AN ANTHOLOGY OF AMATEUR SATELLITES & ORGANISATIONS

1. **Introduction**

Amateur Satellites are currently named within two generic groups, one is OSCAR which is an acronym for Orbiting Satellite Carrying Amateur Radio and the other is RS which is an acronym for Radio Sport, the description used for Amateur Radio in the former Soviet Union. More recently a nomenclature has developed that includes a reference to either the group that built the satellite or a name that the builders would like assigned to their satellite e.g. UoSAT-OSCAR-22 that was built by the University of Surrey and Fuji-OSCAR-20 which was built in Japan where Fuji has an
obvious significance. Also, for simplicity most Amateur Satellite names are abbreviated to XX-yy e.g. UoSAT-OSCAR-22 is known as UO-22 and Fuji-OSCAR-20 is known as FO-20. Most of the Russian built Amateur Satellites are simply known as RS-yy.
Apart from beacons and data transmitters amateur satellites often carry linear transponders, *previously* specified by a mode type as per the table below:

MODE	Uplink between	Downlink between
A	145.8 - 146.0 MHz	29.3 - 29.5 MHz
B	435 - 438 MHz.	145.8 - 146.0 MHz
J	145.8 - 146.0 MHz	435 - 438 MHz
K	21.26 - 21.30 MHz	29.40 - 29.50 MHz
L	1260 - 1270 MHz	435 - 438 MHz.
S	435 - 438 MHz	2400 - 2450 MHz
T	21.26 - 21.30 MHz	145.8 - 146.0 MHz

A second letter may be attached to the mode letter:
A - Analog
D - Digital
Combinations of mode letters are also possible:
BLS - B+L+S
However, a *new transponder mode designator* has been developed where the input (uplink) is always specified first. A slash “/” is used to separate input and output.

	Wavelength	Designator
21 MHz	15m	H
29 MHz	10m	T
144MHz	2m	V
435MHz	70cm	U
1260MHz	24cm	L
2400MHZ	13cm	S
5650MHz	6cm	C
10GHz	3cm	X
24GHz	1.5cm	K

Transponder Names

	Old Name	New Name
Mode	A	V/T
Mode	B	U/V
Mode	J	V/U
	K	H/T
	KA	H,V/T
	KT	H/T,V
	L	L/U
	S	U/S
	T	H/V

In the IARU Region 1 bandplans for the bands allocated to the Amateur (Satellite) Service the following frequency segments are designated for use by the Amateur Satellite Service:

145.800 - 146.000 MHz
435.000 - 438.000 MHz
1.260 - 1.270 GHz uplink only
2.400 - 2.450 GHz
5.650 - 5.670 GHz uplink only
5.830 - 5.850 GHz downlink only
10.450 - 10.500 GHz
24.000 - 24.050 GHz
47.000 - 47.200 GHz
76.000 - 81.000 GHz
142.000 - 144.00 GHz
248.000 - 250.00 GHz

2. **Historical overview**

Amateur Satellites have gone through several phases:

Phase 1 - were short-lived (low earth orbit) and designed to gather information on basic satellite system performance. i.e. Oscars 1 to 5

Phase 2 - were characterised by low altitudes (a fraction of an Earth radius), long lifetimes and communications capabilities. i.e. Oscars 6-9, Oscars 11, 12, 14 - 23, 25-36 RS 1-8 and RS 10-16 and ISKRA 2, 3

Phase 3 - satellites reside in highly elliptical orbits having an apogee of several Earth radii. They have high power transmitters, high gain antennas and complex telemetry and control systems offering predictable long distance communications. i.e. OSCAR 10, OSCAR 13 and OSCAR 40.

The next satellite in this category is Phase 3E and expected to be launched in 2005

Phase 4 - is a term applied to geostationary satellites. Such spacecraft only exist in design stage.

Phase 5 – is used to refer to satellites designed for lunar or Mars missions that have a significant Amateur Radio component.

OSCAR-1 was launched December 12, 1961 and lasted 20 days. Its 140 mW transmitter on 144.983 MHz sent "HI-HI" in Morse code. The speed of the “HI-HI” message was controlled by a temperature sensor inside the spacecraft. Power was supplied by non-rechargeable batteries. It re-entered the earth’s atmosphere on January 31, 1962.

OSCAR-2 was launched June 2, 1962 and lasted for 18 days. It was similar to OSCAR-1 except it had improved thermal coatings to improve the internal temperature, modified sensing system so that satellite temperature could be measured more accurately as the batteries decayed and lowered the transmitter power output to extend battery life.

OSCAR-3 was launched March 9, 1965 and was the first Amateur communication satellite and the first to have solar power. It lasted 15 days and contained a 50 KHz wide 1W linear transponder from 145.9 MHz uplink to 144.1 MHz downlink, but this was only partially successful. It also had 2 beacon transmitters that continued operating for several months.

OSCAR-4 was launched December 21, 1965 and lasted for three months but due to a rocket failure went into a highly elliptical orbit. It had a 3W 10kHz wide transponder with 144 MHz uplink and 432 MHz downlink. Due to failure of the solar cells operation stopped in March 1966 and it re-entered April 12, 1976.

Australis-OSCAR-5 was launched January 23, 1970 and was the first Amateur Satellite to be ground controlled. This satellite, built by students at the University of Melbourne, Australia, was equipped with two transponders in the 144 MHz and the 29 MHz bands, as well as with two telemetry systems (50mW on 144.050 MHz and 250mW on 29.450 MHz) transmitting internal information via beacon transmitters. It also had two bar magnets to provide passive magnetic attitude stabilisation. It lasted for slightly more than one month.

