Greetings!

Hi there! Welcome to WinOrbit. This message will appear automatically each time the program starts, unless you **Save Settings** (search for "Save Settings").

I just wanted to remind you to check out this **Help** file for lots of hints and useful information, as well as installation and troubleshooting instructions. To see what's available, click **Contents** in the button bar above, or here.

If you are upgrading, read about the **New Features.**

73!

New Features in version 2.5

This version is mostly bug fixes based on user reports, notably:

* "Next Pass" now determined based on present UTC, not local (CPU) clock time.
* Fixed the "resume without error" bug in Print Ephemeris when not printing to a file.
* If map (land/ocean) colors are changed, it is no longer necessary to "clear display" in each map after restarting the program.
* Observer QTH now displays properly in the Main window.
* Help file displayed automatically if .INI file is not current.

K8CG, 6 May 1995

Back to **Startup Message**.

Help for WinOrbit 2.5

Table of Contents

Introduction

WinOrbit is a program for computing artificial Earth-satellite position and visibility, with the Amateur Radio Satellite operator in mind.

WinOrbit is free. If you enjoy the program and want to express your support, you could join AMSAT, or make a donation to the Amateur Satellite program, but that's up to you.

Please note: absolutely **no guarantees** of accuracy or precision are made! Commercial use is prohibited.

You can read more about:

- Features of the program
- Getting copies and updates
- History
- Performance, including:
  - Accuracy
  - Speed
- Acknowledgements

To learn more about satellite orbital calculations, read some of the articles listed in the Bibliography. To learn more about the Amateur Satellite program, beginning with Oscar I, refer to some of the material on individual satellites.

The program (and this help file) are under construction, and your feedback is encouraged. Please send any comments, corrections, suggestions or questions to me.

GL es 73 !

de K8CG, Carl Gregory, May 1995

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Introduction - Features

The principal feature of the program is a series of tracking windows, one per satellite, which display the current position of the satellite and the observer on a simple world map, together with information such as bearing (azimuth), distance, and elevation above the observer's horizon. *(To see the latest changes, bug fixes, and updates, click here.)* Additional noteworthy features include:

* Simultaneous tracking of up to 20 satellites.
* Real-time, pseudo-real-time, and manual calculation modes.
* Choice of 4 tracking algorithms.
* A "view from space" map presentation showing what a particular satellite sees.
* Computation of Doppler shift and path loss for communications satellites.
* Selectable tracking detail, including doppler shift and free-space path loss, for a single satellite.
* Utility functions for modifying and comparing published element sets, including post-launch updating of pre-launch elements.
* DDE server interface to tracking-antenna or doppler-shift correction hardware controllers.
* Tracking data (Keplerian element sets) read from standard, off-the-air bulletins in two different formats (up to 200 satellites). No pre-processing is needed.
* Observer (QTH) data (latitude, longitude) may be imported from a simple text database (up to 1000 locations).
* Printing of tables of tracking data (Ephemerides) in several formats. Table printing does not interrupt tracking. Table output may be directed to a disk file.
* On-line help including direct access to text information about each satellite from the tracking window.
* Standard Windows interface for all functions - no commands to memorize.

Introduction - Distribution

I will try to make **WinOrbit** updates available via some popular shareware/freeware archives, particularly anonymous ftp from oak.oakland.edu and ftp.amsat.org.

Introduction - History

WinOrbit is a descendant of Tom Clark's (W3IWI) original program, written in NorthStar BASIC (**Orbit** magazine, Number 6, March/April 1981, page 6). That article has detailed descriptions of the calculation algorithms, and diagrams showing how the various orbital parameters are defined. This original program did not have the orbital decay parameter. Tom described the addition of the decay rate to me at the Dayton Hamvention in 1982.

My versions of the program have passed through several generations, for TRS-80 model I BASIC, Cromemco CDOS Fortran (Z-80), and eventually to the Intel processor series. At each level, some more convenience features were added. The current version was written for Microsoft Windows 3.1 using Microsoft Visual Basic 3.0, and runs very well on a 486DX33 system. The first public version was released in December 1994.

Introduction - Accuracy

Since the intended use of this program is Amateur Radio satellite tracking (or possibly naked-eye visual observation), great accuracy is not really necessary. Typical Amateur antenna systems (less than 20 dB gain) have beamwidths of 10 degrees or more. Thus, even a low-orbit satellite (at say 600 km altitude) need only be located to within 50 km or so!

There are 3 aspects to the accuracy of tracking predictions:

I. Numerical accuracy of calculations: This includes digital precision (loosely, rounding-off errors), uncertainty in parameter estimates, and the way in which parameters are incorporated into the model (i.e. some parameters may have more "leverage" to influence the results than others). For what it's worth, all calculations, including trig functions, in **WinOrbit** are done in "double precision" (about 14 significant figures). If realized completely, this could give an epoch-time precision of about +/- 100 microseconds, or a position precision of about +/-1 m for a typical orbital velocity. The bottom line here is that (unlike my old Z-80 system) with Windows/386/486-class machines, numerical error is the smallest of the effects on accuracy.

II. Orbital model accuracy: There are varying degrees of detail in representing the orbital motion of a satellite, depending on the required accuracy. **WinOrbit** incorporates 4 different user-selectable mathematical models, ranging from crude to moderately sophisticated. The effects of detail in the model appear in two places: in the exact position of the satellite as it orbits the earth; and in the way the orbit evolves with the passage of time. There is a tradeoff between complexity (and speed of calculation) and accuracy. A further tradeoff occurs because the published parameters (Keplerian Elements) for the models are adjusted to provide the best predictions for a particular model, and may not work as well for other models.

III. Observer model accuracy: Once the satellite's position is known to the desired degree of accuracy, we need to compute where to look (or point the antenna). Once again, there are levels of accuracy here. The simplest approach is to treat the Earth as a sphere, and assume line-of-sight propagation (no atmospheric distortion for visible objects, or ionospheric refraction for radio objects). Some improvement in accuracy can be had by representing the earth as an ellipsoid (decreased position errors at the poles and equator of up to about 20 km). One can include higher-order shape terms, but with rapidly diminishing benefit (the ellipsoid is accurate to about +/- 100m at sea level). **WinOrbit** permits either the sphere or the simple ellipsoid representation to be selected. Some satellite programs also incorporate an atmospheric bending correction for satellites near the horizon. This correction is strictly valid only for some standard set of pressure, temperature, and relative humidity, in the visible wavelength band. For radio propagation, particularly at HF or low VHF frequencies, ionospheric effects are highly variable and relatively unpredictable. Therefore, **WinOrbit** does not include any correction to the geometric line-of-sight calculation.

Other aspects of accuracy relate to the presentation of the results:

The Maps: The accuracy of the on-screen display depends not only on the resolution of the display adaptor (how many independent pixels exist on the screen, like 1024x768) but also on the underlying map information. The maps are all generated by expanding, contracting, or distorting an internal bitmap which has a resolution of about 1000x500 pixels. Thus, accuracy better than about 0.3 degrees is impossible. In practice there are some problems with the bitmap, particularly in the antarctic regions, and near the International Date Line. Small islands have also been omitted in many cases. So don't expect too much.

Note: **WinOrbit** calculates the satellite perigee, apogee, etc. based on the spherical earth model. Only the instantaneous satellite altitudes reflect the selected geodetic model (altitude above mean sea level).

Note : Doppler shifts are calculated based on the difference of two successive ranges, so the accuracy here will depend on the resolution interval as well as the above factors.

Introduction - Speed

One concern about programs such as WinOrbit is how fast they run - how frequently can the screen be updated, and what effect the program has on other programs running at the same time. Since speed is highly machine-dependent, I can only report what I have found on my personal system.

Test System Configuration

486DX33, 8 Meg physical RAM, WD 90C31 (Paradise) SVGA adaptor, 1024 x 768 x 256-color screen resolution.

Speed results

Basic orbital model, elliptical Geodetic model, tiled tracking maps, standard map colors, ground track and footprint display on.

1) Maps can be updated at about 6 per second (i.e. 6 maps take 1 second, 12 maps take 2 seconds).

2) Ephemeris calculations proceed at about 250-300 intervals/second (for example, 10 days of predictions at 2 minute intervals in 25 seconds). Time to actually print was not measured (depends on brand of printer!).

Optimizing speed

Choose a reasonable update interval (5-10 seconds is nice for LEO satellites).

Omit the ground track, solar illumination, and footprint when not needed.

Use the Basic orbital model whenever possible.

Use the standard map colors (for land and water). Changing these colors (but not the symbol colors) will slow the loading of the maps (but not the calculation or display).

The Globe display is VERY slow. I'm working on this. It will go a bit faster if you are not updating the maps frequently in real time (e.g. choose a 30 second interval, or change to Step mode). Also, the larger the Globe window, the longer it takes to draw.

Introduction - Acknowledgment

In addition to Tom Clark's major impetus through his **Orbit** article, I'd like to acknowledge having looked at or read some of the many software and documentation offerings provided by Tom Kelso on the Celestial BBS (via archive.afit.af.mil), and more recently by KB5MU and the folks at Qualcomm on the AMSAT BBS (via ftp.amsat.org). These include offerings said to be based on work by G3RUH, James Miller, and by DL4ZC, Karl Meinzer.

The SGP/SGP4 code was adapted from the FORTRAN listings published by Tom Kelso in the Project SpaceTrack documentation.

Kep files have been obtained from the N9LNQ PBBS in Champaign, IL.

Thanks to the many users who have given bug reports, suggestions, or other feedback - every message is appreciated.

See the Bibliography for other articles whose content influenced this program.

My wife has also supported this project by her encouragement of my "hobby time".

Setting up the program

If you have gotten this far, I can assume you have obtained a copy of the program archive (WINORBxx.ZIP, where xx is the version number), and "unzipped" it. Follow the instructions below for a quick setup.

Set up files

1) Put all the files in a subdirectory of your choice.

Run the program

2) Start the program from Program Manager (or File Manager, by double-clicking WINORBIT.EXE). After a minute or so, the Main, Map and Info Windows will appear. The default satellite will be "Phase III" - the original preliminary orbit information for what later became Oscar 10, and the default Observer will be W3IWI in Maryland, USA.

Customize

3) In the **Setup** menu, choose **Observer/QTH...** and enter your latitude and longitude. South latitudes and East Longitudes are entered as negative numbers. For now, the program only accepts decimal values (not degrees, minutes, seconds). You can also enter your callsign and other descriptive information as desired. Click **OK** when everything is right.

4) In the **Setup** menu, choose **Time Zone** and fill in the time difference.

Choose a satellite

5) Select the "Phase III" Map window in the **Windows** menu. Position the window as desired. In the "Phase III" window, select **Satellite...** to bring up the satellite-selection dialog.

6) Choose your favorite satellite from the list. Enter the communication frequency in MHz (for Doppler and path loss calculations). Click **OK** to accept the choice.

Save your settings

7) In the Main Window, choose **Setup:Save Settings Now** to save all your settings. The program will start up in the same configuration next time. The information is stored in WINORBIT.INI in the c:\windows directory.

You're done! Refer to the various help topics such as menus and commands for operation of additional features. In case of trouble, refer to the Frequently-Asked-Questions (FAQ) , or the troubleshooting hints.

For more setup information, click here

Advanced Setup

Once you are familiar with the program, you'll want to take advantage of some of the following options to improve your satellite operating:

Add additional map windows with other satellites. In the Main Window, choose **Window:New**. After the window appears, choose **Satellite...** In the Satellite dialog box, select a different satellite. Enter the new frequency, and click **OK**. Repeat as often as desired. When done, choose **Window:Cascade** or **Window:Tile** in the Main Window, to organize the windows on the screen.

Obtain a more recent Keplerian element file and put it in the same subdirectory with the program. In any map window, choose **Satellite...** to bring up the dialog box. Choose **File:Open 2-Line** or **File:Open Keps** (depending on the file format) to select the file. The file will be read, and the new entries will appear at the end of the list in the box. Note: the updated elements do not automatically replace the ones in use - you must manually select each new element set before it takes effect.

Always remember to **Save Settings** after any changes that you wish to make permanent!

Move the files CMDIALOG.VBX, VBRUN300.DLL to c:\windows\system, to reduce the clutter in your \WINORBIT directory.

Create a Program Manager item for the program file (WINORBIT.EXE). The icon should be a little globe with orbiting satellite. Refer to the Windows Program Manager documentation and on-line Help for procedures.

In Case of Trouble

Here are some commonly-reported problems, and the explanations or fixes. Maybe these will go away in the next version. Maybe not.

Q: I can't run the program at all. I get a message about "cannot find file or one of its components".

A: As noted in the README.TXT file, you need to get VBRUN300.DLL from your favorite software source (see README.TXT for suggestions). It is generally found as VBRUN30x.EXE, a self-extracting archive file. Put the file in \WINDOWS\SYSTEM, or in the same directory with **WinOrbit**.

