShack's Peel 'n Stick heating elements for DSS dishes. They stop ice and snow buildup, and come with a 75-foot hook-up cable and power supply.

And how about an extra dish for the traveler? You guessed it: RadioShack has one you can take almost anywhere. Includes the 18-inch dish, of course, and LNB, mounting bracket, wall mount for an RV or vacation home, and a 25-foot hookup cable. It even comes with installation tools and a travel bag.

Say you need a new LNB? Check with RadioShack for replacements and upgrades.

And if you think your C- or Ku-band satellite system is obsolete, RadioShack has news: They'll tell you that a big-dish satellite system is still a good investment. They'll sell you one if you want, and they have replacement parts if you need them. They offer big-dish systems up to 10-feet in diameter, which are useful in the northwest, northeast, and southeast extremities of the U.S..

You'll find all this and more at your local RadioShack store, or in their full-color, 305-page, 1998 *ANSWERS* catalog.

New Atlas Features Results of Hipparcos Study

In June, 1997, the European Space Agency (ESA) published the long-awaited results of its Hipparcos astrometry mission. Launched in 1989, the Hipparcos satellite spent more than three years measuring stellar positions, brightness, and distances with unprecedented accuracy. After several additional years of painstaking data analysis, astronomers are now sharing with the world the scientific discoveries of this historic mission. Hipparcos documented more than 118,000 stars.

Another study, the Tycho Catalogue, provides data for more than a million stars, with precision measured in tenths to hundredths of an arcsecond of magnitude.

In collaboration with ESA's Hipparcos Project, *Sky & Telescope* has introduced the first all-sky atlas based on the new data from

SPACE WATCH

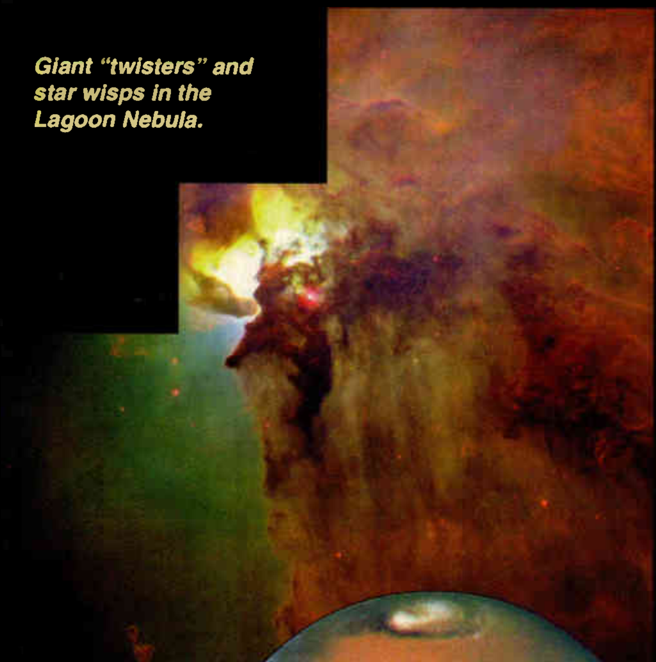
By Larry Van Horn

Hubble's 1997 Gallery: *ST's* Top Ten

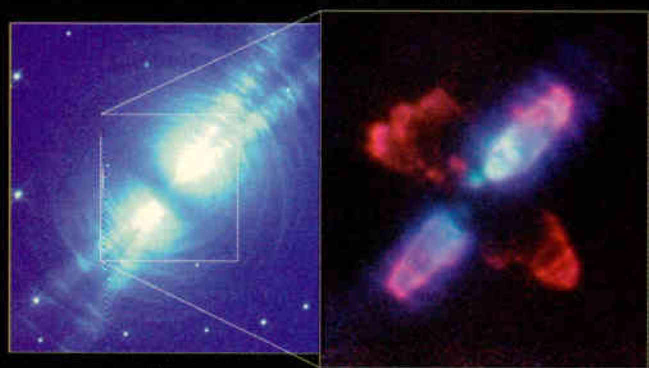
The Hubble Space Telescope has concluded another year of exciting science and discovery. This month's Space Watch presents the top ten images of 1997. All photos courtesy of the Space Telescope Science Institute and NASA.

Right: Destruction of circumstellar disks in Orion's Trapezium.

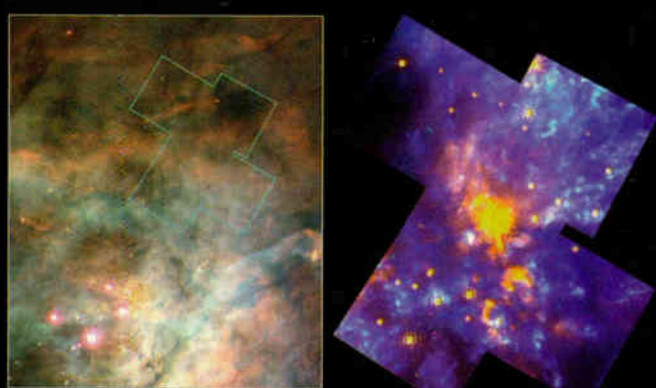
Giant "twisters" and star wisps in the Lagoon Nebula.



Hubble's sharpest view of Mars.



Hubble peers into the heart of a dying star (above) and....