AMSAT-OSCAR-6 was launched October 15, 1972, the first of the Phase II Amateur satellites and had a 2W PEP 100 KHz wide transponder with uplink on 144 MHz and downlink on 29 MHz (mode A) and also carried a forward message relay system (codestore) and a beacon on 435 MHz. Its lifetime was 4.5 years. It had solar panels powering NiCd batteries which failed on June 21, 1977. Subsystems were built in U.S., Australia and Germany.

AMSAT-OSCAR-7 was launched November 15, 1974 and survived for 6.5 years until battery failure in mid 1981 but see below. In addition to various beacons transmitting telemetry data and codestore, it carried two transponders, one with 145 MHz uplink and 29 MHz downlink (mode A) and the other with 432 MHz uplink and 145 MHz downlink (mode B), both with 2W transmitting power. Under normal conditions OSCAR-7 worked two days in mode B, followed by one day in mode A. If the battery voltage dropped below 60 % of its maximum value, the transponders were switched off and a 24 hours charging period was started. The 2304.1 MHz beacon was never switched on because of international treaty constraints.
After being declared dead due to battery failure, AO-7 has miraculously sprung back to life and was first detected by Pat Gowen, G3IOR on June 21, 2002 at 1728 UTC. Jan King, W3GEY reports AO-7 is running off the solar panels only. It is on when in sunlight and off in eclipse.
Therefore, AO-7 will reset each orbit and may not turn on each time.

Uplink: 145.850 to 145.950 MHz CW/USB 432.125 to 432.175 MHz CW/LSB
Downlink: 29.400 to 29.500 MHz CW/USB 145.975 to 145.925 MHz CW/USB
Beacon: 29.502 MHz, 145.972 MHz, 435.1 MHz, 2304.1 MHz
Launched: November 15, 1974 by a Delta 2310 from Vandenberg Air Force Base, Lompoc, California.
Status: Semi-operational in sunlight.

On July 11, 2002 AO-7 was successfully commanded for the first time since it was declared dead 21 years ago. Commands were sent and accepted to change the CW beacon code speed. Command investigation continues. So far, 11 different commands have been accepted by AO-7.
Emily, W0EEC has created a website to allow the users of AO-7 to record contacts,
observations and use of the satellite more effectively. This includes the ability to log contacts. http://www.experthams.net/ao7
Tim, K3TZ has written a program to decode AO-07 telemetry. The program can be downloaded at http://www.qsl.net/k3tz/files/K3TZ_AO-07_Telemetry_Decoder_0.5.zip
For more info: http://www.amsat.org/amsat/sats/n7hpr/ao7.html

AMSAT-OSCAR-8 was launched March 5, 1978 and was the third Phase II satellite and carried two transponders, 145 MHz uplink and 29 MHz downlink (mode A) and 145 MHz uplink and 435 MHz downlink (mode J) plus two telemetry/beacon transmitters. It also failed due to battery failure on June 24, 1983.

RS-1 and **RS-2** were launched by the Soviet Union on October 26, 1978. These satellites transponded 145 MHz uplink to 29 MHz downlink (mode A) and contained a beacon on 29.400 MHz, transmitting telemetry data in CW at a speed of 25 words per minute. These satellites were operational for about 5 months before battery problems disabled both spacecraft. RS-1's beacon could still be heard for many years when there was sufficient solar illumination.

AMSAT's first attempt at a **Phase 3** experiment (the satellite known as Phase-3A) never achieved orbit because the Ariane launch rocket plunged into the Atlantic Ocean on May 23, 1980.

UoSAT-OSCAR-9 (UO-9) was the first research satellite in the Amateur Satellite Service. Constructed by the University of Surrey and also known as UoSAT-1, it did not contain transponders but was equipped with telemetry/beacon transmitters, enabling Amateurs to participate in scientific/educational experiments. It was also the first Amateur satellite to have a onboard computer for battery and attitude management, remote control and experiments. It was launched into a polar orbit on October 6, 1981 and made its re-entry into the atmosphere on October 13, 1989.

RS-3 to **RS-8** were all ejected from the same rocket December 17, 1983. RS-3 and RS-4 were retired from 29 MHz beacon duty in the summer of 1983, and RS-6 became defunct in 1985. RS-5, RS-7 and **RS-8**, which carried transponders with 145 MHz uplink and 29 MHz downlink (mode A), went out of operation during 1990.

RS-5 and **RS-7** carried a "Robot", that allowed making of a QSO with the satellite using Morse code. The Robot called CQ and expected to be called back with its own callsign as well as that of the calling station. It then responded with a sequential serial number. A ground station in the USSR extracted the callsigns by interrogating the RS satellite, and QSL cards were sent via the normal channels.

ISKRA-2 and **ISKRA-3**, two "get-away-special" satellites, were ejected from the Soviet space station Salyut-7, ISKRA-2 on May 17, 1982 which re-entered July 9, 1982 and ISKRA-3 on November 18 1982 which re-entered on December 16, 1982. These ISKRAs were low-orbit satellites, carrying transponders with 145 MHz uplinks and 29 MHz downlinks. They had only limited success, and lifetime before re-entry was about six weeks for each of them.