Q: I can't see the maps at all - they just look like garbage. What's wrong ?

A: This effect has been reported by some users with 32k-color and 64k-color video drivers. It is reported that changing to a 256-color driver (in the Windows control panel, or using your system's setup utility) will fix the problem. The display also looks ok with 16 colors, or 16 million colors. Please send a report if you have this problem.

Q: The map looks fine on the screen, but the printer output is (almost) blank.

A: Try changing the printer settings (especially any settings pertaining to colors) in the Windows Print Manager. Or change the map colors (**Options:Colors...** in the Main Window) by trial and error until you get something satisfactory. It all depends on the specifics of the printer you have.

Q: The program "hangs" at a certain point with no error messages, and must be killed from Windows using "Ctrl-Alt-Del" ?

A: This may be due to use of a memory manager (like QEMM or MemMaker). Or it could be a problem with my code. Please try to reproduce the problem and send me a description. Try reorganizing your TSRs (loaded in DOS from CONFIG.SYS and AUTOEXEC.BAT) to see if you can get past the problem area.

Q: After editing the Keps in the Satellite Dialog, the new values are not saved correctly. It looks like everything is truncated to an integer value.

A: Make sure that the Number Format, Decimal Separator is ".", not ",", in the International Control Panel. (Hopefully fixed in v 2.4).

Q: There's only one satellite (Phase III) in the list to choose from ?

A: Try **File:Open** in the Satellite Dialog Box. Pick a file (of the proper type - NASA-2-line or AMSAT-text-kep format). The program will look for a file of the proper type in the current directory when it starts, but if it cannot find one for some reason, it will just skip this step.

Q: I get a "Checksum Error" when opening a satellite data file ?

A: There are three possibilites: 1) the data file is corrupted or contains one or more typographical errors; 2) the person who generated the original file computed the checksum improperly; or 3) a different algorithm was used to compute the checksum than that used by **WinOrbit**. If you can determine that the file is ok, and can find the checksum algorithm, please let me know. The *number* given in the error message box is the checksum computed by the program.

Q: The satellite does not move, and the displayed UTC date and time does not change.

A: Be sure you have chosen **Epoch:Real Time** (checkmark in the Main Window menu). Check the **Res (sec)** box in the Main Window. The value should be a whole number larger than zero. If it is too large, the screen will update very infrequently. The default is 100 sec, which is pretty slow. Try 5 or 10 seconds. Choose **Epoch:Now** in the Main Window to update the display to the present time and restart the timer. On the other hand, if the interval is too small, the screen may not be updated properly in between. In some cases, the clock may appear to run, but the satellites are frozen. Try a larger interval.

Q: The display in "Show position" is the same regardless of whether inertial or geodetic coordinates are chosen ?

A: The report text box may not be big enough to see the X,Y,Z values. Use the horizontal scroll bar to scroll to the end of the line.

Q: "Overflow" error message crashes the program when printing.

A: This has been reported to occur if the selected interval is too short (or the resolution too coarse), so that the selected satellite is never visible at the observer location. Please report any other circumstances causing this error to the author (so it can be fixed)

Q: "Type mismatch" error crashes the program on startup (or when changing satellites or entering a date) ?

A: This has been a persistent bug, due to the various time and date formats Windows uses. Try changing the date (or time, or number) format in the Windows International Control Panel. (Hopefully fixed in v 2.3)

Q: I keep typing in numbers to change a parameter, and the program ignores them - it just keeps using the old number.

A: Some of the text boxes will accept multi-line entries. If you type a number followed by hitting "return", you will see a blank box. However, the program sees the number that was typed. If you enter another number, it may be ignored. Solution - don't hit "return" when entering data - use the mouse or the TAB key to change to the next box. (Fixed in v2.3).

Frequently Asked Questions (and Answers)

Here are the answers to some frequently-asked questions about **WinOrbit**.

Q: How do I track more than one satellite at a time?

A: At present there is one satellite per tracking window.   You need to add additional windows, by using the Windows:New or File:Open commands in the Main Window.

Q: Why do I get the message "Invalid Keyword" from WinHelp, when I click "Info" on the Tracking Map or Satellite Window ?

A: The Info command asks WinHelp to display the text page from this Help file, for the currently-displayed satellite.   If the satellite isn't in the file, you will get the message.   The satellite name (shown in the title bar of the tracking window) must match exactly.

Q: Can I change or add to the satellite info file ?

A: Not directly.   This is a Windows Help hypertext file and requires a special compiler. However, you can add your own notations using the **Edit:Annotate** menu option in Windows Help.   This will put your notes in a separate file (\WINDOWS\WINORBIT.ANN), and mark the topic with a "paperclip" icon you can click to recall the notes.

Q: What if the satellite I want isn't in the available data files ?

A: If you have a source of tracking data (Keplerian elements), you can type them in yourself, in the Satellite window (Choose **Satellite...** in the Map window, or **File:New** in the Main window).   Be sure to **Setup:Save Settings** after doing this, or you will have to type the information in again next time you start the program.

Q: What about a geo-synchronous satellite ?

A: All you need is the longitude.   In the Satellite Dialog Box, click **Edit Elements**, then select **Special:Make Geosynchronous**.   You'll be prompted for a longitude.   It's best to use the Ideal orbital model for these, otherwise the position will drift slowly (these satellites have to use fuel to adjust their orbits).

Q: Why are there duplicate entries in the satellite list?

A: You have probably opened more than one data file.   At present, the program does not overwrite any existing entries when you read a new file.   It just adds them at the end of the list.   Thus you could have several entries for one bird, possibly representing different element sets.   Check the Description box in the Satellite dialog to see which set you have selected.   In addition, there is a separate entry (near the beginning of the list) for each tracking window.   Thus, you can have a modified entry for the tracking window, and keep the original entry below it in the file list.

Advanced Features

DDE Server: A DDE client can establish links to any of the following TEXT-format items (listed below). These can be manual, automatic or notify links. All topics are updated each time the maps are updated, whether they are visible or not. All information refers to the currently-selected satellite (the one chosen in the Main window, for which detailed tracking information appears in the Info window).

Application Name: WinOrbit

Topic Name: TrackingInfo

Item Name: SatelliteName - Text indicating the currently-selected satellite.

Item Name: AzimuthDegrees - Provides the antenna azimuth to the nearest degree (0-359) for the currently-selected satellite.

Item Name: ElevationDegrees - Provides the antenna elevation to the nearest degree (-90 - 90)

Item Name: FreqMHz - Operating frequency in megahertz.

Item Name: DopplerHertz - Doppler shift (+/-) in hertz.

It is up to the client program to decide what to do with the data. For example, antenna elevations below the horizon are probably undesirable, but the horizon may vary at different observer sites and with different systems. Similarly, the mechanism and resolution of Doppler correction may vary. By using the DDE mechanism, WinOrbit can concentrate on the calculation and display, and the client program can concentrate on tracking.

At this time there is no System topic since there doesn't seem to be a standard format for it. Refer to Microsoft documentation for DDE implementation.

Updating the Elements

WinOrbit uses publicly available data sets called Keplerian Elements, which are updated frequently to include new satellites, and reflect the gradual changes of the orbits of old ones. These tables are available from many BBSes, and in the form of bulletins on the Amateur Radio packet networks and in bulletin broadcasts from various Amateur Radio stations. The program accepts two basic formats, but is not terribly picky about the details of the files - all you need to do is save a bulletin file in ASCII text format with the right sort of filename.

The two formats commonly used are:

* the "2-Line Element Sets" published by NASA and others, where two cryptic lines of numbers describe each satellite; and

* the "AMSAT format", where each value is on a separate line together with the English name of the element.

Either format is ok. The first kind should be given a filename ending in ".2LI", and the second type should end in ".KEP". The program can find its way past the header information, so there's no need to edit the files at all in most cases. Currently published element sets have a checksum included to verify that the numbers were transcribed or transmitted correctly. If the checksum is absent or wrong, an error message appears, giving you the option to keep the data anyway or discard it.

There is a limit of 200 satellites in the internal buffer of the program. The list can be compiled from several different files, by opening them one at a time in succession. The program will always start next time with the last file that was read (with **File:Open**). Thus, if all your satellites are in the same file, you don't even have to enter the filename unless you are updating to a newer data set.

You can also "adjust" an existing set of elements automatically (or manually), for example to compensate for a late launch when using a pre-launch data set. See Hints for more.

Hints and Suggestions

Here are some suggestions for ways to use the program:

Long-range planning (which days should I come home early to listen to a particular satellite?) Use **File:Print Ephemeris...** and choose a long duration (e.g. 240 hr = 10 days), with the Timeline option. To avoid a long wait, use a resolution interval of 2 minutes or so (120 sec).

Intermediate planning. For planning a specific operating sessions, acquisition-of-signal (AOS), loss-of-signal (LOS), and time-of-closest-approach (TCA) tables are useful. These may be generated from the **File:Print Ephemeris...** selection in the Main window. For highest accuracy, select a small resolution interval (e.g. 10 seconds).

Field Day (or for other portable operations, using an OscarLocator instead of a computer for tracking): Equator-crossing times (EQX) are required. These may be generated from the **File:Print Ephemeris...** selection in the Main window. For highest accuracy, select a small resolution interval (e.g. 10 seconds).

Mutual Visibility. Use the **Observer/QTH** dialog to set up some locations of interest in SPECIAL.QTH. These locations can then be displayed on the map (**Options:...**). When the satellite footprint includes any pair of locations, they have a *mutual visibility window*. Use the **Calc:Step** or **Calc:Pseudo-Real-Time** modes to schedule a QSO. Set a starting time in Step mode, then switch to pseudo-real-time to see the motion of the satellite.

Satellite eclipses. Display the Solar Illumination on the map. If the satellite footprint crosses into the sunny side of the terminator, the satellite is in sunlight.

State Vectors. The position part of the state vector (but not the velocity) can be obtained by choosing **Calc:Position - Geodetic** in the Main Window. Multiply by 3280.839895 feet/km to compare with NASA values.

Generating other tables. Generate a printout with high time resolution (1 or 10 seconds), but output it to a file. Then use a spreadsheet program to extract other information.

Identify Landmarks in a Satellite Photo. Wonder what you're looking at in a Webersat or Kitsat image ? Using the acquisition time of the photo, the proper satellite selection, and the Calc:Step mode, obtain the satellite position at the time of the photograph. Then generate a "view from space", with latitude and longitude grids. Compare the calculated view with the image to identify landmarks.

Compare algorithms. This is an interesting and educational exercise. Select one satellite element set. Generate 2 more windows (with **Window:New**). Change the algorithms in the new windows using the **Options** menu in each tracking window. Choose **Calc:Step** in the Main Window, and **Calc:Reference** . This will set the time to the reference data set time. All algorithms should give virtually the same results for this time. Now step forward or back and see how long it takes for the predictions to diverge. Change the step size (**Res (sec)**) if things are changing too slowly.

Add a new window, but this time choose a different element set for the same satellite (a few weeks earlier or later). Set the time to the reference time of the later element set. Which of the algorithms does the best job of predicting the correct position from the earlier elements ?

Repeat the exercise with different satellites. What happens to the predictions for DOVE ? How about MIR, in a very low orbit ?

Update a pre-launch kep set. Prior to certain launches, preliminary kep files are often available. To be useful, they must show the assumed launch time. Once you know the actual launch time, you can generate your own prediction, even before the official elements are published. Here's how: In the Satellite Dialog Box, load the pre-launch data file. Choose **Edit** . Calculate the difference between the proposed and actual launch times. Add this amount to the epoch time of the pre-launch elements (generally it is not the launch time!), and enter it in the **Adjust Epoch** box. Then choose **Special:Adjust RAAN to Epoch** . Then **Use Adj** to retain the updated elements. **Save Settings** to avoid losing the result.

Check the Magic Angles. Certain values of inclination, mean motion and eccentricity lead to interesting effects. For example, proper choice of the inclination can lead to a sun-synchronous orbit, which passes over a given spot at exactly the same local time each day. Other values will inhibit the precession of the orbit, so that the satellite position will repeat every year. And so on. One way to investigate this, is to use the Satellite Dialog Box **Edit** option, enter a set of elements, and a new epoch (for example the same time of day, but 1 day week, or year later). Then choose **Special:Propagate Elements to Epoch** to calculate the new elements. Note the longitude of the node (position on earth) and the Right Ascencion of the node (position n space). Also the Argument of Perigee (related to the latitude of perigee) is interesting.

Function Key List

WinOrbit uses function keys to speed some important operations (each of these functions can also be selected using the mouse, of course). Function keys (like **F1**) can be used with Shift (**sF1**), Alt (**aF1**), or Control (**cF1**) to perform different tasks. Also, check the various window menus, for additional function key possibilities.