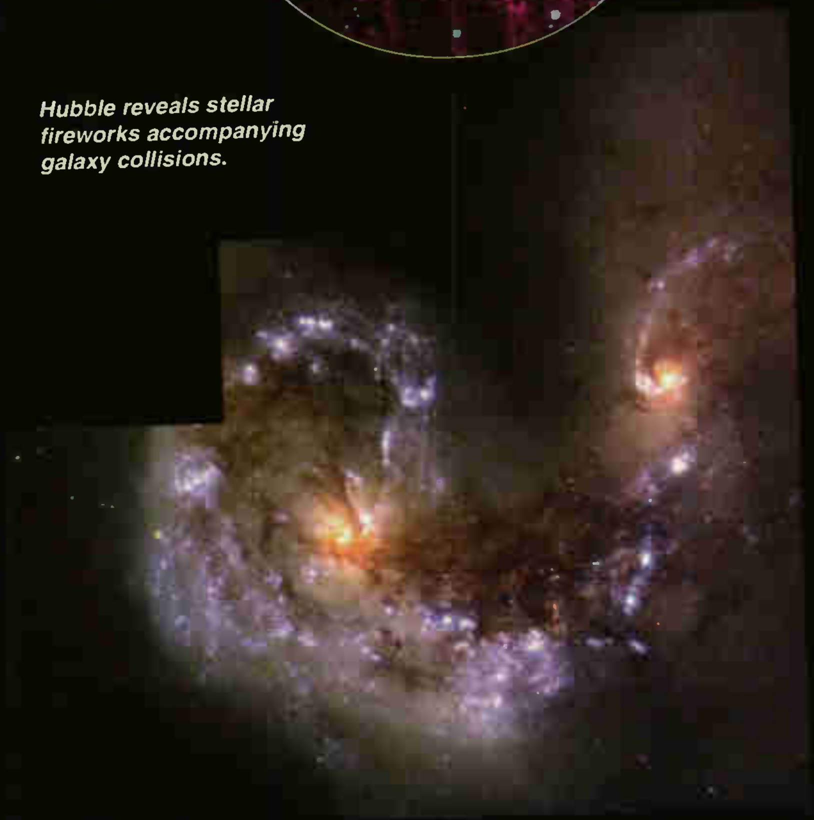
...captures the heart of OMC-1.

Hubble captures volcanic eruption plume from Io.

Left: Hubble uncovers brilliant star in Milky Way's core.

Above: Hubble astronomers use lens in nature to uncover most distant galaxy in the universe.

Hubble reveals stellar fireworks accompanying galaxy collisions.



Hubble takes first peek at Uranus and tracks clouds.

By Larry Van Horn

Kennedy Space Center, Florida

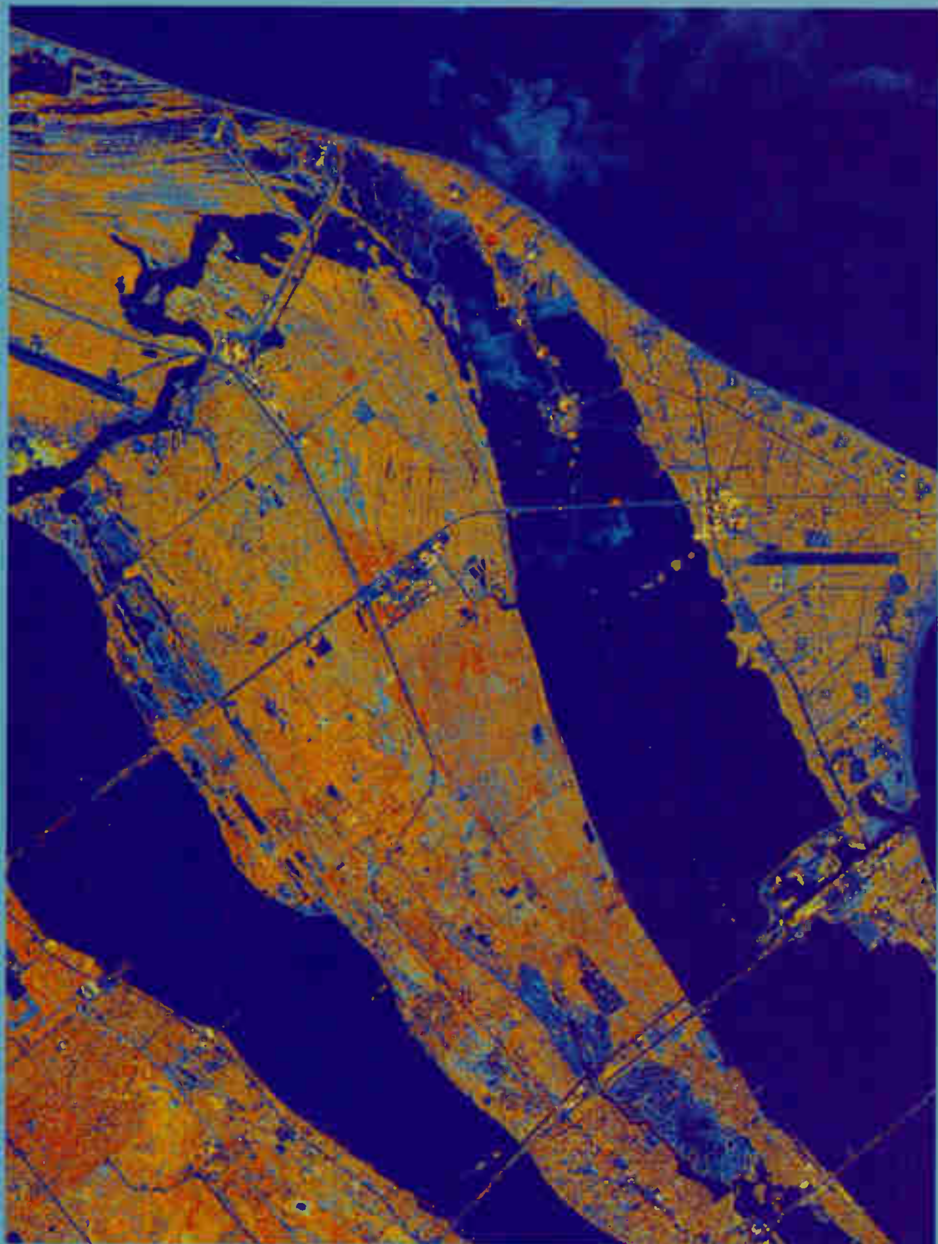
This radar images shows the east coast of central Florida, including the Cape Canaveral area. The Indian River, Banana River and the Atlantic Ocean are the three bodies of water (shown in deep blue) from the lower left to the upper right of this false color image. Parts of NASA's John F. Kennedy Space Center (KSC) and the Cape Canaveral Air Station (CCAS) are visible.