AMSAT-OSCAR-10 (AO-10), AMSAT's second attempt at a Phase 3 satellite, was successfully launched on June 16, 1983. The world's VHF/UHF/SHF radio Amateurs, after 10.5 years of low-orbit satellites and associated short visibility periods at last enjoyed the equivalence of a permanently open 14 MHz band

with practically world-wide communications coverage through two transponders, 435 MHz uplink and 145 MHz downlink (mode B) and 1296 MHz uplink to 436 MHz downlink (mode L). AO-10 is still operational in mode B, albeit on a predictable but intermittent basis when there is sufficient solar illumination to power the transponder. This is due to the fact that the onboard computer used to manage the satellite failed due to radiation damage**.**

Uplink 435.030 to 435.180 MHz CW/LSB
Downlink 145.975 to 145.825 MHz CW/USB
Beacon 145.810 MHz (unmodulated carrier)

Launched June 16, 1983 by an Ariane launcher from Kourou, French Guiana
Believed to be semi-operational but has been heard from since mid 2002.
Stacey Mills, W4SM, has more information about the satellite at
http://www.cstone.net/~w4sm/AO-10.html

UoSAT-OSCAR-11 (UO-11) was launched into a polar orbit on March 1, 1984. Like its predecessor UoSAT-1, UoSAT-2 satellite was intended for scientific and educational purposes, and was equipped with digital communication-systems to demonstrate store-and-forward packet communications.

Downlink 145.826 MHz FM, 1200 baud PSK
Beacon 2401.500 MHz

Launched March 1, 1984 by a Delta-Thor rocket from Vandenberg Air Force Base in California
Semi-operational.
OSCAR-11 now operates in a default mode, controlled by the watch-dog timer. The satellite transmits continuous ASCII telemetry for about 8 - 9 days on 145.826 MHz., followed by about 10 - 12 days of silence. These times appear to be somewhat variable, and this regular sequence might be interrupted by ground control. The mode-S beacon on 2401.5 MHz transmits continuously.
More information on OSCAR-11 is available at
http://www.users.zetnet.co.uk/clivew/

Fuji-OSCAR-12 (JAS-1A or FO-12) a Japanese satellite developed by the Japan Amateur Radio League (JARL) with system design and integration by NEC was launched on August 12, 1986. It contained a mode J transponder, split up in two parts: mode JA for analogue work (SSB voice etc.), and mode JD for digital communication with 1.5 Mb RAM for store-and-forward. From the beginning this satellite experienced trouble with the power budget and on November 5 1989
FO-12 was taken out of service because of battery failure.

RS-10 and **RS-11** were launched together, build into the COSMOS 1861 navigation satellite on June 23, 1987. These two satellites were launched into a transfer orbit with a SKEAN C-1 rocket, and at a later stage with the aid of a second burn were put into a circular orbit at a height of approx. 1000 km (lower

than all other RS satellites) with an inclination of 82 degrees. Both satellites are not operational anymore. They carried mode A, K and T.

AMSAT-OSCAR-13 (AO-13) was constructed by an international group of Amateurs from many countries including Germany, United States, Hungary and South Africa and was the third of the Phase III satellites. AO-13 was launched on June 15, 1988 and had mode B, mode L and mode S transponders, four beacons and the RUDAK-I digital experiment. Unfortunately, due to orbital perturbations not fully appreciated at launch time a fully operational AO-13 decayed in December 1996.

On January 22, 1990, a group of 6 satellites, OSCAR 14-19, were ejected from the same Ariane 4 launch vehicle.

UoSAT-OSCAR-14 (UO-14) known as UoSAT-D at the University of Surrey where it was constructed was the first Amateur Satellite to feature a 9600 baud store-and-forward packet-radio mailbox, intended to be used for scientific/educational purposes. In 1992 this satellite was withdrawn from the Amateur Satellite Service and moved to commercial frequencies. It was returned to amateur service in 1998 as an FM bent pipe repeater following the failure of some of its on board computer system

Operational
Uplink 145.975 MHz FM
Downlink 435.070 MHz FM

Tim, KG8OC, features UO-14 information on the Michigan AMSAT web site, see http://www.qsl.net/kg8oc
Ray, W2RS, has revised the AO-27 FAQ on http://www.amsat.org/amsat/intro/ao27faq.html to include information on UO-14.

UoSAT-OSCAR-15 (UO-15 or UoSAT-E) was intended as a testbed for new space techniques. It contained a transputer (parallel CPUs) and a high-resolution CCD camera. Due to an unknown cause this satellite ceased transmitting a few days after its launch.

AMSAT-OSCAR-16 (MicroSat-C, PACSAT, AO-16) built by AMSAT-North America featured a Mode J 1200 baud PSK store-and-forward packet radio mailbox (PACSAT). It also carried a 2401 MHz beacon.

Uplink 145.900, 145.920, 145.940, 145.960 MHz FM, 1200 bps Manchester FSK
Downlink 437.026 MHz SSB, 1200 bps 1200 Baud PSK
Beacon 2401.1428 MHz.
Broadcast callsign: PACSAT-11
BBS: PACSAT-12

Launched January 22, 1990 by an Ariane launcher from Kourou, French Guiana
Semi-operational. Digipeater on.