Universal functions

F1 - Help (takes you to the contents page)

sF1 - Satellite Information (general or specific, depending on context)

F2 - Activate the Main Window

sF2 - Activate the Info Window

F3 - Activate the next (or first) map window.

sF3 - Activate the previous map window.

cF3 - Activate the current map window (for the currently-tracked or active satellite).

sF4 - Tile windows.

sF5 - Cascade (stagger) windows.

Main Window Functions

F5 - Update all tracking maps to the current time.

F6 - Real-time mode.

sF6 - Step mode.

cF6 - Pseudo-real-time mode.

F7 - Update all tracking maps to the reference time.

F8 - Update all tracking maps to the current time.

F9 - Show next visible pass for all satellites.

Map Window Functions

F5 - Clear and redraw map.

F9 - Show next visible pass for current satellite.

F12 - Begin tracking the currently-displayed satellite (forces the Info window to refer to this satellite - same as selecting the satellite in the Main Window scrolling list).

Required Files

WinOrbit uses the following files:

WINORBIT.EXE The actual program. Can be run directly from Program Manager or File Manager in the usual way.

WINORBIT.INI Standard Windows format .INI file. Normally located in the \WINDOWS directory.

WINORBIT.HLP Standard Windows format help file (what you are reading now). Normally located in the same directory as the WINORBIT.EXE file.

***.KEP** Text file in standard bulletin format (with complete element names - sometimes called AMSAT format). Can often be created by simply saving a packet or HF RTTY/AMTOR bulletin directly to disk - most of the extra lines will be ignored by the program. May contain multiple satellite data sets. If you create this file by hand from a voice or cw bulletin, or from a magazine, be sure to copy the EXACT format and spelling of the satellite element names.

***.2LI, *.TLE, *.ELE** Text file in standard bulletin format (with NASA 2-Line element data). Can often be created by simply saving a packet or HF RTTY/AMTOR bulletin directly to disk - most of the extra lines will be ignored by the program. May contain multiple satellite data sets.

***.QTH** Text files containing latitude and longitude data for QTHs of interest in the following format: callsign/ITU prefix, location, latitude, longitude. LAUNCH.QTH and SPECIAL.QTH are two such files with special significance: each is automatically loaded at startup, and used to draw the corresponding locations on the tracking maps, if selected.

CMDIALOG.VBX Microsoft Windows "control" file for Visual Basic. Belongs in \WINDOWS\SYSTEM. Should be included with the distribution file.

VBRUN300.DLL Microsoft Windows program library file. Normally located in WINDOWS, or else inthe same directory as WINORBIT.EXE. Can be obtained free from many BBS's or may be included in the .ZIP file distribution.

COMMDLG.DLL Microsoft Windows program library file. Normally located in WINDOWS, or else inthe same directory as WINORBIT.EXE. Can be obtained free from many BBS's, if it did not come with your copy of Windows. I only mention this one because I ran across a couple of older systems that did not have it.

Displays and Windows

There are three types of windows:

Control windows
The **Main Window (at the top of the screen) and the info window (at the left edge) are normally present at all times, and there is only one of each, regardless of the number of satellites being tracked. Actions taken in the main window affect all of the tracking windows, while the Info Window is specific to a single satellite. Information to be used for hardware control comes from the info window.**

Map windows
One **Map Window appears for each satellite being tracked. The tracking displays are synchronized (by the main window), although certain options may be independently selected for each map.**

Special windows
These windows appear only when there is a need for the user to provide information, or for the program to display it. The most important are:
Report Window: view, edit, save and print numerical results.
Globe Window ("View from Space"): more than a map.
Observer I nformation Window: select, display and edit observer data and other points to be plotted on the maps.
Satellite I nformation Window: select, display, edit, print, and manipulate satellite data.
Print D ialog Window: specify format of ephemeris printouts.

Menus and Commands

Function Keys

Main Window Menus and Controls

- File
- Edit
- Setup
- Calc
- Windows
- Help
- Miscellaneous Functions

Info Window Controls

- Info
- Miscellaneous Functions

Map Window Menus

- File
- Satellite
- Functions
- Options
- Info

Globe Window Menus ("View from Space")

- File
- Options
- Help

Report Window Menu

- File
- Edit
- Help

Satellite Setup Window

- File Menu
- Options Menu
- Special Menu (Only enabled in **Edit** mode.)
- Help Menu
- Data Fields

Observer Setup Window

- File Menu

Main Window

The Main window appears (normally) at the top of the screen and has menus for setup/customizing, control of tracking, window arrangement, creation of new tracking windows, and help. The date and time of the current map displays is shown in the Main window, as is the location of the observer for whom azimuth and elevation information are calculated. Note that the date and time may be different from the clock-on-the-wall time, depending on the calculation mode.

Minimizing this window will hide all windows except for map windows with the "Don't Hide" option checked.

Ephemeris printouts are initiated from the Main window (File Menu)

Exit the program by closing this window (or from the File Menu).

Main Window Menus and Controls

- File
- Edit
- Setup
- Calc
- Windows
- Help
- Miscellaneous Functions

File Menu (Main Window)

New (alt-F, N) - Open a new tracking window with selection of satellite from the currently-loaded database.

Open 2-Line (alt-F, 2) - Open a 2-line-element (NASA format) satellite data file and add the satellites to the current data-base. Then open a new tracking window after selecting a satellite from the augmented database.

Open Keps (alt-F, K) - Open a Keplerian element (AMSAT format) satellite data file and add the satellites to the current data-base. Then open a new tracking window after selecting a satellite from the augmented database.

Save As (alt-F, S) - Not yet implemented.

Print Ephemeris (alt-F, P; or ctrl-P) - Bring up the Print dialog box to print one or more tables of satellite positions ("Ephemerides").

Exit (alt-F, X) - End the program. If the "save settings on exit" option is chosen, all window positions and satellite information will be saved at this time.

Edit Menu (Main Window)

The commands are not presently implemented from the menu. However, *cut/paste* to/from most data entry fields will work, using the Windows 3.1 standard ctrl-C, ctrl-V keys.

Setup Menu (Main Window)

Observer/QTH... (alt-S, Q) - Allows selection of the observer location ("QTH" in an old Morse code abbreviation) from a database, or by typing in coordinates.

Time Zone... (alt-S, T) - Allows specification of the difference between computer clock and UTC. All calculations are performed in UTC.

Colors... (alt-S, C) - Permits changing the colors of certain symbols on the tracking maps.

Distances in Miles (alt-S, D) - Toggles conversion from kilometers (default) to miles. Conversion is in effect when the check mark is present. Affects range and altitude calculations for satellite, only.

Show FootPrints (alt-S, F) - Toggles the display of a "footprint" or "circle of visibility" on the tracking maps. Points inside the circle have the satellite above their local horizon. The footprint does not look like a circle when the satellite is near the poles, due to the distorted map projection. Display is "on" when the check mark is visible.

Show Ground Tracks (alt-S, G) - Toggles the display of a ground track on the tracking maps. This ground track is simply a series of dots representing previous subsatellite points. Display is "on" when the check mark is visible.

Save Settings Now (alt-S, N) - Save all configuration information immediately. This includes window size and position, satellite orbital elements, filenames, and options.

Save Settings on Exit (alt-S, S) - Will automatically save all settings when the program exits normally. This option is toggled on and off (on when check mark is present).

Calc Menu (Main Window)

(Formerly Epoch Menu, in v2.2 or earlier)

The options in this menu control how the satellite positions are calculated. The positions are always calculated at specific time intervals (e.g. 10 seconds apart). This interval is the "resolution". The actual rate of the calculation can be the same as the resolution (real time), at some other selected rate (e.g. 10 minute intervals calculated every 15 seconds) (pseudo-real time) or manually (e.g. 10 minute intervals, updated when the button is clicked) (step mode). This allows speeded-up and stop-action displays in addition to the real-time mode, for investigation of satellite behavior in the past or future, or other purposes.

Step (alt-C, S; or shift-F6) - Selects step mode. Two buttons - "fwrd" and "back" appear in the Main window to control the updating of position. Date and time may also be entered directly in the Epoch box, in which case the dislay updates if a "return" is typed.

Pseudo-real Time (alt-C, P; or ctrl-F6) - Selects pseudo-real-time mode. A scroll-bar appears in the Main window to control the update rate.

Real Time (alt-C, R; or F6) - Selects real-time tracking. The satellite positions are calculated at the current clock time. Updates are done every "interval" seconds.

Now (alt-C, N; or F5) - Reset the display time to Now by reading the computer's clock. Useful when returning to real-time mode after step mode, for example.

Reference (alt-C, f; or F7) - Reset the display time to the reference epoch of the currently selected satellite. The tracking mode is set to Step at the same time.

Show Position (Inertial or Geodetic) (alt-C, I; or alt-C,G) - Pops up the Report Window and displays the current position (state vector) of each satellite in either inertial coordinates (fixed with respect to the stars) or geodetic coordinates (fixed with respect to the earth). The NASA state vector E, F, and G values (in feet) can be obtained from the Geodetic position (multiply by 3280.839895 feet/km).

Show Next Pass (alt-C, x; or F9) - Pops up the Report Window and displays the AOS/LOS/TCA for the next visible overhead pass of each satellite, up to 48 hours from now, with a resolution of 10 seconds. May take considerable time to complete.

Windows Menu (Main Window)

New (alt-W, N) - Create a new tracking window by copying the last window. The new window inherits all the settings of the previous window. To change the satellite, choose "Satellite..." in the menu bar of the new window.

Cascade (alt-W, C; or shift-F5) - Resize the Main and Info windows to fit the screen. Arrange all tracking windows in a "cascade" from upper-left to lower-right.

Tile (alt-W, T; or shift-F4) - Resize the Main and Info windows to fit the screen. Arrange all tracking windows side-by-side in the remaining space.

Show Info (alt-W, S; or shift-F2) - Toggle display of the Info window on or off. Note - in early releases, the Info window cannot be moved by the user - just turned off.

Show Report (alt-W, R; or ctrl-F2) - Toggle display of the Report window on or off.

Tracking window list - A list of all currently-loaded tracking windows appears at the bottom. Selecting a window from the list will bring it to the front of the display.

Help Menu (Main Window)

Help (alt-H, H; or F1) - Bring up the contents page of WinOrbit Help (The file you are reading now).

Satellite Info (alt-H, S; or shift-F1) - Bring up a window with a list of satellites on which text information (history, description, frequencies) is available. This uses the standard MicroSoft WinHelp utility. Information may be updated or personalized by using the WinHelp Edit:Annotate menu item.

System Info - Display a box with a summary of system features. Useful for troubleshooting or corresponding with the author. The box can be printed (screen-dump).

About Orbit (alt-H, A) - Display version and copyright information.

Miscellaneous Functions (Main Window)

Tracking (alt-T) selection box. Allows selection of one satellite, from those currently being tracked, for detailed display in the **Info** window (and for antenna pointing or radio control via the DDE interface).

UTC Date and Time (alt-U). Shows the epoch for the currently displayed satellite positions. In **Step** **mode, this field may be edited to specify a different time. The calculation will be done when "return" is typed.**

Res (sec) (alt-R)**.** Time Resolution for tracking. This is the size of a step for calculations in all modes. In **Real-Time** **mode, it is also the interval between updates of the display. Note: When the value is changed, the new resolution will take effect at the completion of the current interval.**

The following controls appear in **Step** **mode:**

Fwrd (alt-d)**.** Advance the epoch by **Res** seconds and update the displays.

Back (alt-B)**.** Decrease the epoch by **Res** seconds and update the displays.

The following control appears in **Pseudo-Real-Time** **mode:**

Delay (msec). A new calculation will be done every **Delay** milliseconds, with the epoch advanced by Res seconds and the displays updated to the new epoch. If **Delay** is too short and the CPU is too slow, the updates will be done as fast as the computer can process them.

Map Window

One Map Window appears for each satellite being tracked. The tracking displays are synchronized (to the time displayed in the Main window). However, certain options and functions may be independently selected for each map. For example, to print a specific map, the Print Map option is selected from its File Menu.

Each map has the following components: A colored world map ("rectangular" projection - not Mercator!) with linear degree scales along both latitude and longitude; Grid lines, spaced every 30 degrees in each direction; Satellite position marker (small circle); and Observer position marker (larger circle with dot in center). The colors of some of these features can be changed from the Main window, Setup Menu.

Optional features include: Ground track (a trail of solid dots representing previous satellite positions); Footprint (a line indicating the horizon as seen from the satellite - every point inside the line has the satellite above its local horizon); Other observer locations (two groups); Solar illumination (a sun icon, representing the subsolar point, and a line representing the terminator or twilight locus).

At the bottom of the map is a strip showing some tracking parameters - azimuth/elevation from the observer; satellite latitude, longitude, altitude; and doppler shift.

Map Window Menus

- File
- Satellite
- Functions
- Options
- Info

In earlier versions of the documentation, I referred to the Map Windows as "Tracking Windows". I have found this to be confusing, since the Info Window was also called the "Tracking Info Window". If hardware is connected, the satellite being physically "tracked" is controlled not by the Map Window, but by the Tracking Info Window. Hence the new designation: "Map Window".