KSC occupies much of Merritt Island in the center of the image, as well as, the northern part of Cape Canaveral along the right side of the image. The light blue areas on Cape Canaveral are the launch pads used by NASA and the Air Force. The two pads in the upper left of the image (light blue hexagons with bright yellow areas in the middle) are Launch Complex 39 pads A and B, originally designed for the Apollo program and now used by the space shuttle. The other launch pads that dot the coastline are part of the CCAS and are used to launch robotic spacecraft, like the Cassini mission to Saturn

Two runways also appear as dark lines in the image. The runway in the upper left is part of the space shuttle landing facility and it is one of the longest runways in the world at 15,000 feet (4,572 meters) long and 300 feet (91.4 meters) wide. This image is centered at 28.5 degree north latitude, 80.63 degrees west longitude. The area shown is approximately 14 miles by 20.5 miles (23 kilometers by 33 kilometers).

North is toward the upper left. Colors are assigned to different frequencies and polarizations of the radar as follows: red is L-band vertically transmitted and received; green is C-band vertically transmitted and received; and blue is the difference of L-band and C-band.

This image was acquired by the Spaceborne Imaging-C/X-Band Synthetic Aperture Radar when it flew aboard the shuttle Endeavour on Oct. 4, 1994. SIR-C/X-SAR is a joint mission of the U.S./German and Italian space agencies.



Spaceborne Imaging Radar-C and X-Band Synthetic Aperture Radar (SIR-C/X-SAR) is part of NASA's Mission to Planet Earth. The radars illuminate Earth with microwaves allowing detailed observations at any time, regardless of weather or sunlight conditions. SIR-C/X-SAR uses three microwave wavelengths: L-band (24 cm), C-band (6 cm) and X-band (3 cm). ST

Avcom PSA65C Spectrum Analyzer

Anyone who has been exposed to radio reception for very long eventually comes across the spectrum analyzer, a handy tool for adding vision to hearing for acquisition of signals. Spectrum analyzers graphically represent a large chunk of radio spectrum as a left-to-right baseline across the screen, low frequencies to the left and high frequencies to the right; active signals pop up as peaks or "spikes" on the screen, relative to their position in the spectrum.

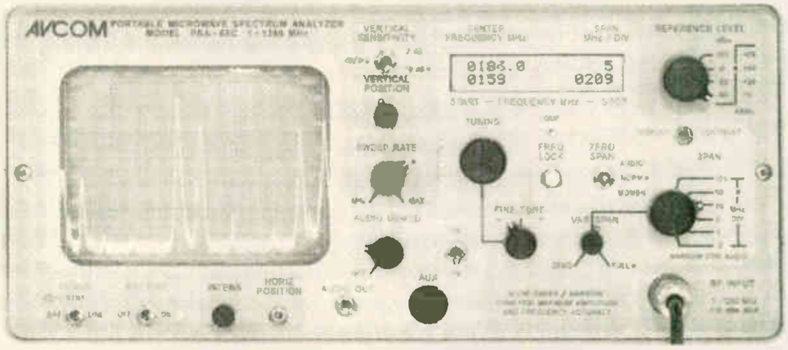
For example, if you are "looking" at signals between, say, 88 and 174 MHz, you would see tall spikes clustered at the left representing powerful FM broadcasters, and somewhat reduced spikes between 150-174 MHz where the land mobile radio services operate.

More advanced models include FM or even AM detectors to enable the spectrum analyzer to hear the communications for their identification. A digital frequency display helps nail down the unknown even further.

The spectrum analyzer is the one instrument valued most by technical surveillance countermeasures (TSCM) specialists — "debuggers" who offer their services to "sweep" offices, homes, industrial installations, and other vulnerable targets of eavesdroppers. A quick look at the screen, and roughly 99% of the surreptitious radio transmitters in use can be spotted.

Spectrum analyzers are also invaluable for field testing radio frequency (RF) systems, antennas, aligning satellite systems, cable TV maintenance, electronic R&D labs, manufacture and production, and for technicians of cellular, trunking, and conventional two-way radio systems.

Arguably, the most popular, low cost spectrum analyzer on the market is the AVCOM PSA65C (upgraded from the former PSA65A). With competitive units selling upwards of $10,000 and more, the basic AVCOM costs less than $3000. It provides 1-1250 MHz frequency coverage (extendable to 200 kHz-4200 MHz



with optional accessories); AM and FM demodulators may be purchased separately for audio recovery of signals.

The amount of spectrum which can be displayed at one time (span) is variable from 0-1250 MHz. Sensitivity is on the order of -95 dBm, roughly 3-4 microvolts, adequate for general signal detection and monitoring. The optional FM and AM demodulators are rather wideband, but do a reasonable job on stronger narrowband signals which aren't too closely spaced in the spectrum.

The spectrum analyzer can also be used as a spectrum display unit with any receiver equipped with an IF output, such as the popular ICOM R7000, R7100, R8500, and R9000 series, as well as the AOR AR3000 and AR5000 receivers.

Front panel controls include a calibrated attenuator and span selector, as well as scope adjustments.

The unit is powered by 120 VAC, an external source of 12 VDC, or its own internal rechargeable battery, good for a half hour or more. The well shielded, metal cased AVCOM weighs a hefty 18 pounds and measures 11-1/2"W x 5-1/2"H x 13-1/2"D. A BNC connector is provided for antenna attachment.