A WOD collection of current graphics along with general information and telemetry samples can be found at http://www.telecable.es/personales/ea1bcu

DOVE-OSCAR-17 (MicroSat-A, DO-17) was developed and built on behalf of AMSAT-Brazil. This satellite was intended to 'advertise' Amateur Radio in educational institutes. It was equipped with a multi-language speech synthesizer for the transmission of messages. A 2M 1200 baud AFSK/FM packet radio telemetry transmitter was also included. Like AO-16 a 2401 MHz beacon was included. DO-17 is no longer operational.

WEBERSAT-OSCAR-18 (MicroSat-D, WO-18) was developed at the Weber State College in Ogden, Utah, USA. A CCD camera transmits images using 1200 baud PSK packet-radio on 70cm. The satellite also contained an ATV experiment with the NTSC image-system, and pictures were transmitted regularly. It also carries a store-and-forward packet radio mailbox, like AO-16

LUSAT-OSCAR-19 (MicroSat-B, LO-19) was partly developed in Argentina by AMSAT-LU and features a Mode J 1200 baud PSK store-and-forward packet-radio mailbox similar to AO-16 and also had digipeater facility as does AO-16. It also carried a CW beacon.

Uplink 145.840, 145.860, 145.880, 145.900 MHz 1200 bps Manchester FSK
Downlink 437.150 MHz SSB, 1200 bps RC-BPSK
CW Downlink 437.125 MHz
Broadcast callsign: LUSAT-11
BBS: LUSAT-12
Launched January 22, 1990 by an Ariane launcher from Kourou, French Guiana
The CW beacon is sending eight telemetry channels and one status channel on 437.126 MHz.
No BBS service is available. The digipeater is not active.

General information and telemetry samples can be found at
http://www.telecable.es/personales/ea1bcu

Fuji-OSCAR-20 (JAS-1B or FO-20) was a satellite developed in Japan by JARL and produced by NEC. It was launched on February 7, 1990, as a successor to FO-12. It was designed in such a way that mode JA and JD could be used simultaneously.

Uplink 145.900 to 146.000 MHz CW/LSB
Downlink 435.800 to 435.900 MHz CW/USB
Beacon: 435.795 MHz
Launched February 7, 1990 by an H1 launcher from the Tanegashima Space Center in Japan
Operational.
FO-20 is in mode JA continuously.
FO-20 has been reported silent by numerous operators.

RS-14 & AMSAT-OSCAR-21 (AO-21) was launched by a Wostock rocket on January 29, 1991 as a piggy-back satellite on board of a GEOS scientific

satellite. This was cooperative effort between AMSAT-Russia and AMSAT-DL. The satellite contains an analogue transponder and a RUDAK digital experiment which served as a testbed for future Amateur digital experiments.
Perfect quality speech synthesis using DSP (Digital Signal Processing) were amongst the many possible experiments.
As of September 16, 1994 the spacecraft was switched off including the Amateur payload due to the cost of maintaining the satellite when the usefulness of the primary payload was exhausted.

RS-12 and **RS-13** were launched February 5, 1991 inside navigation satellite Cosmos 2123 and are operationally very similar to RS-10 and RS-11. RS-12 and RS-13 are no longer operational

UoSAT-OSCAR-22 (UoSAT-E or UO-22) was launched on July 17, 1991. It was intended to replace the failed OSCAR 15 (UO-15) and to provide store-and-forward facilities to Satelife (a non-profit humanitarian organization). Due to practical problems, UO-14 was originally dedicated to VITA - Satellite and UO-22 to the Amateur Satellite Service. The satellite features a 9600 baud FSK store-and-forward system and a CCD camera, and operates primarily as a satellite link for global terrestrial packet radio using satellite gateway ground stations.

Uplink 145.900 MHz FM
Downlink 435.120 MHz FM 9600 Baud FSK
Broadcast callsign: UOSAT5-11
BBS: UOSAT5-12
Launched July 17, 1991 by an Ariane launcher from Kourou, French Guiana
Operational
UO-22 has been reported as silent (July 2003) but the control operator is hopeful of a return to service..
More information on the satellite is available at http://www.sstl.co.uk/

KITSAT-OSCAR-23 (KO-23) was launched on August 10, 1992. This satellite was built at the University of Surrey for KAIST, the Korean Advanced Institute for Science and Technology and is similar to UO-22. It has 2 CCD cameras and a 9600 baud FSK up and down link. It is no longer operational.

ARSENE-OSCAR-24 (AO-24) was launched May 13, 1993 into an equatorial elliptical orbit. It had Mode B (145.975 MHz downlink (1200 bps FM AFSK)) and Mode S (2446.54 MHz downlink) transponders. ARSENE was a French packet relay satellite built by French Radio Amateur Club de l'Espace. The packet system was never implemented because the 2M transponder failed soon after launch. ARSENE was then used to relay SSB and CW signals on 2.4 GHz for several months until this transponder failed as well.

On September 26, 1993, a group of 4 satellites, OSCAR 25-28, were ejected from the same Ariane 4 launch vehicle.

KITSAT-OSCAR-25 (KO-25) was a South Korean experimental microsatellite based on the SSTL UoSAT bus built by the Korean Advanced Institute of Science and Technology (KAIST).
KO-25 is operated from The Satellite Technology Research Center (SaTReC) in South Korea. KO-25's mission was to take CCD pictures, process numerical information, measure radiation, and receive and forward messages. The Infrared Sensor Experiment (IREX) was designed to acquire I/V characteristics of IR sensors. KO-25 is no longer operational.