File Menu (Map Window)

Show Main (alt-F, M; or F2) - Displays the Main Window (if hidden) and makes it the active window.

Show All (alt-F, A) - Recalls all hidden windows.

Save as .BMP (alt-F, S; or ctrl-S) - Saves the map, with ground-track, footprint, observer, etc. in a Windows bitmap file (.BMP). This can be edited with PaintBrush, printed or used in a document. The filename is TRKMAPnn.BMP, where nn is the number of the current window. The size of the file depends on the size of the window on the screen.

Print Map (alt-F, P; or ctrl-P) - Prints the map on the default Windows printer. This is just a crude screen-dump. The appearance will depend strongly on how your printer handles colors. The size will be proportional to the size on the screen, but the scaling will also depend upon the printer.

Exit (alt-F, X; or ctrl-F4) - Exit the map, close and discard the window.

Satellite Menu (Map Window)

Simply calls up the satellite selection window (dialog box). The map will change to track the newly selected satellite. Additional database files can be loaded in the satellite selection window.

Functions Menu (Map Window)

Clear Display (alt-u, C; or F5) - Erases and redraws the map. All ground-track information will be lost. The same effect can be had by double-clicking the map.

Track (alt-u, T; or F12) - Causes the display in the Info Window (and hence the satellite tracked via the DDE interface) to switch to the satellite displayed in the current map.

Show Next Pass (alt-u, x; or F9) - Pops up the Report Window and computes the next visible pass (within 48 hours) of the current satellite.

Show View from Satellite (alt-u, x; or F9) - Pops up the Globe Window and to display a view of Earth from space.

Options Menu (Map Window)

Don't Hide Window (alt-O, H) - When this option is selected, the tracking map will not be minimized or hidden when the Main window is minimized. Useful for keeping one display on the screen during an operating session, while still tracking other satellites in "background".

Show Launch Sites (alt-O, L) - Toggles display on the map of the locations in the file LAUNCH.QTH (if any). When this is turned off, the sites will not be erased until the map is redrawn (F5).

Show Special Sites (alt-O, S) - Toggles display on the map of the locations in the file SPECIAL.QTH (if any). When this is turned off, the sites will not be erased until the map is redrawn (F5). Useful for determining *mutual visiblity* with locations of interest.

Show Solar Illumination (alt-O, I) - Toggles display on the map of the location of the Sun (subsolar point) and the twilight zone (terminator). Useful for determining satellite illumination or eclipse. If any part of the satellite footprint is in the illuminated region of the earth, the satellite is in sunlight. When this is turned off, the solar diagram will not be erased until the map is redrawn (F5).

Orbital Models - Brings up a submenu on which the favored orbital model can be chosen.

Ignore Drag Terms (alt-O, D) - Toggles inclusion of the drag terms in the calculation of the current satellite's orbit. Included mainly for instructional purposes (just how much difference does drag actually make ?)

Info Menu (Map Window)

Display text information on the currently selected satellite (if it exists). Uses WinHelp. If the satellite is not found in the help file, a message "topic not found" will be displayed.

Info Window

At any given time, one satellite is selected for detailed consideration - for example the satellite you are currently listening to, or operating through. The Info window displays a summary of current tracking information for this satellite. The choice is made from among the satellites which are currently displayed on the maps, by pressing F12 in a map window, or by selecting from the list in the Main window.

The Info window can be kept on the screen while the rest of the program is minimized (for example, to use a data terminal or telemetry decoding program while monitoring the satellite position).

The Info window controls the information that is made available to DDE client programs (such as a transceiver or antenna control program). By this mechanism, you can use custom hardware without having to re-invent the calcultion part of the tracking software.

Info Window Controls

Info

Miscellaneous Functions

Info Menu (Info Window)

This window displays similar information to that shown at the bottom of the tracking windows, for a single satellite, selected from the scrolling list in the Main window. The window background turns red if the selected satellite is above the horizon at the observer location. This window is also the interface to the DDE server - the data (azimuth, elevation, etc.) displayed in the window will be passed to the client.

Satellite Position (alt-I, P) - Toggle position display. When this item is checked, satellite latitude, longitude, and altitude will appear in the Info window.

RF Info (alt-I, R) - Toggle rf display. When this item is checked, frequency (MHz), doppler shift (Hz) and one-way path loss (dB) will appear in the Info window. A frequency may also be entered manually here, if none was specified in the Satellite selection window.

Antenna Pointing (alt-I, A) - Toggle antenna display. When this item is checked, antenna azimuth, elevation, and range to the satellite, will appear in the Info window. The information may also be useful for visual observation.

Orbit Info (alt-I, O) - Toggle orbit display. When this item is checked, satellite orbit number and "phase" (mean anomaly on 0-255 basis, used in AMSAT phase III birds) will appear in the Info window.

Don't Hide Window (alt-I, H) - When this item is checked, the Info Window will remain on the screen when the rest of the program is minimized.

Show All (alt-I, S; or F2) - Restore the Main (and Tracking) windows, if they are minimized.

Exit (alt-I, x; or ctrl-F4) - Closes the Info window to make more space available for tracking maps.

Miscellaneous Functions (Info Window)

RF Info - Freq (MHz) For calculation of Doppler shifts and path loss, the frequency should be entered here (or in the Satellite dialog box). At the present time, only one frequency can be entered, and is used for both calculations.

Warning: For two-way analog frequency translators (transponders), the net doppler shift depends upon the difference between uplink and downlink frequencies. If it is desired to calculate this shift, enter the difference (+/-) and ignore the path loss value.

Globe Window

"View from Space"

Sometimes it is interesting to see what the Earth looks like from the satellite.   The globe window provides this capability.   The map of the earth is redrawn in the form of a globe (sometimes called an "orthographic" map projection).   Unfortunately, this is a slow process (unless you have a Pentium), so this view is not updated in real time.   The view is drawn in three steps - a blank, "ocean-colored" globe; a crude map, and a higher resolution map.   To stop drawing the current view, click "Stop".   To generate a new view, click "Refresh".   The view is scaled to the size of the window, and drawing will be faster for smaller windows. Only one Globe can be on the screen at a time.

This view may be useful in identifying land features seen in satellite photos.   If you know the photo time, you can use the Main window in Step mode to compute the satellite position at that time.   Then draw the corresponding Globe view.

Globe Window Controls

- File
- Refresh
- Options
- Help

File Menu (Globe Window)

This window displays similar information to that shown at the bottom of the tracking windows, for a single satellite, selected from the scrolling list in the Main window. The window background turns red if the selected satellite is above the horizon at the

Refresh/Stop Menu (Globe Window)

This menu item will initiate drawing a new globe, as seen from the latest position of the selected satellite. Once drawing commences, it will change to halt the drawing of the globe.

Options Menu (Globe Window)

Only one option exists - a set of choices for the resolution of the latitude/longitude grid to be drawn on the globe.

Help Menu (Globe Window)

Displays help for the Globe Window.

Report Window

This window pops up in response to the various **Show** commands, as a place for text and tables of data to be displayed. It is a standard Windows text editor, and responds to the usual cut (ctrl-C, ctrl-X) and paste (ctrl-V) commands. Comments may also be typed here, before saving or printing the contents.

Report Window Menus

- File
- Edit
- Help

File Menu (Report Window)

You can save the contents of the window as a text file, or print it. Exit will close the window and return to the Main window.

Edit Menu (Report Window)

Not implemented - use ctrl-C, ctrl-X, ctrl-V

Help Menu (Report Window)

Display help for this window.

Observer Dialog Box

The ground-based observer location (*QTH* , in amateur radio jargon) is controlled by this dialog box, which appears when the Main Window **Setup:Observer/QTH... menu item is selected. The observer location is required for calculating antenna azimuth, elevation, range, and doppler shift. The observer position is shown on each map by a circle (default is yellow) with a dot in the center.**

Observer locations may be selected from a list (contained in a user-editable data file, normally LATLONG.QTH , distributed with the program), or may be entered directly from the keyboard, either as decimal latitude and longitude, or as a *Maidenhead Grid Locator .*

The observer location will be displayed on the map in the selected color , with the *callsign* printed below and to the right of the map symbol.

Only one observer at a time may be selected, although other locations may be displayed on the map. Provision is made for two lists of other locations: *Launch Sites* (contained in the file LAUNCH.QTH), and *Special Sites* (contained in the file SPECIAL.QTH). These two files have the same comma-delimited text-file format as LATLONG.QTH , the main geographic database. Display of either or both of these two groups is controlled by the menu flags in the Map Window **Special Menu. The two groups may be used for any purpose, of course - the name "Launch Sites" simply reflects my interest in knowing where the satellites come from. For example, one list could represent ground control stations, and another a list of stations you would like to contact (for mutual-visibility determination). Special sites use the** *callsign* to label the map symbol, while Launch sites are labelled with their *location* .

More Help is available for:

File Menu

Options Menu

Help Menu

Data Fields on the Form

Use the following buttons to accept or reject the changes made to the observer data:

OK (cr)- Accept values in all fields and return to tracking. The new observer location will be displayed immediately on all maps.

Cancel (esc)- Ignore any changes, retain the previous observer information and return to tracking.

File Menu (Observer Dialog)

New (alt-F, N) - Deletes all entries in the callsign list and brings up a standard file-selection dialog for a new .QTH file.

Open (alt-F, O) - Choose a data file (such as LATLONG.QTH) from which to read potential locations. The file is read and added to the current list (at the end).

Save As... (alt-F, A) - Creates a new file containing all the entries in the current list.

Options Menu (Observer Dialog)

Add to Launch Sites (alt-O, L) - Adds the currently-displayed location to the list of "Launch sites" in the file LAUNCH.QTH .

Add to Special Sites (alt-O, A) - Adds the currently-displayed location to the list of "Special sites" in the file SPECIAL.QTH .

Help Menu (Observer Dialog)

Alt-H brings up the Help entry entry for this dialog box.

Observer Dialog Data Fields

Filename - Name and path of the most-recently-read .QTH file on disk. This file will be automatically loaded at startup if **Setup:Save Settings** is chosen in the Main Window . This field changes automatically after **File:Open** .

Call Sign (alt-C) - Locations are indexed in the file by ITU radio call-sign prefixes (familiar to Amateur Radio operators). A prefix or call may be selected from the list, or a new one typed in. Part of the location text is also shown in the list as a memory aid. Non-amateur-radio users could replace the callsigns with 3-character airport city identifiers (LAX, ORD, etc.).

Location/QTH, Description (alt-Q, alt-D) - Two text fields describing the observer location. Type in notes of your choice (no commas, please).

Grid Locator (alt-G) - A 6-character identifier (the *Maidenhead Grid Locator or grid square) locating a 2.5 x 5 minute "square" containing the specified latitude and longitude. This system is commonly used by Amateur Radio operators to identify their locations. Entering a valid grid locator in this field will automatically compute the latitude and longitude for the center of the grid square.*

Latitude, Longitude (alt-a, alt-n) - Observer coordinates from file, or entered manually. For South latitude, or East longitude, use negative numbers. Must be in decimal format (*not* hours, minutes, seconds). Latitude should be between -90 (south pole) and +90 (north pole). Longitude should be between +180 and -180. Longitudes in the range +360 to -360 will be accepted and converted. The correct grid square identifier is automatically calculated.

Altitude (alt-t) - Observer location in meters above mean sea level.

Horizon Elevation (alt-E) - Minimum antenna elevation. Used to determine when a satellite will be "visible" from this location.

Geodetic Model (alt-M) - Select a spherical earth model (for faster calculation) or elliptical earth (for slightly better accuracy, particularly in range calculations).

Satellite Dialog Box

Satellite selection, and orbital element specification, is controlled by this dialog, which is brought up from the **Tracking** window **Satellite...** menu item (or **Main** window **File:New** and **File:Open** menu items).

This window permits one to read data files (including ASCII-text bulletins with some extraneous text) in AMSAT or NASA 2-line formats. The elements can be examined, printed, edited or edited by hand. Some functions are also available for automatically generating modified element sets.

More help is available for:

File Menu

Options Menu

Special Menu (Only enabled in **Edit** mode.)

Help Menu

Data Fields

Buttons on the window are described here:

Sat Info (alt-I). Brings up the text page (if any) associated with the currently displayed elements (using WinHelp). If none is found, displays "Topic not found" message.

Edit (alt-E). Displays the full element set for editing and enables the **Special** menu.

OK (alt-K; or cr) Accept the new parameter set, return to tracking.

Cancel (alt-l; or esc) Ignore any changes made to the parameter set, return to tracking.

In Edit mode, additional buttons appear (and the Special menu is enabled):

Back (alt-B). Returns to the reduced display (selection only) and displays the Description again.