Frequency readout is provided by a backlit, microprocessor-controlled LCD; accuracy is only good to about one decimal place (roughly 100 kHz), but usually adequate to identify the likely signal. The display also reads span and start/stop frequencies. Although the VCO does drift, strong signals may be stabilized for monitoring by digital frequency lock function. There is no memory storage.

The Bottom Line

Scanner and shortwave listeners will find the PSA65C very handy, but a little obstinate to use. A tiny touch of the main tuning knob skews the dial far in frequency; although a second (fine tuning) knob is provided. Signals do drift, requiring retuning. Wide bandwidth means stronger signals are favored at the expense of weaker signals. The AVCOM is heavy and big. Dial accuracy of +/-100kHz is rather coarse compared to the high-resolution readouts available on scanners and communications receivers. You can't sweep a spectrum and hear a signal at the same time.

On the other hand, a combination wide-coverage receiver and matching spectrum display unit (SDU) can provide better single-signal reception and finer frequency readout, but it represents two pieces of expensive equipment, and the span of such combinations is limited to a mere 10 MHz maximum, compared with more than 1000 MHz on the AVCOM.

Keep the spectrum analyzer in perspective. It is not intended to replace a communications receiver, it is designed to give a visual command of the entire spectrum and allow monitoring of signals present. And in that respect, the AVCOM PSA65C probably delivers the biggest bang for the buck.

(Contact Grove Enterprises for pricing with accessories)

By Steve Dye, gpsyes@aol.com

2000 and Then? A Space Oddity

Two thousand–the most loved number this decade. It seems we can not escape any news item that reports the shortcoming of most software packages that refuse to acknowledge the year 2000 will happen.

It's not that software and Nostradamus have been working together; programs that currently use a 2 digit field to indicate the year will display 00 for the year 2000. This will wreak havoc in any system that calculates an item's age, for instance. If 2000 is represented as 00, it will think that the year 2000 is in fact 1900 as it only works with the last two digits. Woops!

So, what has this to do with GPS? Well, nothing escapes the wrath of the year 2000, and GPS is no exception. Of the Defense Department's myriad of systems, the Global Positioning System is the most vulnerable to malfunction and most likely to suffer devastating consequences due to year 2000 code problems unless resolved.

GPS has proliferated so much this decade that its civil operations are as important as its military applications. We all rely on GPS now whether we know it or not. People and industry depend on GPS far beyond anybody's expectations, and the DOD are taking this matter very seriously.

GPS, in its intended military role, is becoming more and more dependent on the Navstar system. Even though the military should never become 100 percent reliant on any given system, GPS is worming its way into becoming the one.

So irresistible is it's attraction, the Department of Defense (DoD) plans for all military aircraft to use GPS for navigation by the year 2000. Additionally the military's growing dependence on GPS-guided smart bombs have heightened Pentagon concerns about the vulnerability of the navigation system to year 2000 glitches.

GPS was first showcased during Operation Desert Storm, and has become the source for precise and accurate targeting information for the Tomahawk cruise missile, Joint Direct Attack Munitions, Army Tactical Missile System and Joint Standoff Weapon.

The GPS year 2000 problem is threefold and reflects the three components of the navigation system:

1 The space segment
2 The ground control segment
3 The user segment

For those new to GPS, it consists of 24 operational Navstar satellites in six orbital planes that continuously broadcast navigation signals to ground stations placed at known locations. These ground stations feed back corrective information based on their known locations to the constellation. Specialized computers built into inexpensive, portable GPS receivers in turn derive highly accurate position and velocity information by quantifying the transit time and hence distance from each satellite it can see.

According to documents provided to Congress, the year 2000 problems within the space segment can be found in two pieces of ground equipment: the Bus Ground Support Equipment vehicle checkout stations and the Boeing Mission Operation Support Center (MOSC). Software to correct the year 2000 problem in the Bus Ground Support Equipment vehicle checkout stations already exists, and the DoD will install it during the normal systems maintenance lifecycle.

The MOSC date code problem exists in its underlying commercial products. The DoD will replace MOSC with the Integrated Mission Operation Support Center (IMOSC), which it expects to finish in December 1999. (Let's hope for no delays there)! The IMOSC project is part of a $1.3 billion GPS Block IIF satellite contract that the DoD awarded to Boeing Co. in April 1997–or should that have been 1997?

The GPS ground control segment consists of six monitor stations, four ground antennas and a master control station. The software needing date code correction generates the uplink code to the satellites. This software was coded in the 1970s and uses only two-digit date fields. GPS JPO officials have decided to rewrite some of the existing legacy code for the ground control segment at a cost of $7.6 million. Lockheed Martin Federal Systems has been assessing the code and will rewrite it under an existing maintenance contract.

Until then, GPS JPO will incrementally integrate modifications as part of its normal software maintenance releases.

Though the GPS user segment does not have a year 2000 problem *per se*, it does have a clock overflow problem. This is part of the embedded operating system in GPS and is known as the Z-count rollover. This rollover occurs every 1,024 weeks: the first one comes in August 1999. The Z count was zero at GPS' System Time start in 1980 when 2000 seemed oh-so far away.

GPS' System Time origin is, 00:00:00 UTC 6 January 1980, which is Julian Day 2,444,244.500. A GPS Cycle is 1,024 weeks, or 7,168 days, so the first GPS rollover will occur at Julian Day (2444244.5+7168)= 2,451,412.5, which is 00:00:00 UTC 22 August 1999 AD, being midnight between Saturday night the 21st of August, and Sunday morning the 22nd of August, 1999. On 22 August 1999, unless repaired, many GPS receivers will claim that it is 6 January 1980 again. The 23rd of August will become 7 January, and so on. Accuracy of navigation may also be severely affected.

Although GPS broadcasts do contain sufficient data to ensure that navigation need not be affected by rollover in 1999, it is not proven that the firmware in all receivers will handle the rollovers in stride; some receivers may claim wrong locations in addition to incorrect dates. Having said that, some manufacturers have already solved the problem, but not all. I am currently researching this and will provide readers of *ST* with updates on the situation.