ITAMSAT-OSCAR-26 (IO-26) was built by AMSAT-ITALY. Its mission is to store and forward amateur radio messages like AO-16, LO-19, UO-22, KO-23 and KO-25. IO-26's operation is identical to the 1200 baud PSK microsatellites AO-16 and LO-19. The ITAMSAT Command Team can be contacted via internet: Alberto Zagni, I2KBD, i2kbd@amsat.org or Luca Bertagnolio, IK2OVV, ik2ovv@amsat.org

Uplink 145.875, 145.900, 145.925, 145.950 MHz FM
Downlink 435.812 MHz SSB, 1200 Baud PSK
Broadcast callsign: ITMSAT-11
BBS: ITMSAT-12
Launched September 26, 1993 by an Ariane launcher from Kourou, French Guiana
Semi-operational.

AMRAD-OSCAR-27 (AO-27) is a secondary amateur communications payload carried aboard the EYESAT-1 experimental MICROSAT satellite built by Interferometrics Inc. of Chantilly, Virginia. The commercial side of the spacecraft's mission is the experimental monitoring of mobile industrial equipment. The amateur equipment aboard the satellite was constructed by members of AMRAD, a technically-oriented, non-profit organization of radio amateurs based in the Virginia suburbs of Washington, D.C., to meet the needs of amateurs for a platform to conduct digital satellite communications experiments. AO-27 is available on all daylight passes over the Northern Hemisphere. The "TEPR" states describe the time in minutes from when the spacecraft enters and then leaves eclipse.
The latest information on AO-27 from control operator Michael Wyrick, N3UC (former N4USI), can be found at http://www.ao27.org
An AO-27 question-and-answer page is available on the AMSAT-NA web site, with updates by Ray, W2RS: http://www.amsat.org/amsat/intro/ao27faq.html.

PoSAT-OSCAR-28 (PO-28 or PoSAT-1) is Portugal's first satellite achieved through a technology transfer program with Surrey Satellite Technology, Ltd. (SSTL) and was built at the University of Surrey in a collaborative programme between a consortium of Portuguese academia and industry. Like KO-23, PoSAT-1 carries a wide range of technology experiments, including earth imaging cameras, DSP and space-radiation experiments. In addition, PoSAT-1 carries the first microsatellite GPS experiment and an ultra-low-cost CCD star sensor. PoSAT-1 is operated jointly by the University of Surrey command station at Guildford and the Portugese command station at Sintra. PoSAT was operated on amateur frequencies for several weeks in early 1994. Presently, PO-28 is not

operational on Amateur frequencies but may be after the primary mission has been completed.

RS-15 was launched December 16, 1994 from Baykonur Space Center aboard a "Rokot"
launcher which is made on base of rocketry boosters (1st and 2nd stages) of missiles well known as SS-19 and new booster "Briz" (3th stage). Satellite is spherical like unit about 1 meter diameter and its weight is approximately 70 kg. (used the same trunk as on RS-3 - RS-8). On the board exist transponder, two beacons, CW -broadcast bulletin board (2kb), remote control system and telemetry system.

Uplink 145.858 to 145.898 MHz CW/USB
Downlink 29.354 to 29.394 MHz CW/USB
Beacon 29.352 MHz (intermittent)
SSB meeting frequency 29.380 MHz (unofficial)
Launched December 26, 1994 from the Baikonur Cosmodrome
Semi-operational, Mode A (2m uplink, 10m downlink)

UNAMSAT-A (Mexico) and **TechSat-1A (Israel) UNAMSAT-1 (Mexico)** and **TechSat-1a**
(Israel) Both satellites were launched from Plesetsk, Russia on March 28, 1995. Unfortunately the Russian Start-1 launcher failed and destroyed both spacecraft. In a second attempt, UNAMSAT-B was launched September 5, 1996 and was designated as Mexico-OSCAR 30 (see below). Unfortunately, it failed after about a day of transmitting due to a dead uplink receiver. Israel's successful second attempt is called TechSat-1B. (see below)

Fuji-OSCAR-29 (FO-29 or JAS-2) like its predecessors FO-12 and FO-20 contains digital and analogue transponders and has a digi-talker. Launched August 17, 1996, by an H-2 launcher from the Tanegashima Space Center in Japan.

Voice/CW Mode JA
Uplink 145.900 to 146.000 MHz CW/LSB
Downlink 435.800 to 435.900 MHz CW/USB
Beacon: 435.795 MHz
Digital Mode JD
Uplink 145.850, 145.870, 145.910 MHz FM
Downlink 435.910 MHz FM 9600 baud BPSK
Callsign 8J1JCS
Digi-talker Mode
Downlink 435.910 MHz FM
Operational.
Mineo, JE9PEL, has an FO-29 satellite telemetry analysis program that will automatically
analyze all digital telemetry from the satellite (such as current, voltage and temperature).
FO29CWTE is available at http://www.ne.jp/asahi/hamradio/je9pel/

Mexico-OSCAR-30 (MO-30 or UNMSAT-B) was launched September 5, 1996 and was the
second nearly identical Microsat satellite constructed by the Autonomous University of Mexico by students and staff led by David Liberman, XE1TU. Due to unforeseen circumstances MO-30 was not released from the launch vehicle and the spacecraft temperature dropped to –30 degrees centigrade which caused the crystal oscillator in the uplink receiver to fail.

RS-16 was launched March 4, 1997 and had a Mode A transponder and two 70cm transmitters but was never activated due to technical problems. RS-16 decayed October 25, 1999.