Use Ref (alt-U). Selects the Reference elements for use.

Use Adj (alt-A). Selects the Adjusted elements for use (after a selection from the Special menu).

File Menu (Satellite Dialog)

Open (alt-F,O) Open a satellite data file (AMSAT or NASA 2-line format) to add to the current data base. The last-opened file will be read at the next startup, if **Setup:Save Settings** is chosen in the **Main** window .

Print a table with the current elements (on the default printer).

Options Menu (Satellite Dialog)

The format for display of the epoch time (in the satellite dialog only) can be changed from the usual *date and time* , to the *numerical* epoch format (and back). Date and time can be entered in either format, regardless of the display mode. Date/time is interpreted according to the Windows International Control Panel settings.

Date/Time format: 5/23/80 23:15
Numerical format: 80144.512000053

Special Menu (Satellite Dialog)

This menu is only enabled after the Edit button is clicked and the complete element set appears. To accept the elements, click OK, or Back, then OK.

Make Geosynchronous (alt-p,G) - Replaces the elements with an Ideal Geosynchronous satellite. The eccentricity is set to 1e-6 to avoid a "divide by zero error" if the SGP model is in use. The user is prompted to enter a longitude, from which the RAAN is calculated.

Propagate Elements to Present (alt-p,P) Adjusts the elements to the present (based on the computer's clock) according to the current model.

Propagate Elements to Epoch (alt-p,E) Adjusts the elements to the epoch entered in the "Adjust to Epoch" field (based on the computer's clock) according to the current model.

Adjust RAAN to Epoch (alt-p,R) Adjusts only the Right Ascension of the node to the epoch specified in the "Adjust to Epoch" field.

Orbital Models (alt-p,O) - Allows changing the orbital model for propagation.

Help Menu (Satellite Dialog)

(F1) Brings up the help text for this dialog box.

(shift-F1) Brings up the satellite information (if any).

Data Fields (Satellite Dialog)

Satellite - Select a satellite for inspection of orbital elements or tracking. The list contains three groups: the current settings for the tracking window; the settings for each of the other tracking windows; and the list read from the file. If the desired satellite is not in the list, type the name here.

The following fields are filled in from the data file, but may be edited by the user (for a new satellite, for example):

Beacon Freq, MHz - user entry, used for calculating path loss and doppler shift.

Mode - user entry, to designate the mode or type of signal expected.

Ephemeris - From NASA 2-line data, the type of model used to generate the elements

NORAD ID - The 5-digit object identifier (serial order of launch)

International - The international identifier (year, launch number, object number)

Element Set - 3-digit number identifying the data set. Multiple element sets can be loaded and identified in the selection window by this number.

UTC Epoch - The epoch of the element set.

Description - Allows entry of text to describe the satellite. In the case of NASA 2-line data files, this contains the element set number and the object number, if available. In the case of AMSAT data files, contains any comments found in the element set.

In **Edit** mode, additional fields appear for **Reference** and possibly **Adjusted** Element sets. Any of these fields may be edited.

Adjust to Epoch - Epoch for adjustment of Keplerian Elements (by the **Special** Menu).

Orbit #, Mean Anomaly, Mean Motion, Derivative of Mean Motion, Inclination, Eccentricity, Argument of Perigee, and Right Ascension of Ascending Node (RAAN). All angles are in degrees. These are the "Reference" Keplerian Elements .

The following fields are calculated and should not be edited:

Semi-Major Axis, Altitude at Perigee, Altitude at Apogee . All distances are in kilometers here. These are relative to spherical earth.

Long of Node. The (earth) longitude of the ascending node. Useful for setting up geosynchronous satellites, for example. Entering a value here will change the Right Ascension of the Node to match.

Miscellaneous Dialog Boxes

The following dialog boxes appear in response to the indicated menu selections:

UTC Correction (Main Window, **Setup:Time Zone...**). Enter a time in hh:mm format representing the difference between your computer's clock and UTC or GMT. This allows the program to operate in real time using UTC, regardless of your time zone or preference.

Customize Map Colors (Main Window, **Setup:Colors...**) By clicking on one of the colored squares (to bring up yet another dialog box), you can get a choice of colors for various map features. This can be used to make the maps easier to see or print. Note: the ocean and land colors in the maps are more difficult to change than the grid, ground track, and observer colors. Modifying ocean or land colors will cause the program to take longer to load. Some extra disk space (up to a few hundred kbytes) will also be used during the loading phase.

Note: Because of the way SVGA graphics boards generate colors, certain colors may not display the same way in different windows. Only the so-called "system colors" (typically about 16 solid colors) are entirely consistent in their appearance. So some tinkering may be necessary to get a pleasing result.

Print Ephemeris Dialog Box

Hardcopy printouts are controlled by this dialog, which is brought up from the **Main** window **File:Print Ephemeris...** menu item. These printouts are independent of the tracking windows - the system can continue to track in real-time while printing various tables for different epochs and satellites. Printing is done using the current Windows default printer. To change the printer, use the Windows Print Manager or Control Panels. To create a file (for use with a spreadsheet for instance), check the box "Print to file" (see below, under Print Options).

Satellite Selection - Choose a satellite for printout. The selections are the same as the in the Satellite Dialog Box.

Print Options - Turn on or off various features to be included in the printout. If No Header is chosen, the other options are ignored. Margin allows putting a few spaces at the left of a printout for better appearance. **Print to File** will cause the program to ask for a filename each time a printout is initiated. The file will be simple ASCII text format (use Windows NotePad to display or print it).

Satellite Position - Choose one of three position reporting methods (mutually exclusive): azimuth/elevation/doppler shift; x/y/z (km) in inertial celestial coordinate system (fixed with respect to the sky); or x/y/z (km) in geocentric coordinate system (fixed with respect to earth - Greenwich meridian = x axis).

Selective Printing - Choose the type of printout. **Every Interval** : print each calculation; **Above Horizon** : print only positions that are above the Observer's horizon; **AOS/LOS/TCA** : print only the position at AOS, LOS, and TCA (first, last and closest positions above horizon). For the latter, a high resolution (e.g. 10 seconds or less) is better; **Equator Crossing** : print only the position (EQX) nearest to the equator (ascending node); **Apogee/Perigee** : print only the positions nearest to apogee/perigee; **Timeline** : print a timeline showing whether or not the satellite is visible in each half-hour interval (minimum one day). Useful for tracking long-range trends.

Orbital Model - Select the math model to use for the calculation.

Geodetic Model - Same.

Comment - Allows entry of text to describe the printout (reason for printing, assumptions, etc.) to be printed in the table heading (if selected under Print options). Note: typing a "return" will close the whole dialog box. To start a new line in this field, type ctrl-"return" instead.

Time Frame - Select the start time, duration, and resolution interval for the table by typing in the fields provided.

Now - Set the start time to now.

Ref - set the start time to the satellite's reference epoch.

Print Table - Print one table immediately.

Done - Dismiss the dialog box.

Satellites

The following information can also be accessed directly from the tracking maps, by clicking the **Info** menu item. Access to this list can be had by typing **shift-F1** in most windows. More information is available for the following satellites:

OSCAR Series

- PO-28 - POSAT OSCAR 28
- AO-27 - AMRAD OSCAR 27
- IO-26 - ITAMSAT OSCAR 26
- KO-25 - KITSAT OSCAR 25
- KO-23 - KITSAT OSCAR 23
- UO-22 - UoSAT OSCAR 22
- AO-21 - AMSAT OSCAR 21 - also called RS-14
- FO-20 - Fuji OSCAR 20
- LO-19 - LUSAT OSCAR 19
- WO-18 - Webersat OSCAR 18
- DO-17 - DOVE OSCAR 17
- AO-16 - AMSAT OSCAR 16
- UO-15 - UoSAT OSCAR 15
- UO-14 - UoSAT OSCAR 14
- AO-13 - AMSAT OSCAR 13
- FO-12 - Fuji OSCAR 12
- UO-11 - UoSAT OSCAR 11
- AO-10 - AMSAT OSCAR 10
- UO-9 - UoSAT OSCAR 9
- AO-8 - AMSAT OSCAR 8
- AO-7 - AMSAT OSCAR 7
- AO-6 - AMSAT OSCAR 6
- AO-5 - AMSAT OSCAR 5
- AO-4 - AMSAT OSCAR 4
- AO-3 - AMSAT OSCAR 3
- AO-2 - AMSAT OSCAR 2
- AO-1 - AMSAT OSCAR 1

Radio Sputnik Series

- RS-15 - Radio Sputnik 15
- RS-14 - Radio Sputnik 14 - also called AO-21.
- RS-12/13 - Radio Sputnik 12/13
- RS-10/11 - Radio Sputnik 10/11
- ISKRA-2
- RS-8 - Radio 8
- RS-7 - Radio 7
- RS-6 - Radio 6
- RS-5 - Radio 5
- RS-4 - Radio 4
- RS-3 - Radio 3
- RS-2 - Radio 2

RS-1 - Radio 1

Others

SAREX - US Space Shuttle - also called STS (Space Transportation System).
MIR - Space Station
ARSENE
SARA
OSCAR Zero - the Moon (a natural satellite).

Wherever possible, I have referenced post-launch articles, since details were often changed between the preliminary announcement of various projects and the actual implementation. If you would like to see more information added about one or more satellites, please pass it along and I'll include it in the next edition.

PoSAT-OSCAR-28

NASA/NORAD number: 22829

Launch Date: 0145 UTC 26 September 1993, Kourou, French Guiana (Ariane V-59).

Orbit type: Circular LEO, inclination 98 degrees, 800 km altitude.

Transponders: Packet BBS, 9600b FSK, 145.975 uplink, 435.075 downlink.

Notes: Launched with KO-25, IO-26, AO-27, SPOT-3, HealthSat. Part of a commercial satellite belonging to Portugese Industrial Consortium. Constructed by University of Surrey (UK).

References:

"New Satellites in Orbit", John Hansen, WA0PTV, The AMSAT Journal, v. 16, no. 5, September/October 1993, p. 1.

"PoSAT OSCAR 28 Open to Amateurs", Steve Ford, WB8IMY,QST, April 1994, p. 110.

Satellite List

AMRAD-OSCAR-27

NASA/NORAD number: 22825
Launch Date: 0145 UTC 26 September 1993, Kourou, French Guiana (Ariane V-59).
Orbit type: Circular LEO, inclination 98 degrees, 800 km altitude.
Transponders: Mode J, Analog FM and digital packet modes using DSP.

Notes: Launched with KO-25, IO-26, PO-28, SPOT-3, HealthSat. AO-27 is part of EyeSat-A.

References:

"New Satellites in Orbit", John Hansen, WA0PTV, The AMSAT Journal, v. 16, no. 5, September/October 1993, p. 1.

"AMRAD Oscar 27", Steve Ford, WB8IMY, QST, December 1993, p. 107.

Satellite List

ITAMSAT-OSCAR-26

Callsign: ITMSAT

NASA/NORAD number: 22826

Launch Date: 0145 UTC 26 September 1993, Kourou, French Guiana (Ariane V-59).

Orbit type: Circular LEO, inclination 98 degrees, Altitude 800 km

Transponders: Mode JD, Downlink 436.5 MHz, 9600 bps FSK, Uplink 145.98 9600 bps FSK (AX.25). (or 1200 bps PSK, 4W downlink, like AO-16, LO-19.)

Notes: Built by AMSAT Italy. Launched with KO-25, AO-27, PO-28, SPOT-3, HealthSat.

References:

"New Satellites in Orbit", John Hansen, WA0PTV, The AMSAT Journal, v. 16, no. 5, September/October 1993, p. 1.

"Two More PACSATS!" , Steve Ford, WB8IMY, QST, October 1993, p. 98.

Satellite List

KITSAT-OSCAR-25

Callsign: HL02

NASA/NORAD number: 22828

Launch Date: 0145 UTC 26 September 1993, Kourou, French Guiana (Ariane V-59).

Orbit type: Circular LEO, inclination 98 degrees, Altitude 800 km

Transponders: Mode JD, Downlink 436.5 MHz, 9600 bps FSK, Uplink 145.98 9600 bps FSK (AX.25).

Notes: KITSAT-B. Built by Korean Advanced Institute of Science and Technology. Similar to KO-23. Launched with IO-26, AO-27, PO-28.

References:

"KITSAT-2 Imaging System", Sang-Keun Yoo, SaTRec, The AMSAT Journal, v. 17, no. 3, May/June 1994, p. 27.

"New Satellites in Orbit", John Hansen, WA0PTV, The AMSAT Journal, v. 16, no. 5, September/October 1993, p. 1.

"Two More PACSATS!" , Steve Ford, WB8IMY, QST, October 1993, p. 98.

Satellite List

KITSAT-OSCAR-23

Callsign: HL01

NASA/NORAD number: 22077

Launch Date: 10 August 1992, from Kourou,French Guiana (Ariane V-52)

Orbit type: Circular, inclination 66 degrees, Altitude 1300 km

Weight: .