The GPS user segment consists of the antennas and receiver-processors that provide positioning, velocity and precise timing to the users, such as the Army handheld GPS receivers and Navy shipboard receivers, as well as all the civilian users in the world, be they pilots, hikers, mariners or elephants in Africa being tracked by game park wardens. Although GPS JPO established specifications for GPS receivers, some manufacturers did not account for the Z-count rollover in the satellites' atomic clocks, which essentially synchronize the navigational signals.

So, if you are the proud owner of a GPS receiver, just how well will it work in August 1999? Watch this column for more updates on the year 2000 problem.

TABLE 1: Russian GLONASS Constellation Status

Courtesy of Richard B. Langley

GLONASS Numbers	Kosmos Numbers	Intl ID	NORAD Catalog	Plane Number	Channel Almanac Launch Date Number	(Date (Slot)	Status	(UTC) withdrawn)
49 249	2111	1990-110C	21008				8-Dec-90	15-Aug-96
50 750	2139	1991-025A	21216				4-Apr-91	14-Nov-94
51 753	2140	1991-025B	21217				4-Apr-91	4-Jun-93
52 754	2141	1991-025C	21218				4-Apr-91	16-Jun-92
53 768	2177	1992-005A	21853				29-Jan-92	29-Jun-92
54 769	2178	1992-005B	21854				29-Jan-92	25-Jun-97
55 771	2179	1992-005C	21855				29-Jan-92	21-Dec-96
56 774	2206 (2204)	1992-047A	22056			30-Jul-92	26-Aug-96	
57 756	2204 (2205)	1992-047B	22057			30-Jul-92	4-Aug-97	
58 772	2205 (2206)	1992-047C	22058			30-Jul-92	27-Aug-94	
59 773	2234	1993-010A	22512				17-Feb-93	17-Aug-94
60 757	2236 (2235)	1993-010B	22513			17-Feb-93	23-Aug-97	
61 759	2235 (2236)	1993-010C	22514			17-Feb-93	4-Aug-97	
62 760	2276 (2275)	1994-021A	23043	3	24	17	11-Apr-94	OK
63 761	2277 (2276)	1994-021B	23044			11-Apr-94	29-Aug-97	
64 758	2275 (2277)	1994-021C	23045	3	10	18	11-Apr-94	OK
65 767	2287	1994-050A	23203	2	22	12	11-Aug-94	OK
66 775	2289 (2288)	1994-050B	23204	2	22	16	11-Aug-94	OK
67 770	2288 (2289)	1994-050C	23205	2	9	14	11-Aug-94	OK
68 763	2295 (2294)	1994-076A	23396	1	21	3	20-Nov-94	OK
69 764	2296 (2295)	1994-076B	23397	1	13	6	20-Nov-94	OK
70 762	2294 (2296)	1994-076C	23398	1	12	4	20-Nov-94	OK
71 765	2307	1995-009A	23511	3	1	20	7-Mar-95	OK
72 766	2308	1995-009B	23512	3	10	22	7-Mar-95	OK
73 777	2309	1995-009C	23513	3	3	19	7-Mar-95	UNH
74 780	2316	1995-037A	23620	2	4	15	24-Jul-95	OK
75 781	2317	1995-037B	23621	2	9	10	24-Jul-95	OK
76 785	2318	1995-037C	23622	2	4	11	24-Jul-95	OK
77 776	2323	1995-068C	23736	2	6	9	14-Dec-95	OK
78 778	2324	1995-068B	23735	2	11	9	14-Dec-95	Res
79 782	2325	1995-068A	23734	2	6	13	14-Dec-95	OK

Notes:
1.NORAD Catalog Number is also known as U.S. Space Command (USSPACECOM) object number and NASA catalog number.
2. The numbers listed first in the "Kosmos Numbers" column are the designators assigned by the Russian Federation. Where these differ from the designators assigned by the United States, the latter are given in parentheses.
3. Channel number, k, indicates L1 and L2 carrier frequencies:
L1 = 1602. + 0.5625 k (MHz)
L2 = 1246. + 0.4375 k (MHz)

4. Status codes:
Res = satellite not in service but held in reserve
OK = satellite fully operational.
UNH = satellite currently flagged unhealthy.
The date listed is the date the satellite was removed from service (Moscow Time) as reported by the Coordinational Scientific Information Center, Moscow.
5. All GLONASS satellites employ cesium atomic clocks.
6. The first GLONASS satellite was launched on 12-Oct-82. GLONASS 1 through 61 are no longer in service.
7. GLONASS 40 and 41 were launched with the Etalon 1 laser ranging satellite. GLONASS 42 and 43 were launched with Etalon 2.
8. The GLONASS numbering scheme used in this table includes the 8 "dummy" satellites orbited as ballast along with "real" satellites on the first 7 GLONASS launches. The second number in the "GLONASS Numbers" column is that assigned by the Russian Space Forces.
9. New GLONASS channel allocations were introduced in September 1993 aimed at reducing interference to radio astronomy. Note the use of the same channel on pairs of antipodal satellites.
10. The most recent triple GLONASS launch took place on 14-Dec-95. GLONASS 776 (in slot 9) became operational on 7-Jan-96 (ref. NAGU 089-960109), GLONASS 782 (in slot 13) became operational on 18-Jan-96 (ref. NAGU 093-960118). GLONASS 778 is a spare. The next triple launch is scheduled for 4 December 1997.
11. GLONASS 769 (in slot 8) had been reported as unhealthy since 23-May-97 (ref. NAGU 039-970526) and was withdrawn from service on 25-Jun-97 with the end of all operations (ref. NAGU 054-970625).
GLONASS 771 (in slot 1) had been reported as unhealthy since 25-Oct-96 (ref. NAGU 218-961031) and was withdrawn from service on 21-Dec-96 with the end of all operations (ref. NAGU 240-961223).
GLONASS 756 (in slot 21) had been reported as unhealthy since 27-Jun-97 (ref. NAGU 058-970630) and was withdrawn from service on 4-Aug-97 (ref. CSIC).
GLONASS 757 (in slot 2) had been reported as unhealthy since 27-Jul-97 (ref. NAGU 071-970728) and was withdrawn from service on 23-Aug-97 with the end of all operations (ref. NAGU 075-970825).
GLONASS 759 (in slot 7) had been reported as unhealthy since 30-Jun-97 (ref. NAGU 059-970630) and was withdrawn from service on 4-Aug-97 (ref. CSIC).
GLONASS 761 (in slot 23) had been reported as unhealthy since 24-Jul-97 (ref. NAGU 070-970728) and was withdrawn from service on 29-Aug-97 (ref. CSIC).
12. Number of GLONASS satellites currently operating: 15
13. Status of satellites obtained from Peter Daly, CAA Institute of Satellite Navigation, Dept. of Electronic and Electrical Engineering, University of Leeds (pd@elec-eng.leeds.ac.uk); Michael G. Lebedev, Coordinational Scientific Information Center, Russian Space Forces (sfcsic@iki3.iki.rssi.ru); and from the Massachusetts Institute of Technology Lincoln Laboratory GLONASS Group. Compiled by Richard B. Langley, Dept. of Geodesy and Geomatics Engineering, University of New Brunswick.