RS-17 (Spoutnik–40) was a scale model satellite built by high school students to commemorate the 40th anniversary of the launching of Sputnik I. It was launched by hand on November 3, 1997 by Russian cosmonauts from the MIR space station. RS-17 broadcast its bip-bip signal for 57 days on 145.822 MHz. The last known recordings were made on December 30, 1997, at about 1100 utc by an English radio amateur. RS-17 decayed on May 21, 1998.

TMSAT-OSCAR-31 (TO-31 or TMSAT-1) was launched July 10, 1998 from the Russian
Baikonur Cosmodrome. TO-31 is the first Thai Microsatellite. TMSAT stands for Thai-Microsatellite and was constructed by Thai engineers with engineers at SSTL at the University of Surrey. TMSAT is also the name of a company that Mahanakorn University of Technology (MUT) and Thai Satellite Communication (TSC) are investing in, in order to develop satellite technology in Thailand. TO-31 can take multispectral images. They are produced by combining data from the Narrow Angle Camera, sensing in the green, red, and near-IR spectra. Each image has 1020 x 1020 pixels, covering an area of 100 x 100 km at mean ground resolution of 98 meters / pixel. Red areas indicate healthy vegetation (due to the strong near-IR reflectance of chlorophyll). Urban areas are generally blue-grey. The different colors of fields provides an indication of the state of vegetation (bare soil, marsh, young or mature vegetation, etc). These images can be downloaded from TO-31 on Amateur frequencies using the pacsat protocol as used on UO-22, KO-23 and KO-25. No longer operational due to failed batteries.

GO-32 TechSat-1B
Downlink: 435.325, 435.225 MHz FM (9600-baud FSK)
Uplinks: 145.860, 145.880, 145.890, 145.930 FM
Downlink: 435.225 MHz FM (9600-baud FSK)
(435.325 n/a - temperature problems)
Uplinks: 145.850, 145.890, 145.930 FM
1269.700, 1269.800, 1269.900 FM
Broadcast Callsign: 4XTECH-11
BBS Callsign: 4XTECH-12
Launched July 10, 1998 by a Russian Zenit rocket from the Baikonur Cosmodrome
Semi-operational.
Ground station control only, system beacon every 30 seconds.

Output Power - 1W
WinTelem v1.0 - TechSat's telemetry decoding software is now available for amateur use.
For more info check: http://www.iarc.org/techsat/

SO-33 SEDSAT
Downlink 437.910 MHz FM 9600 Baud FSK
Launched October 24, 1998 by a Delta 2 rocket from Cape Canaveral in Florida
Semi-operational.
The satellite is not currently available for uplink transmissions and image and transponder
recovery efforts have been unsuccessful.
SEDSAT-1 signifies Students for the Exploration and Development of Space (satellite number one). For more information on SedSat-1 visit the satellite web site at http://www.seds.org/sedsat

PO-34 PANSAT
Uplink/downlink frequency (listed on the PanSat web site) 436.500 MHz
Launched October 30, 1998 by the Shuttle Discovery
Status: Telemetry downloads only.
The satellite is not available for general uplink transmissions.
The Naval Postgraduate School developed PanSat. At the time of launch, PanSat spread-spectrum digital transponders were to be available to amateur radio operators along with
software to utilize this technology. The satellite is still operating, however, the spread spectrum packet radio portion never took place. The spacecraft is now beyond it's initial 2-year mission life, but telemetry records are still being downloaded.
For more information, visit the official PANSAT web site at:
http://www.sp.nps.navy.mil/pansat/

RS-18 (Sputnik-41) was launched by hand November 10, 1998 from the MIR space station and was basically a repeat of RS-17 (Spoutnik-40). RS-18 also transmitted voice messages. It stopped transmitting on December 11, 1998 and decayed on January 11, 1999.

SUNSAT-OSCAR-35 (SUNSAT) was launched February 23, 1999 and is a micro-satellite
designed and built by post-graduate engineering students in the Electronic Systems Laboratory, in the Department of Electrical and Electronic Engineering at the University of Stellenbosch. Payloads include NASA experiments, Radio Amateur communications, a high resolution imager, precision attitude control, and school experiments. The 70cm/2M FM voice repeater was activated and was popular amongst Radio Amateurs with simple 70cm and 2M FM equipment.

UO-36 UoSAT-12 carried payloads for multi-spectral and panchromatic Earth imaging;
experimental S-band/L-band communications; and operational VHF / UHF store-and-forward messaging. In addition to these payloads, UoSAT-12 demonstrated Surrey's new minisatellite bus subsystems, including GPS orbit and attitude

determination; cold-gas orbit and attitude control; Nitrous Oxide resistojet orbit control; star imagers; reaction wheels; Ethernet LAN; and 28-V power system.

Uplink 145.960 MHz, 9600 baud FSK
Downlink 437.025, 437.400 MHz, 9600 baud FSK
Broadcast callsign: UO121-11
BBS: UO121-12
Launched April 21, 1999 by a Russian launcher from the Baikonur Cosmodrome
UO-36 has not been operational since late July 2001. The VK5HI viewer shareware for UO-36 is available on the AMSAT-NA web site at ftp://ftp.amsat.org/amsat/software/win32/display/ccddsp97-119.zip
Further information on UO-36 is available at http://www.sstl.co.uk/

OSCAR-37ASUSat, built at Arizona State University,

OSCAR-38 OPAL, built at Stanford University in California

OSCAR-39 JAWSAT, built at Weber State University in Utah

AO-40 AMSAT-OSCAR 40
Launched: November 16, 2000 aboard an Ariane 5 launcher from Kourou, French Guiana.
AO-40 experimental transponder operation started on May 05, 2001 at approximately 08:00 UTC when the U-band and L1-band uplinks were connected to the S-2 transmitter passband downlink via the matrix switch.