Stabilization: .

Payloads: Earth Imaging System (EIS) - two CCD cameras, Digital Signal Processing Experiment (DSPE), Cosmic Ray Experiment (CRE).

Transponders: Mode JD, Downlink 435.175 MHz, 9600 bps FSK, Uplink 145.85/145.90 9600 bps FSK (AX.25).

Notes: KITSAT-A. Built by Korean Advanced Institute of Science and Technology in collaboration with University of Surrey. PCS similar to UO-22. EIS compatible with UO-22 format. Downlink may transmit synthesized FM voice for experimental purposes (DSPE).

References:

"Computer Processing of UO-22 and KO-23 Images", Walter Daniel, N3KVQ, The AMSAT Journal, v. 16, no. 1, January/February1993, p. 8.

"Spotlight on: KITSAT-OSCAR-23", John A. Magliacane, KD2BD, The AMSAT Journal, v. 16, no. 2, March/April 1993, p. 17.

"KITSAT-OSCAR 23 Reaches Orbit", Steve Ford, WB8IMY, QST, October 1992, p.93.

Satellite List

UoSAT-OSCAR-22

Callsign: UOSAT5

NASA/NORAD number: 21575

Launch Date: 17 July 1991, Kourou, FrenchGuiana.

Orbit type: Circular LEO, inclination 98 degrees, altitude 775 km/482 miles

Weight: 46 kg

Stabilization: Gravity gradient

Payloads: PACSAT Communications System (PCS), Earth Imaging System (EIS) - one CCD camera.

Transponders: Mode JD, 9600 bps FSK, 435.20 MHz, AX.25

Notes: Co-launched with SARA-1 amateur astronomy satellite. UOSAT-F. Replacement for UO-15, which failed after launch. Original primary function, VITA/Satelife packet project, exchanged with UoSAT-OSCAR-14. Now serves amateur packet communications.

References:

"Computer Processing of UO-22 and KO-23 Images", Walter Daniel, N3KVQ, The AMSAT Journal, v. 16, no. 1, January/February 1993, p. 8.

"Spotlight on: UoSAT-OSCAR-22", John A. Magliacane, KD2BD, The AMSAT Journal, v. 15, no. 3, May/June 1992, p. 17.

"The UO-22 Earth Imaging System", Jeff Ward, G0/K8KA, The AMSAT Journal, v. 14, no. 6, November/December 1991, p. 1.

"UoSAT Oscar 22 in Orbit", Jeff Ward, G0/K8KA, QST, September 1991, p. 70.

Satellite List

AMSAT-OSCAR-21

Radio Sputnik 14

NASA/NORAD number: 21087

Launch Date: 7 January 1991, NorthernCosmodrome, Plesetsk, USSR.

Orbit type: Circular LEO, inclination 83 degrees, Altitude 1000 km

Stabilization: Gravity gradient.

Payloads: RM-1 linear transponder. RUDAK-2 digital system.

Transponders: Mode B analog, RUDAK-2. Rudak downlink is 145.983 MHz, 3W, 1200 bps BPSK (AX.25) like FO-20. RUDAK can also operate in a narrow-band FM voice mode. Transponder downlink center 145.892 MHz, Uplink 435.062 MHz, inverting, 10 W. See references for other frequencies.

Antennas: 435 MHz RHCP helix, 3dB gain. 145 MHz 1/2 wave dipole.

Notes: Piggyback on INFORMTR-1. Last heard in mid-October 1994, shortly after INFORMTR-1 was decomissioned. RUDAK-1 was launched on AO-13, but failed to operate properly.

References:

"RUDAK-II on AMSAT OSCAR-21: Full System Overview, Current activities and future planning", Peter Guelzow, DB2OS, The Amsat Journal, v. 16,no. 2, March/April 1993, p.14.

"Spotlight on RS-14/OSCAR-21", John A. Magliacane, KD2BD, The Amsat Journal, v. 16, no. 1, January/February 1993, p. 23.

Satellite List
Other RS satellites

Fuji-OSCAR-20

Fuji-2

Callsign: 8J1JBS

NASA/NORAD number: 20480

Launch Date: 7 February 1990, Tanegashima Space Center, Japan

Orbit type: Elliptical LEO, inclination 99 degrees, altitude at apogee 1084 miles/1745 km, at perigee 567 miles/912 km.

Weight: 50 kg

Transponders: Mode JA, Mode JD. Mode JD beacon and downlink 435.910 MHz, 1 W, 1200 bps BPSK. Mode JA beacon 435.795 MHz, 100 mW CW/BPSK

Antennas: 145 MHz ring turnstile 0.5dBi, 435 MHz turnstile array 4dBi, both CP.

Notes: Standard packet mailbox - no special software required, unlike the microsats. Very similar to FO-12. Packet telemetry beacon 435.91 PSK, 1200 baud (AMSAT UK or TAPR modem)

References:

"The Telemetry Formats of JAS-1b/Fuji-OSCAR 20", JR1NVU, The AMSAT Journal, v. 13, no. 4, Sep 1990, p. 20.

"Introduction of JAS-1b", JARL, QEX, September 1989, p 12.

"Spotlight on: Fuji-2/OSCAR-2", John A. Magliacane, KD2BD, The AMSAT Journal, v. 15, no. 5, November/December 1992, p. 17.

"The Fuji-OSCAR-20 Spacecraft", The AMSAT Journal, Joe Kasser, W3/G3ZCZ, v. 13, no. 3, July 1990, p. 7.

Satellite List

LUSAT-OSCAR-19

Callsign: LUSAT-1

NASA/NORAD number: 20442

Launch Date: 22 January 1990, Kourou, French Guiana, Ariane V-35.

Orbit type: Circular LEO, inclination 98.6 degrees, altitude 497 miles/800 km.

Weight: 9 kg

Stabilization: Passive magnetic.

Transponders: Mode JD, 1200 bps BPSK (AX.25, special software required). Downlink 437.153, uplink ca. 145.84. Beacon 437.127 MHz CW, 750 mW.

Notes: Microsat (Oscar 16-19) mass launch together with SPOT-2, UO-14/UO-15.

References:

"Six for the Price of One", Part I: The AMSAT Journal, v. 13, no. 1, March 1990, p. 1. Part II: The AMSAT Journal, v. 13, no. 2, May 1990, p. 1.

"The First Flock of Microsats", Tom Clark, W3IWI, et al., The AMSAT Journal, v. 12, no. 1, May 1989, p. 3.

"Microsat: The Next Generation of OSCAR Satellites", Doug Loughmiller, KO5I, and Bob McGwier, N4HY, Part 1: QST, May 1989, p. 37; Part 2: QST, Jun 1989, p. 53.

"Successful OSCAR Launch Ushers in the 90's", Doug Loughmiller, KO5I, QST, April 1990, p. 52.

"Spotlight on: The Microsats", John A. Magliacane, KD2BD, The AMSAT Journal, v. 15, no. 4, September/October 1992, p. 17.

Satellite List

WeberSat-OSCAR-18

NASA/NORAD number: 20441
Launch Date: 22 January 1990, Kourou, French Guiana, Ariane V-35.
Orbit type: Circular LEO, inclination 98.6 degrees, altitude 800 km.
Weight: 9 kg
Stabilization: Passive magnetic.
Payloads: Color CCD camera. Miscellaneous experiments.
Beacons: 437.100, 437.075 MHz.

Notes: Built by Weber State College (Ogden, Utah, USA). Microsat (Oscar 16-19) mass launch together with SPOT-2, UO-14/UO-15. Telemetry is PSK 1200 baud.

References:

"Six for the Price of One", Part I: The AMSAT Journal, v. 13, no. 1, March 1990, p. 1. Part II: The AMSAT Journal, v. 13, no. 2, May 1990, p. 1.

"The First Flock of Microsats", Tom Clark, W3IWI, et al., The AMSAT Journal, v. 12, no. 1, May 1989, p. 3.

"Microsat: The Next Generation of OSCAR Satellites", Doug Loughmiller, KO5I, and Bob McGwier, N4HY, Part 1: QST, May 1989, p. 37; Part 2: QST, Jun 1989, p. 53.

"Successful OSCAR Launch Ushers in the 90's", Doug Loughmiller, KO5I, QST, April 1990, p. 52.

"Spotlight on: The Microsats", John A. Magliacane, KD2BD, The AMSAT Journal, v. 15, no. 4, September/October 1992, p. 17.

Satellite List

DOVE-OSCAR-17

NASA/NORAD number: 20440

Launch Date: 22 January 1990, Kourou, French Guiana, Ariane V-35.

Orbit type: Circular LEO, inclination 98.6 degrees, altitude 800 km.

Weight: 9 kg

Stabilization: Passive magnetic.

Beacons : 145.825 synthesized voice or 1200 bps FM AFSK, AX.25 telemetry. 2401.2205 MHz, 1200 bps BPSK, 1 Watt (S Band).

Notes: Digital Orbiting Voice Encoder. Microsat (Oscar 16-19) mass launch together with SPOT-2, UO-14/UO-15. Downlink 145.825 AFSK/Voice 1200 baud packet

References:

"Working the EasySats", Steve Ford, WB8IMY, QST, September 1992, p. 30.

"Six for the Price of One", Part I: The AMSAT Journal, v. 13, no. 1, March 1990, p. 1. Part II: The AMSAT Journal, v. 13, no. 2, May 1990, p. 1.

"The First Flock of Microsats", Tom Clark, W3IWI, et al., The AMSAT Journal, v. 12, no. 1, May 1989, p. 3.

"Microsat: The Next Generation of OSCAR Satellites", Doug Loughmiller, KO5I, and Bob McGwier, N4HY, Part 1: QST, May 1989, p. 37; Part 2: QST, Jun 1989, p. 53.

"Successful OSCAR Launch Ushers in the 90's", Doug Loughmiller, KO5I, QST, April 1990, p. 52.

"Spotlight on: The Microsats", John A. Magliacane, KD2BD, The AMSAT Journal, v. 15, no. 4, September/October 1992, p. 17.

Satellite List

AMSAT-OSCAR-16

"PACSAT"

Callsign: PACSAT-1

NASA/NORAD number: 20439

Launch Date: 22 January 1990, Kourou, French Guiana, Ariane V-35.

Orbit type: Circular LEO, inclination 98.6 degrees, altitude 800 km.

Weight: 9 kg

Stabilization: Passive magnetic.

Transponders: Mode JD, 1200 bps BPSK (AX.25, special software required). Downlink 437.051, uplink ca. 145.90. Beacon 2401.143 MHz (S-Band).

Notes: Microsat (Oscar 16-19) mass launch together with UO-14/UO-15, SPOT-2.

References:

"Six for the Price of One", Part I: The AMSAT Journal, v. 13, no. 1, March 1990, p. 1. Part II: The AMSAT Journal, v. 13, no. 2, May 1990, p. 1.

"The First Flock of Microsats", Tom Clark, W3IWI, et al., The AMSAT Journal, v. 12, no. 1, May 1989, p. 3.

"Microsat: The Next Generation of OSCAR Satellites", Doug Loughmiller, KO5I, and Bob McGwier, N4HY, Part 1: QST, May 1989, p. 37; Part 2: QST, Jun 1989, p. 53.

"Successful OSCAR Launch Ushers in the 90's", Doug Loughmiller, KO5I, QST, April 1990, p. 52.

"Spotlight on: The Microsats", John A. Magliacane, KD2BD, The AMSAT Journal, v. 15, no. 4, September/October 1992, p. 17.

Satellite List

UoSAT-OSCAR-15

Launch Date: 21-22 January 1990, Kourou, French Guiana, Ariane V-35.
Orbit type: LEO.

Notes: UOSAT-E. Co-launched with UO-14, SPOT-2, and the microsats (Oscar 16-19). Went dead the next day.

References:

"The UOSAT-Oscar 14 and 15 Spacecraft", Joe Kasser, G3ZCZ, Martin Sweeting, G3YJO, Jeff Ward, G0/K8KA, The AMSAT Journal, v. 13, no. 2, May 1990, p. 9.

"A Tale of Two UoSATs", Jeff Ward, G0/K8KA, QST, July 1990, p. 62.

"Six for the Price of One", Part I: The AMSAT Journal, v. 13, no. 1, March 1990, p. 1. Part II: The AMSAT Journal, v. 13, no. 2, May 1990, p. 1.

"Successful OSCAR Launch Ushers in the 90's", Doug Loughmiller, KO5I, QST, April 1990, p. 52.

"Spotlight on: The Microsats", John A. Magliacane, KD2BD, The AMSAT Journal, v. 15, no. 4, September/October 1992, p. 17.

Satellite List

UoSAT-OSCAR-14

NASA/NORAD number: 20437

Launch Date: 21 or 22 January 1990, Kourou, French Guiana, Ariane V-35.