LATIN AMERICAN CHANNEL LINE-UP FOR PAS-5

- HBO Ole
- Animal Planet
- Associated Press Television
- CBS Telenoticias
- ESPN International
- Eurochampions
- MGM Gold Brazil
- Television Nacional de Chile
- Universidad Catolica de Television
- Mujer International, Fashion and Bravo
- The Weather Channel Latin America

be paying off. One gets the feeling that there are even better things to come. With aggressive positioning in the new market for DTH satellite TV in Latin America, PanAmSat could have a most impressive revenue stream for the next 10 to 15 years.

PanAmSat is no stranger in service to Latin America. In 1989 CNN became PanAmSat's first customer, broadcasting news to the Americas. Now, in addition to the services listed above (see chart 2), PAS-5 will be home to Sky Latin America's DTH service to Mexico. Sky Latin America, using 12 Ku-band transponders onboard PAS-5, is a consortium comprised of News Corp. (FOX etc.), Grupo Televisa, Organizacoes Globo, and Tele-Communications International, Inc. — all major players in Latin American television programming.

PAS-6, which was launched just weeks before PAS-5, features 36 Ku-band only transponders and is entirely given over to Sky Latin America, the DTH service for all of Latin America.

Tuning In

Viewing PAS-5 or any of the other satellites east of Galaxy 6 is easy if you have a 36" actuator arm or a horizon-to-horizon mount. Either will allow the dish to "look" as far to the east as your immediate surroundings permit. And there's the next problem: Most C-band installations are made with the only concern being how well the Clarke Belt from G6 to C1 is seen (basically from due south to due west). If you have obstacles in the way, don't despair, there may still be enough signal coming through to provide adequate viewing. Still, the more interesting satellites are quite a ways down on the horizon. You may have to consider doing a little tree trimming.

Even if you have an 18" actuator arm you can still view the Atlantic birds. First, you'll need a friend willing to be a human actuator arm while you make adjustments on your dish. Next, you'll need to turn the dish to C1. This will cause the arm to fully retract. Take a felt marker and mark both sides of the actuator arm clamp. Now, have your friend support the dish while you loosen the clamp which holds the outer sleeve of the actuator arm still while the inner sleeve turns the dish.

CAUTION: When you loosen this clamp the whole weight of the dish will want to drop down. That's why you have your friend there to support it. If you have a fiberglass dish you may need two friends. I've done this by myself using a cement block under the dish to assure it doesn't fall down and bend the rim.

Next, gently shove the arm up through the clamp about two feet. This will cause the whole dish to move east as if driven by the motor. Your friend can assist by gently raising the edge of the dish up as you push from the actuator arm. Tighten the clamp. Your receiver is convinced that the dish is still pointed at F1, but in reality it's somewhere around Galaxy 6.

If you go back into the house and move the dish east or west you'll soon discover just where you are. Don't use the menu to position the dish as the receiver still thinks it's looking at C1. Instead, use the East or West buttons on the receiver to move the dish east from where it is. Do it slowly until you come to a satellite you recognize. G6 is easy: Just look for the ubiquitous Dr. Scott on channel 19.

Move the dish slowly east, stopping every 10 counts to run through the channels. Switch to the Ku-band and run through those channels as well. To help locate unknown satellites, it's useful to know how many actuator counts per degree of travel your dish uses. For instance, if your receiver indicates that Galaxy 1 is at 1016 counts (as seen on the on-screen display) and that F3 is 1000 counts, that indicates that there are 16 counts between the two satellites. Since we know that G1 and F3 are separated by 2 degrees, we know that your receiver travels 8 counts for each degree.

Therefore, if your dish is on G6, which we know is at 74 degrees, and you're trying to find PAS-5 at 58 degrees, you must move the dish 16 degrees east to find PAS-5. Since we know that your dish travels 8 counts per degree, you must move your dish 128 counts. It should be right there! Keep in mind that every receiver/dish combination may have a different counting method, so do the math on your own dish.

To return your dish to normal operations retract the arm by pressing the west button until the arm is fully retracted. Once again, have your friend stand by to support the dish. Loosen the clamp again and let the actuator arm slide through the clamp until it is exactly between the two marks you made earlier. It's just that simple.

Make it a practice to periodically return to these easternmost satellites. You will be amazed at what you'll find. Don't forget to tune around the SCPC frequencies, too. On PAS-5 I found a Spanish language charismatic Catholic FM radio station on channel 3 SCPC. There might be considerably more in the future.