Uplink V-band 145.840 to 145.990 MHz CW/LSB
U-band 435.550 to 435.800 MHz CW/LSB
L1-band 1269.250 to 1269.500 MHz CW/LSB
L2-band 1268.325 to 1268.575 MHz CW/LSB
S1-band 2400.350 to 2400.600 MHz CW/LSB
Downlink S2-band 2401.225 - 2401.475 MHz CW/USB
K-band 24,048.010 - 24,048.060 MHz CW/USB
Beacon: 2401.323, 24,048.035
For the current transponder operating schedule visit http://www.amsat-dl.org/journal/adlj-p3d.htm
Gene, W3PM has an Excel spreadsheet that will help evaluate your AO-40 groundstation.
Download it at http://www.amsat.org/amsat/ftp/software/spreadsheet/w3pm-ao40-v2.1.zip
The "AO-40 FAQ", compiled by Steve, VK5ASF is now available at http://www.amsat.org
Ground stations capturing telemetry from AO-40 are asked to send a copy of the data to the AO-40 archive at ao40-archive@amsat.org.
For the current transponder-operating schedule visit http://www.amsat-dl.org/journal/adlj-p3d.htm

SO-41 SAUDISAT-1A
Uplink 145.850 MHz
Downlink 436.775 MHz

Broadcast Callsign SASAT1-11
BBS SASAT1-12
Launched: September 26, 2000 aboard a converted Soviet ballistic missile from the Baikonur
Cosmodrome.
Operational but intermittent
The spacecraft is operating in Mode J, currently configured as an analog FM voice repeater, as power and spacecraft experiments permit. Further information is available at http://www.amsat.org/amsat/sats/n7hpr/so41.html

SO-42 SAUDISAT-1B
Uplink to be released
Downlink 437.075 MHz
Broadcast Callsign SASAT2-11
BBS SASAT2-12
Launched September 26, 2000 aboard a converted Soviet ballistic missile from the Baikonur Cosmodrome
Status: Unknown
When/if operational, SaudiSat-1B will operate as 9600-baud digital store-and-forward systems as well analog FM repeater mode capability. One of two new ham satellites from the Kingdom of Saudi Arabia built by the Space Research Institute at the King Abdulaziz City for Science and Technology.
Further information is available at
http://www.amsat.org/amsat/sats/n7hpr/so42.html

Starshine OSCAR-43 (SO-43). Starshine-3 was a mirror ball with AX.25 9600-baud telemetry, transmitted on 145.825 MHz. Starshine-3 was visible to the eye and provided students the opportunity to participate in its primary mission of satellite tracking.
A Kodiak Star launch vehicle (an Athena-I rocket) boosted three amateur radio payloads into orbit on September 30th 2002. The payloads included the APRS equipped PCSat, Starshine-3 and SapphireStarshine-3 is a mirror ball with AX.25 9600-baud telemetry, transmitted on 145.825 MHz.
NO-44 PCSat

Uplink/downlink 145.827 MHz 1200 baud AX.25 AFSK via W3ADO-1
Aux/Uplink 435.250 MHz 9600 baud via PCSAT (off)
APRS Downlink 144.390 MHz (Region 2)
Launched: September 30, 2001 aboard an Athena-1 rocket from the
Kodiak Alaska launch complex.
Status: Non Operational since July 2003
PCSat is a 1200-baud APRS digipeater designed for use by stations using hand-held or mobile transceivers. Downlinks feed a central web site http://pcsat.aprs.org. The APRS-equipped PCSat was built by midshipmen from the U.S. Naval Academy under the guidance of Bob Bruninga, WB4APR.
For more information, visit the PCSat web site at
http://web.usna.navy.mil/~bruninga/pcsat.html

NO-45 Sapphire
Downlink 437.095 MHz 1200 baud AX-25 AFSK

Uplink 145.945 MHz UI digipeater
Launched: September 30, 2001 aboard an Athena-1 rocket from the Kodiak, Alaska launch
complex.
Status: Non-operational
Student built Sapphire was launched through the U.S. Naval Academy Satellite program. Its
primary missions are sensor experiments, a camera, and voice synthesizer. For more information, visit the Sapphire web site at
http://students.cec.wustl.edu/~sapphire/sapphire_overview.html

MO-46 TIUNGSAT-1
Uplink 145.850 or 145.925 MHz 9600 baud FSK
Downlink 437.325 MHz
Broadcast callsign: MYSAT3-11
BBS: MYSAT3-12
NUP: MYSAT3-10
Launched September 26, 2000 on a converted Soviet ICBM from the Baikonur Cosmodrome
Status: Operational at 38k4 baud FSK
TiungSat-1 is Malaysia's first micro-satellite and in addition to commercial land and weather
imaging payloads will offer FM and FSK amateur radio communication.
TiungSat-1, named after the mynah bird of Malaysia, was developed as a collaborative effort between the Malaysian government and Surrey Satellite Technology Ltd.