Orbit type: Circular LEO, inclination 99 degrees, altitude 786/805 km.

Payloads: PACSAT Communications Experiment (PCE).

Transponders: Mode JD?, 435.070 MHz, 9600 bps FSK, 1.5W normal, uplink 145.975 (AX.25).(K9NG/G3RUH format).

Antennas: 145 MHz linear polarization, 435 MHz linear polarization.

Notes: Built at University of Surrey (UK). UOSAT-D. Co-launched with UO-15, SPOT-2, and the microsats (Oscar 16-19). Originally intended for amateur use. Later (1992) switched with UO-22 for Satelife/VITA project (no longer in general amateur use).

References:

"The UOSAT-Oscar 14 and 15 Spacecraft", Joe Kasser, G3ZCZ, Martin Sweeting, G3YJO, Jeff Ward, G0/K8KA, The AMSAT Journal, v. 13, no. 2, May 1990, p. 9.

"A Tale of Two UoSATs", Jeff Ward, G0/K8KA, QST, July 1990, p. 62.

"Six for the Price of One", Part I: The AMSAT Journal, v. 13, no. 1, March 1990, p. 1. Part II: The AMSAT Journal, v. 13, no. 2, May 1990, p. 1.

"Successful OSCAR Launch Ushers in the 90's", Doug Loughmiller, KO5I, QST, April 1990, p. 52.

"Spotlight on: The Microsats", John A. Magliacane, KD2BD, The AMSAT Journal, v. 15, no. 4, September/October 1992, p. 17.

Satellite List

AMSAT-OSCAR-13

NASA/NORAD number: 19216

Launch Date: 15 June 1988, Kourou, French Guiana.

Orbit type: Elliptical ("Molniya-type"), inclination 57 degrees, altitude 720 km/38000 km

Weight: 140 kg with fuel, 90 kg after engine burn.

Stabilization: Magnetorquer.

Transponders: Mode B, Mode J, Mode S, Mode L

EIRP: 145 MHz - 50 W; 435 MHz - 111 W; 2350 MHz - 1.25 W.

Beacons: 145.812 (general), 145.985 (engineering), 435.652, 2400.664 MHz. CW, ASCII (400 bps BPSK), RTTY 60 wpm 170 Hz shift.

Telemetry: 64 channels, ASCII or Baudot teletype.

Antennas: 145 MHz: monopole, ZL-special (CP); 435 MHz: monopole, 3-element phased dipole array; 1296 MHz: 5-turn helix; 2350 MHz: 6-turn helix.

Power: 50 W solar array, NiCd battery.

Notes: Phase 3C. Carried RUDAK-1, which failed. Kick motor fuel N2O4/AZ-50. Re-entry anticipated in 1996. General beacon on 145.812 has CW bulletins at 0/30 past hour, RTTY 50 baud at 15/45 minutes, PSK 400 baud otherwise (G3RUH type). Beacon only on during mode B.

References:

Amsat Satellite Report, no. 177-179, June 8, July 5, July 18, 1988.

"Spotlight on Amsat Oscar 13", John A. Magliacane, KD2BD, The Amsat Journal, v. 15, no. 2, March/April 1992, p. 17.

"The Orbital Decay of AMSAT-OSCAR-13?", Karl Meinzer, DJ4ZC, The AMSAT Journal, v. 13, no. 3, July 1990, p. 1.

"Measure AO-13 Squint Directly", James Miller, G3RUH, The AMSAT Journal, v. 16, no. 1, January/February 1993, p. 20.

"OSCAR at 25: The Amateur Space Program Comes of Age", Jan King, W3GEY, et al., QST, December 1986, p. 15.

"Introducing Phase 3C: A New, More Versatile OSCAR", Vern Riportella, WA2LQQ, QST, June 1988, p. 22.

Satellite List

Fuji-OSCAR-12

NASA/NORAD number: 16909
Launch Date: 2045 UTC, 12 August 1986, Tanegashima Island (S. Japan).
Orbit type: circular LEO, 50 degree inclination, 1500 km altitude.
Weight: 50 kg
Stabilization: Passive magnetic.
Transponders carried: Mode J, 1W output.
Telemetry: 66 channels. CW, PSK.
Antennas: 145 MHz 1/4 wave monopole, 2 turnstiles on 435 MHz.
Power: 8.5 W solar array, 6 Ah NiCd battery.

Notes: Launched with Experimental Geodetic Payload - first multi-payload launch by NASDA. Went off air in Fall 1989 due to power problems.

References:

Amsat Satellite Report, no. 131, September 1, 1986.

"The Flight of JAS-1", Shozo Hara, JA1AN, QEX, August 1986, p. 4.

"Introducing Japanese Amateur Satellite Number One (JAS-1)", Vern Riportella, WA2LQQ, QST, June 1986, p. 71.

"Birth of a New OSCAR: First All-Japanese Project Debuts", Vern Riportella, WA2LQQ, QST, October 1986, p. 73.

"OSCAR at 25: The Amateur Space Program Comes of Age", Jan King, W3GEY, et al., QST, December 1986, p. 15.

Satellite List

UoSAT-OSCAR-11

(UoSAT-2)

NASA/NORAD number: 14781

Launch Date: 1 March 1984, Vandenberg AFB, Lompoc, CA.

Orbit type: Circular LEO, inclination 98 degrees, altitude 680 km.

Weight: 60 kg

Stabilization: Gravity-gradient, magnetorquer.

Payloads: Digitalker, Digital Communications Experiment (DCE), CCD camera, space dust and radiation experiments.

Beacons: 145.825, 435.025, 2401.5 MHz,1200 bps FM AFSK

Telemetry: 150 channels, 1200 baud ASCII teletype.

Antennas:

Power: 25 W solar array, 12 v, 6.4 Ah NiCd battery.

Notes: Built at University of Surrey (UK). Launched with LANDSAT-5. Took only 5 months to design, build and launch. Although the telemetry is nominally similar to terrestrial FM AFSK teletype, the mark/space tones are inverted from the normal convention, and from UO-9 or AO-13. Some modems cannot handle this in software at 1200 baud, e.g. the PK-232 RXREV command.

References:

Amsat Satellite Report, no. 74, 19 March 1984.

"Spotlight on: UoSAT-OSCAR-11", John A. Magliacane, KD2BD, The AMSAT Journal, v. 16, no. 2, January/February 1992, p. 17.

"OSCAR at 25: The Amateur Space Program Comes of Age", Jan King, W3GEY, et al., QST, December 1986, p. 15.

Satellite List

AMSAT-OSCAR-10

NASA/NORAD number: 14129
Launch Date: 16 June 1983, Kourou, French Guiana.
Orbit type: Elliptical, inclination 27 degrees, altitude 3997/35449 km
Weight: 90 kg with fuel.
Stabilization: Magnetorquer.
Transponders: Mode B 50W, Mode L 50W (nominal?)
Telemetry: 64 channels, ASCII/Baudot teletype.
Antennas:
Power: 50 W solar array, 2 NiCd batteries.

Notes: Phase IIIB (IIIA lost in Ariane crash). First amateur satellite with onboard propulsion (which did not function entirely correctly, due to collision with part of the launch vehicle after separation - hence the not-quite-Molniya-type orbit). Computer control failed December 1986 due to radiation damage to memory.

References:

Amsat Satellite Report, no. 60/61, 62, August 1, September 7, 1983.

"The Satellite Experimenter's Handbook", 1st edition, Martin Davidoff, K2UBC, American Radio Relay League, Newington, CT, 1985.

"OSCAR at 25: The Amateur Space Program Comes of Age", Jan King, W3GEY, et al., QST, December 1986, p. 15.

"Phase III suffers Watery Fate", Steve Place, WB1EYI, QST, July 1980, p. 45.

Satellite List

UoSAT-OSCAR-9

NASA/NORAD number: 12888
Launch Date: 6 October 1981, Vandenberg AFB, Lompoc, CA.
Orbit type: Circular LEO, inclination 97.6 degreees, altitude 540 km
Weight: 60 kg
Stabilization: Magnetorquer, Gravity gradient
Payloads: Digitalker, CCD camera, Various experiments
Beacons: 145.825 MHz 350 mW FM, also 7, 14, 21, 29, 435.025, 2401 and 10470 MHz.
Telemetry: 105 channels. ASCII/Baudot teletype (AFSK).
Antennas:
Power: 17 W solar array, NiCd battery.

Notes: Built at University of Surrey (UK). First on-board computer (IHU - Integrated Housekeeping Unit) for battery and attitude management, remote control, and experiments. Re-entry 13 Oct 90 1200 UTC.

References:

Amsat Satellite Report, no. 192, December 15, 1989.

"The Satellite Experimenter's Handbook", 1st edition, Martin Davidoff, K2UBC, American Radio Relay League, Newington, CT, 1985.

"OSCAR at 25: The Amateur Space Program Comes of Age", Jan King, W3GEY, et al., QST, December 1986, p. 15.

Satellite List

AMSAT-OSCAR-8

Launch Date: 5 March 1978.

Orbit type: Circular LEO, inclination 98.9 degrees, altitude 910 km.

Weight: 25.8 kg.

Stabilization: Passive magnetic

Transponders: Mode A 1-2W, Mode J 1-2 W.

Beacons: 29.402 MHz 110mW, 435.095 MHz 100 mW, both Morse CW.

Telemetry: 6 channels, CW.

Antennas: 29 MHz half-wave dipole; 146 MHz canted turnstile (switchable ? CP); 435 MHz quarter wave monopole.

Power: 15 W solar array, NiCd battery.

Notes: Phase-IID. AO-D. Battery failure 24 June 1983.

References:

"The Last Days of OSCAR 8", Frank Wiesenmeyer, K9CIS, QST, May 1984, p. 48.

"The Satellite Experimenter's Handbook", 1st edition, Martin Davidoff, K2UBC, American Radio Relay League, Newington, CT, 1985.

"OSCAR at 25: The Amateur Space Program Comes of Age", Jan King, W3GEY, et al., QST, December 1986, p. 15.

Satellite List

AMSAT-OSCAR-7

Launch Date: 1711 UTC, 15 November 1974, Vandenberg AFB, CA.

Orbit type: Circular LEO

Weight:

Stabilization: Passive magnetic

Beacons: 29 MHz; 145 MHz; 435 MHz, 400 mW; 2304 MHz, 100 mW.

Transponders: Mode A 2 watts, Mode B.

Telemetry: 24 channels, CW; 60 channels Baudot RTTY.

Antennas:

Power: 15 W solar array, NiCd battery.

Notes: Launched with NASA Itos-G weather satellite. Operational lifetime 6.5 years (before battery failure). "Mode C" (low power Mode B) and "Mode D" (recharge) were also defined. Complex telemetry system including CW Morse and RTTY outputs. Early demonstrations of low-budget medical data relay and doppler location of ground transmitters for search-and-rescue operations were done using this satellite.

References:

"Oscar News: Oscar 7 - It Works!", K1ZND, QST, January 1975, p. 49.

"Oscar 7 and Its Capabilities", Joe Kasser, G3ZCZ/W3 and Jan King, W3GEY, QST, February 1974, p. 56.

"The Satellite Experimenter's Handbook", 1st edition, Martin Davidoff, K2UBC, American Radio Relay League, Newington, CT, 1985.

"OSCAR at 25: The Amateur Space Program Comes of Age", Jan King, W3GEY, et al., QST, December 1986, p. 15.

Satellite List

AMSAT-OSCAR-6

Launch Date: 15 October 1972, Vandenberg AFB, CA.
Orbit type: Circular LEO, sun-synchronous.
Weight:
Stabilization: Passive magnetic.
Beacons: 435 MHz, 29 MHz.
Telemetry: 24 channels, CW.
Transponders: Mode A, 1 W downlink. 435 MHz beacon.
Antennas: 1/4 wave monopoles (435 and 144 MHz); 1/2 wave dipole (29MHz).
Power: 5.5 W solar array, NiCd battery.

Notes: Phase II-A. Operational lifetime 4.5 years (battery failure 21 June 1977). First complex control system (discrete logic). First satellite-satellite communication (via Oscar 7). Demonstrated Doppler-location of ground stations for search and rescue. Demonstrated low-cost medical data relay from remote locations.

References:

"The Sixth Amateur Satellite - A Technical Report: Part II", Jan King, W3GEY, QST, August 1973, p. 69.

"OSCAR 6 - Gone but not forgotten", W0LER, QST, November 1977, p. 31.

"The Satellite Experimenter's Handbook", 1st edition, Martin Davidoff, K2UBC, American Radio Relay League, Newington, CT, 1985.

"OSCAR at 25: The Amateur Space Program Comes of Age", Jan King, W3GEY, et al., QST, December 1986, p. 15.