Rules For Watching

While it's perfectly legal to watch, or listen, to unencrypted, in-the-clear, satellite transmissions, many are not intended for reception by the general public. And so, it's prudent to issue a few reminders about viewing or listening to these broadcasts. Sometimes you'll see color bars with lettering across them listing phone numbers. Sometimes they read: "Trouble? Call etc., etc." or "Questions or comments call etc., etc." or "E-mail etc.,etc., with your comments."

This does not mean you. This number is for affiliate stations or other interested parties related to the transmission. They are not interested in hearing that you are watching. In fact, they may be alarmed to know that you are watching. Many corporations or others unfamiliar with satellite broadcasting never imagine that their broadcast may be viewed by anyone bored enough to tune in.

Often, during interactive broadcasts, a toll-free number will be displayed at the bottom of the screen so that participants may join in the discussion. Again, this is not C-SPAN. They do not want the participation of satellite TV hobbyists. Leave them alone. If you are interested in the program, watch, but don't participate.

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SPACE GLOSSARY

The following are some terms used in the satellite business and are described in layman's terms.

ALTITUDE (ALT): The distance between a satellite and the point on the earth directly below it, same as height.

AQUISITION OF SIGNAL (AoS): The time at which a particular ground station begins to receive radio signals from a satellite.

APOGEE: The point in a satellite's orbit farthest from the Earth's center.

ARGUMENT OF PERIGEE: This value is the number of degrees from the ascending node the perigee point occurs. The perigee point is the point where the satellite is the closest to the earth (assuming an orbit which is elliptical to some degree). This number may be entered as a real value between 0.0 and 360.0.

ASCENDING NODE: Point at which the satellite crosses the equatorial plane from the southern hemisphere to the northern hemisphere. (See RIGHT ASCENSION OF THE ASCENDING NODE.)

AZIMUTH (AZ): The angle measured in the plane of the horizon from true North clockwise to the vertical plane through the satellite.

CATALOG NUMBER: A 5-digit number assigned to a cataloged orbiting object. This number may be found in the NASA Satellite Situation Report and on the NASA Two Line Element (TLE) sets.

COORDINATED UNIVERSAL TIME (UTC): Also known as Greenwich Mean Time (GMT). Local time at zero degrees longitude at the Greenwich Observatory, England. Uses 24 hour clock, ie. 3:00 pm is 1500 hrs.

CULMINATION: The point at which a satellite reaches its highest position or elevation in the sky relative to an observer. (Known as the Closest Point of Approach)

DECAY RATE: This is the rate of decay of the orbital period (time it takes to complete one revolution) due to atmospheric friction and other factors. It is a real number measured in terms of Revolutions per Day (REV/DAY).

DECLINATION (DEC): The angular distance from the equator to the satellite measured positive north and negative south.

DIRECT BROADCAST SATELLITE (DBS): Commerical satellite designed to transmit TV programming directly to the home.

DOPPLER SHIFT: The observed frequency difference between the transmitted signal and the received signal on a satellite downlink where the transmitter and receiver are in relative motion.

DOWNLINK: A radio link originating at a spacecraft and terminating at one or more ground stations.

DRAG: The force exerted on a satellite by its passage through the atmosphere of the Earth, acting to slow the satellite down.

EARTH-MOON-EARTH (EMR): Communications mode that involves bouncing signals off the moon.

ECCENTRICITY (ECC): This is a unitless number which describes the shape of the orbit in terms of how close to a perfect circle it is. This number is given in the range of 0.0 to less than 1.0. An perfectly circular orbit would have an eccentricity of 0.0. A number greater than 0.0 would represent an elliptical orbit with an increasingly flattened shape as the value approaches 1.0.

ELEMENT SET: (See ORBITAL ELEMENTS.)

ELEVATION (EL): Angle above the horizontal plane.

EPHEMERIS: A tabulation of a series of points which define the position and motion of a satellite.

EPOCH: A specific time and date which is used as a point of reference; the time at which an element set for a satellite was last updated.

EPOCH DAY: This is the day and fraction of day for the specific time the data is effective. This number defines both the julian day (the whole number part of the value) and the time of day (fractional part of the value) of the data set.
The julian day figure is simply the count of the number of days thatparticular date is from the beginning of the year. (January 1 would have a julian day of 1. Feb 28 would be 59.) This number may range from 1.0 to 366.999999999 (taking into account leap years).

EPOCH YEAR: This is the year of the specific time the rest of the data about the object is effective.

EQUATORIAL PLANE: An imaginary plane running through the center of the earth and the Earth's equator.

EUROPEAN SPACE AGENCY (ESA): A consortium of European governmental groups polling resources for space exploration and development.

FOOTPRINT: A set of signal-level contours, drawn on a map or globe, showing the performance of a high-gain satellite antenna. Usually applied to geostationary satellites.

GROUND STATION: A radio station, on or near the surface of the earth, designed to receive signals from, or transmit signals to, a spacecraft.

INCLINATION (INC): The angle between the orbit plane and the Earth's equatorial plane, measured counter-clockwise. 0 (zero) degrees inclination would describe a satellite orbiting in the same direction as the Earth's rotation directly above the equator (orbit plane = equatorial plane). 90 degrees inclination would have the satellite orbiting directly over both poles of the earth (orbit plane displaced 90 degrees from the equatorial plane). An inclination of 180 degrees would have the satellite orbiting again directly over the equator, but in the opposite direction of the Earth's rotation. Inclination is given as a real number of degrees between 0.0 and 180.0 degrees.

INTERNATIONAL DESIGNATOR: An internationally agreed upon naming convention for satellites. Contains the last two digits of the launch year, the launch number of the year and the piece of the launch, ie. A-indicates payload, B-the rocket booster, or second payload, etc.

LATITUDE (LAT): Also called the geodetic latitude. the angle between the perpendicular to the Earth's surface (plane of the horizon) at a location and the equatorial plane of the earth.