BreizhSAT-OSCAR 47 and 48 (IDEFIX CU1 and CU2)
Launched May 3, 2002 from Kourou, French Guiana on an Ariane 4 flight V151 carrying SPOT 5 as the primary payload.
Two picosats, designed and built by AMSAT-France, were battery powered and estimated to operate approximately 40 days. They remained fastened to the Ariane 4 third stage with an orbit of 800 km. Both picosats transmitted NBFM voice recorded messages and digital telemetry data. BO-47 on 145.840 MHz and BO-48 on 435.270 MHz. Telemetry data was transmitted in 400 bps BPSK, similar to AO-40's telemetry beacon.
BO-47 (CU1) stopped transmitting after 32 days of operation. Final reports came from Japan.
BO-48 (CU2) stopped transmitting after 14 days of operation. Final reports came from Japan indicating that the battery voltage had dropped to 7V and the RF output dropped to -6dB of its normal level.
Both satellites were equipped with 600 Watt-hour batteries. BO-48, transmitting on 435 MHz, had an output power 10 times higher that BO-47. The whole set of collected telemetry data is available upon request for educational purposes. Contact Jean-Louis F6AGR, President AMSAT-F.

RS-20
Beacon: 145.828, 435.319 MHz
Launched: November 28, 2002 aboard a Kosmos 3-M rocket from Plesetsk.
Status: Telemetry heard on the 70 cm beacon.

RS-20 is an experimental payload aboard the Russian satellite known as Mozhayets -- a
navigational and scientific satellite. RS-20 transmits CW telemetry. Each frame begins and ends with the call sign RS-20

AO-49 AATiS OSCAR-49 (SAFIR-M)
Uplink 435.275 1200-baud AFSK
Downlink 145.825 9600-baud FSK
(optional voice message)
Broadcast callsign: DP0AIS
Launched: December 20, 2002 aboard a converted Soviet ballistic missile from the Baikonur
Cosmodrome.
Status: Operational.
AO-49 (SAFIR-M) is a German amateur radio payload onboard the small German scientific
satellite "RUBIN-2". AO-49 was built by the German amateur radio association "AATiS e.V." (German acronym for "Arbeitskreis Amateurfunk und Telekommunikation in der Schule", which means: 'working group for amateur radio and telecommunications in schools'). AO-49 is designed as a "store and broadcast" system for APRS based messages, dedicated for the use of schools in combination with the existing WX-Net and planned buoy experiments in Germany. No transmissions detected since the 1st of February 2003.
Martin DG8UAU has written a small software program "SAFIR-M Decoder" to allow decoding of the received DATA0 frames. It is available at http://amend.gmxhome.de in the section Aktuelles. Details on AO-49 (SAFIR-M) can be found at http://amend.gmxhome.de.
Information about AATiS e.V. is available at http://www.aatis.de

SO-50 SAUDISAT-1C
Uplink: 145.850 MHz (67.0 Hz PL tone)
Downlink: 436.795 MHz
Launched: December 20, 2002 aboard a converted Soviet ballistic missile from the Baikonur Cosmodrome.
Status: Operational.
SO-50 carries several experiments, including a mode J FM amateur repeater experiment
operating on 145.850 MHz uplink and 436.800 MHz downlink. The repeater is available to
amateurs worldwide as power permits, using a 67.0 Hertz tone on the uplink, for on-demand
activation.

ARISS - International Space Station
Worldwide packet uplink: 145.990 MHz FM
voice uplink: 145.200 MHz FM
downlink: 145.800 MHz FM
TNC callsign RS0ISS-1
The ARISS initial station was launched September 2000 aboard shuttle Atlantis.

ARISS is made up of delegates from major national amateur radio organizations, including
AMSAT.
Status: Operational.
The current Expedition 7 crew is:
Commander Yuri Malenchenko, RK3DUP
Flight Engineer Ed Lu, KC5WKJ
The Packet system is currently non-operational.
Information on how to access the amateur radio equipment aboard the ISS is available at
http://www.marexmg.org/fileshtml/unprotopage.html
The ISS daily crew schedule can be found at
http://spaceflight.nasa.gov/station/timelines/. When crew members have free time, they may be available for amateur radio operations.
U.S. callsign: NA1SS Russian callsigns: RS0ISS, RZ3DZR

The QSL routes for stations working the International Space Station (all callsigns):

U.S stations:	Margie Bourgoin KB1DCO Attn: ARISS Expedition-1 (or 2, 3, etc.) QSL ARRL, 225 Main Street Newington, Connecticut 06111	SASE required
Canadian stations:	Radio Amateurs of Canada Attn: ARISS Expedition-1 (or 2, 3, etc.) QSL 720 Belfast Road, Suite 217 Ottawa, Ontario K1G 0Z5	
European stations:	AMSAT-France 16, rue de la Vallee 91360 Epinay sur Orge, France	SASE and 2 IRC's required

5. Amateur satellite organizations

AMSAT-NA Office
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Silver Spring, MD 20910-4703

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Club Office Mgr.
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6. Operating procedures

For amateur-satellite operating procedures see section Vc.

7. Satellite Coordination

See sections Id and VIIc

8. Acknowledgement.

The material for this section was originally prepared by Freddy de Guchteneire, ON6UG and Ron Broadbent, G3AAJ, but has been updated by Graham Ratcliff, VK5AGR, by Bertus Husken, PE1KEH and N.Janssen, PA0DLO and by Graham Shirville G3VZV