LONGITUDE (LONG): The angular distance from the Greenwich (zero degree) meridian, along the equator. This can is measured either east or west to the 180th meridian (180 degrees) or 0 to 360 degrees west. For example, Ohio includes 85 degrees west longitude, while India includes 85 degrees east longitude. But 85 degrees east longitude could also be measured as 275 degrees west longitude.

LOSS OF SIGNAL (LoS): The time at which a particular ground station loses radio signals from a satellite.

MEAN ANOMALY (MA): This number represents the angular distance from the perigee point (closest point) to the satellite's mean position. This is measured in degrees along the orbital plane in the direction of motion. This number is entered like the argument of perigee, as a value between 0.0 and 360.0.

MEAN MOTION (MM): This is the number of complete revolutions the satellite makes in one day. This number may be entered as a value greater than 0.0 and less than 20.0. (See DECAY)

NASA: U.S. National Aeronautics and Space Administration.

ORBITAL ELEMENTS: Also called Classical Elements, Satellite Elements, Element Set, etc. Includes the catalog Number; epoch year, day, and fraction of day; period decay rate; argument of perigee, inclination, eccentricity; right ascension of ascending node; mean anomaly; mean motion; revolution number at epoch; and element set number. This data is contained in the TWO LINE ORBITAL ELEMENTS provided by NASA.

OSCAR: Orbiting Satellite Carrying Amateur Radio.

PERIOD DECAY RATE: Also known as Decay. This is the tendency of a satellite to lose orbital velocity due to the influence of atmospheric drag and gravitational forces. A decaying object eventually impacts with the surface of the Earth or burns up in the atmosphere. This parameter directly affects the satellite's MEAN MOTION. This is measured in various ways. The NASA Two Line Orbital Elements use revolutions per day.

PERIGEE: The point in the satellite's orbit where it is closest to the surface of the earth.

POSIGRADE ORBIT: Satellite motion which is in the same direction as the rotation of the Earth.

RETROGRADE ORBIT: Satellite motion which is opposite in direction to the rotation of the Earth.

REVOLUTION NUMBER: This represents the number of revolutions the satellite has completed at the epoch time and date. This number is entered as an integer value between 1 and 99999.

REVOLUTION NUMBER AT EPOCH: The number of revolutions or ascending node passages that a satellite has completed at the time (epoch) of the element set since it was launched. The orbit number from launch to the first ascending node is designated zero, thereafter the number increases by one at each ascending node.

RIGHT ASCENSION OF THE ASCENDING NODE (RAAN): The angular distance from the vernal equinox measured eastward in the equatorial plane to the point of intersection of the orbit plane where the satellite crosses the equatorial plane from south to north (asecending node). It is given and entered as a real number of degrees from 0.0 to 360.0 degrees.

SATELLITE SITUATION REPORT: A report published by NASA Goddard Space Flight Center listing all known man-made Earth orbiting objects. This report lists the Catalog Number, International Designator, Name, Country of origin, launch date, orbital period, inclination, beacon frequency, and status (orbiting or decayed).

TLM: Short for telemetry.

TRANSPONDER: A device aboard a spacecraft that receives radio signals in one segment of the radio spectrum, amplifies them, translates (shifts) their freuency to another segment and retransmits them.

TELEVISION RECEIVE ONLY (TVRO): A TVRO terminal is a ground station set up to receive downlink signals from 4-GHZ or 12-GHZ commerical satellites carrying TV programming.

TWO LINE ORBITAL ELEMENTS (TLE): See ORBITAL ELEMENTS.

UPLINK: A radio link originating at a ground station and directed to a spacecraft.

VERNAL EQUINOX: Also known as the first point of Aries, being the point where the Sun crosses the Earth's equator going from south to north in the spring. This point in space is essentially fixed and represents the reference axis of a coordinate system used extensively in Astronomy and Astrodynamics.

UPLINK

By Bob Grove, Publisher
E-mail address: st@grove.net

A Giant Step Forward

During a time when many other magazines are quietly closing, *Satellite Times* subscriptions continue to climb. We are now increasing our presence even further by going monthly. We are very proud of our growth and our success in the marketplace. While most other magazines are advertiser driven, *ST* and its sister magazine, *Monitoring Times*, are subscription supported. We like it that way; in fact we *insist* on it that way.

One of the founding principles of both *MT* and *ST* was objectivity, reporting on issues and products with integrity. Writers are chosen for their skills, independent of affiliation with agencies or companies, and unbiased by personal or philosophical agendas.

And now with *Satellite Times* joining the professionals as a monthly publication, you will see more articles, more products, and more timely news. By cutting your waiting time in half and doubling up our editorial content, we will be working even harder to keep you informed of the rapidly emerging arena of space telecommunications.

The satellite age recently celebrated its 40th anniversary with the release into orbit of Sputnik 40, commemorating its friendly "Beep-beep" in the amateur two-meter band. It's hard to believe that in the all-too-brief four decades which followed we would see such a prolific stew of earth satellites in polar and equatorial orbits!

With the imminent explosion of the Personal Communications Services (PCS), digital radio and TV technologies, satellite Internet, and even more, we invite your contribution of ideas for articles. And we invite your writing as well. If you have an area of expertise you would like to share with our readers, let Larry Van Horn, *ST*'s Editor-in-Chief, know about it. Experienced, knowledgeable writers are always welcome in our pages.

After all, our surveys reveal what we always suspected: *ST* readers are savvy, educated, and discriminating. A very large percentage of you enjoy astronomy, and many are "techies" who are fascinated by emerging technologies. You what you want, what you are interested in, and you know that the *ST* staff shares your passion for information.

We invite as well your criticism–or at least your critique–of how we've done so far. What do you like about *ST*? What areas should be developed? Which departments or subjects are of least interest? Remember, we may be the publishers, but *Satellite Times* is *your* magazine. Without your acceptance and approval, we couldn't have survived. ST

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