Satellite List

Australis-OSCAR-5

Launch Date: 23 January 1970, Vandenberg AFB, Lompoc, CA.
Stabilization: Passive magnetic
Beacons: 29.45 MHz 250mW, 144.05 MHz, 50mW
Telemetry: 7 channels, PWM.
Power: Alkaline manganese battery.
Antenna: 29 MHz 1/2 wave dipole, two 145 MHz 1/4 wave monopoles.

Notes: Built at University of Melbourne, Australia. Launched with Tiros weather satellite. Command receiver (on 2m) and hardwired decoder (first remote control of an amateur satellite). Operational life 46 days.

References:

"Australis Oscar 5: The Launch Story", William Dunkerley Jr., WA2INB, QST, April 1970, p. 61.

"Australis Oscar - Its Design, Construction and Operation", David Bellair, VK3ZFB, and Stephen Howard, QST, July 1969, p. 58.

"Strays", anonymous, QST, March 1970, p. 86 (a bibliography on AO-5).

"The Satellite Experimenter's Handbook", 1st edition, Martin Davidoff, K2UBC, American Radio Relay League, Newington, CT, 1985.

"OSCAR at 25: The Amateur Space Program Comes of Age", Jan King, W3GEY, et al., QST, December 1986, p. 15.

Satellite List

OSCAR-IV

Launch Date: 21 December 1965, Cape Kennedy, FL.

Orbit type: Elliptical, inclination 26 degrees, altitude 160 km/ 34000 km.

Weight:

Stabilization: Spin generated by a spring on separation from launchvehicle.

Payloads: Transponder. Beacon (432 MHz).

Transponders: 144 MHz uplink, 432 MHz downlink, 3W, 10kHz BW.

Telemetry: none.

Antennas: Sleeve dipole (432), monopole (144) (Estimated from photos).

Power: 10 W solar cells, battery.

Notes: Intended for high-altitude (18,000 miles) circular orbit. Launch vehicle failure left it in an elliptical orbit with perigee 100 miles. Built by TRW Radio Club.

References:

"The World Above 50 Mc", Sam Harris, W1FZJ, QST, February 1966, p. 81.

"The Satellite Experimenter's Handbook", 1st edition, Martin Davidoff, K2UBC, American Radio Relay League, Newington, CT, 1985.

"OSCAR at 25: The Amateur Space Program Comes of Age", Jan King, W3GEY, et al., QST, December 1986, p. 15.

Satellite List

OSCAR-III

Launch Date: 9 March 1965.
Orbit type: Circular polar LEO (70 degree inclination), altitude 575 miles
Weight: 36 lbs.
Stabilization: none.
Payloads: Transponder, two beacons.
Beacon:
Transponder: 1W, 50kHz bandwidth, 146 MHz uplink, 144 MHz downlink (linear translator).
Telemetry: 3 channels (?).
Antennas: Two half-wave dipoles
Power: 2.5 W solar cells, silver-nickel or silver-zinc battery.

Notes: First Amateur satellite with solar power. First transponder. Transponder operational life 18 days (battery-limited). Beacons operated for several months from the solar cells.

References:

"The Oscar III V.H.F. Translator Satellite", William I. Orr, W6SAI, QST, February 1963, p. 42.

"Oscar III - Technical Description", Arthur M. Walters, W6DKH, QST, June 1964, p. 17.

"Oscar III Orbits the Earth", William I. Orr, W6SAI, QST, May 1965, p.56.

"The Satellite Experimenter's Handbook", 1st edition, Martin Davidoff, K2UBC, American Radio Relay League, Newington, CT, 1985.

"OSCAR at 25: The Amateur Space Program Comes of Age", Jan King, W3GEY, et al., QST, December 1986, p. 15.

Satellite List

OSCAR-II

Launch Date: 0032 UTC, 2 June 1962.
Orbit type: LEO, polar orbit (73 degree inclination), 90 minute period.
Stabilization: none.
Beacon: 145 MHz, CW, 100mW.
Telemetry: 1 channel (morse code speed varied with temperature).
Antenna: 1/2-wave dipole.
Power: Mercury battery.

Notes: Orbital lifetime, 18 days.

References:

"Oscar II: A Summation", William I. Orr, W6SAI, QST, April 1963, p. 53.

"The Satellite Experimenter's Handbook", 1st edition, Martin Davidoff, K2UBC, American Radio Relay League, Newington, CT, 1985.

"OSCAR at 25: The Amateur Space Program Comes of Age", Jan King, W3GEY, et al., QST, December 1986, p. 15.

Satellite List

OSCAR-I

Launch Date: 12 December 1961, Vandenberg AFB, California.
Orbit type: Elliptical, 81 degree inclination, 245/431 km.
Weight: 4.5 kg
Stabilization: none.
Beacon: 145 MHz CW, 100 mW.
Telemetry: 1 channel (morse code speed varied with temperature).
Antenna: 1/4 wavelength monopole.
Power: Mercury battery.
Notes: Launched with Discoverer XXXVI. Orbital lifetime 22 days.

References:

"Oscar I: A Summary of the World's First Radio Amateur Satellite", William I. Orr, W6SAI, QST, September 1962, p. 54.

"The Satellite Experimenter's Handbook", 1st edition, Martin Davidoff, K2UBC, American Radio Relay League, Newington, CT, 1985.

"OSCAR at 25: The Amateur Space Program Comes of Age", Jan King, W3GEY, et al., QST, December 1986, p. 15.

Satellite List

Radio Sputnik 15

NASA/NORAD number: 23439

Launch Date: 26 December 1994 from Baykonur.

Orbit type: Circular, inclination 65 degrees, altitude 1885/2165 km.

Weight: 70 kg

Stabilization: none

Payloads: Transponder, two radio beacons, CW - broadcast bulletin board (2kb), remote control system and telemetry system.

Transponders: Mode A. Uplink 145.858-145.898, Downlink 29.354-29.394, 5 W.

Beacons: Beacon 1: 29.3525 MHz - 0.4/1.2 W; Beacon 2: 29.3987 MHz - 0.4/1.2 W.

Notes: Structure said to be same as RS-3 through RS-8. On board equipment was designed and realized by a group of radio amateurs from Kaluga (180 km SW from Moscow).

References:

"RS-15 Satellite Launched", **The Amsat Journal**, v. 18, No. 1, January/February 1995, p.1.

Satellite List
RS-14 (AO-21)

Radio Sputnik 12/13

NASA/NORAD number: 21089

Launch Date: 5 February 1991.

Orbit type: Circular LEO, inclination 83 degrees, altitude 963/1006 km

Stabilization:

Transponders: Mode A, Mode K, Mode T, Mode KA, Mode KT. ROBOT on modes A, K, T. Generally RS-12, Mode K. Beacons bracket the downlink frequencies.

Beacons (RS-12): 29.408, 29.454, 145.912, 145.958 MHz

Beacons (RS-13): 29.458, 29.504, 145.862, 145.908 MHz

ROBOT uplink (RS-12): 21.129, 145.830 MHz, downlink on 29.454.

ROBOT uplink (RS-13): 21.138, 145.843 MHz

Notes: Two separate packages on same spacecraft (COSMOS 2123 navigation satellite).

References:

"Spotlight on RS10/RS11 and RS12/RS13", John Magliacane, KD2BD, The AMSAT Journal, v. 15, no. 4, July/August 1992, p. 17.

"Working the EasySats", Steve Ford, WB8IMY, QST, September 1992, p. 30.

"Decoding RS-12/13 Telemetry", Keith Bergland, WB5ZDP, The AMSAT Journal, v.15, no. 1, January/February 1992, p. 13.

Satellite List
RS-14 (AO-21)

Radio Sputnik 10/11

NASA/NORAD number: 18129

Launch Date: 23 June 1987.

Orbit type: Circular LEO, inclination 83 degrees, altitude 1000 km

Transponders: Mode A, Mode K, Mode T, Mode KA, Mode KT. ROBOT on modes A, K, T. Generally RS-10, Mode A. Beacons bracket downlink frequencies.

Beacons (RS-10): 29.357, 29.403, 145.857, 145.903 MHz

Beacons (RS-11): 29.407 29.453, 145.907, 145.830 MHz

ROBOT uplink (RS-10): 21.120, 145.820 MHz, downlink on beacons.

ROBOT uplink (RS-11): 21.130, 145.830 MHz

Notes: Single spacecraft (COSMOS 1861 navigation satellite).

References:

"Spotlight on RS10/RS11 and RS12/RS13", John Magliacane, KD2BD, The AMSAT Journal, v. 15, no. 4, July/August 1992, p. 17.

"Working the EasySats", Steve Ford, WB8IMY, QST, September 1992, p. 30.

"New Russian Satellite Sparks Surge of Interest", Vern Riportella, WA2LQQ, QST, November 1987, p. 66.

Satellite List

Radio Sputnik 9

Does anybody know anything about this one ?

Satellite List

Iskra 2 ("Spark")

Callsign: RK02
NASA/NORAD number: 13138
Launch Date: 17 May 1982, from Salyut 7 space station.
Weight: 28 kg.
Beacon: 28.578 MHz.

Notes: Transponder failed to activate due to controller malfunction. Orbit deteriorated rapidly.

References:

Amsat Satellite Report, no. 33-34, 24 May, 31 May 1982.

Satellite List
RS Satellites

Radio 8

NASA/NORAD number:
Launch Date: 17 December 1981.
Orbit Type: Circular, inclination 83 degrees, altitude 1685/1794 km

Notes: Mass launch of RS-3 through RS-8.

References:

Amsat Satellite Report, no. 23-24, 31 December 1981.

Satellite List

Radio 7

NASA/NORAD number:
Launch Date: 17 December 1981.
Orbit Type: Circular, inclination 83 degrees, altitude 1685/1794 km

Notes: Mass launch of RS-3 through RS-8.

References:

Amsat Satellite Report, no. 23-24, 31 December 1981.

Satellite List

Radio 6

NASA/NORAD number:
Launch Date: 17 December 1981.
Orbit Type: Circular, inclination 83 degrees, altitude 1685/1794 km

Notes: Mass launch of RS-3 through RS-8.

References:

Amsat Satellite Report, no. 23-24, 31 December 1981.

Satellite List

Radio 5

NASA/NORAD number:
Launch Date: 17 December 1981.
Orbit Type: Circular, inclination 83 degrees, altitude 1685/1794 km

Notes: Mass launch of RS-3 through RS-8.

References:

Amsat Satellite Report, no. 23-24, 31 December 1981.

Satellite List

Radio 4

NASA/NORAD number:
Launch Date: 17 December 1981.
Orbit Type: Circular, inclination 83 degrees, altitude 1685/1794 km

Notes: Mass launch of RS-3 through RS-8.

References:

Amsat Satellite Report, no. 23-24, 31 December 1981.

Satellite List

Radio 3

NASA/NORAD number:
Launch Date: 17 December 1981.
Orbit Type: Circular, inclination 83 degrees, altitude 1685/1794 km

Notes: Mass launch of RS-3 through RS-8.

References:

Amsat Satellite Report, no. 23-24, 31 December 1981.

Satellite List

Radio 2

Launch Date: 26 October 1978, Plesetsk, USSR.
Orbit type: Circular, inclination 82 degrees, altitude 1688 km/1724 km.
Stabilization: none.
Transponder: Mode A
Antennas: 29 MHz 1/4 wavelength, 145 MHz "inverted vee".
Power: Solar cells.

Notes: Launched with Radio 1 and Cosmos 1045. Operational lifetime - months. Beacon operated until 1981.

References:

"RS - The Amateur Radio Satellites of the Soviet Union", Pat Gowen, G3IOR, Amsat Newsletter, 10 (4), December 1978, p. 4.

"The Satellite Experimenter's Handbook", 1st edition, Martin Davidoff, K2UBC, American Radio Relay League, Newington, CT, 1985.

"Two Russian Amateur Radio Satellites Launched", Bernie Glassmeyer, W9KDR, QST, December 1978, p. 54.

Satellite List

Radio 1

Launch Date: 26 October 1978, Plesetsk, USSR.
Orbit type: Circular LEO, altitude 1720 km.
Transponder: Mode A
Telemetry: CW.

Notes: Launched with Radio 2 and Cosmos 1045. Operational lifetime - months.

References:

"RS - The Amateur Radio Satellites of the Soviet Union", Pat Gowen, G3IOR, Amsat Newsletter, 10(4), December 1978, p. 4.

"The Satellite Experimenter's Handbook", 1st edition, Martin Davidoff, K2UBC, American Radio Relay League, Newington, CT, 1985.

"Two Russian Amateur Radio Satellites Launched", Bernie Glassmeyer, W9KDR, QST, December 1978, p. 54.

Satellite List

The Moon

"Oscar Zero"

Orbit type: Slightly elliptical, 356000/407000 km.

Diameter: 3480 km

Apparent cross-section: 0.5 degrees.

Notes: Round-trip path loss 252.5dB @ 144 MHz, 261.0 dB @ 432 MHz.

Standard Keplerian Elements do not seem to be available for the Moon. Instead, the Moon's position is predicted using a trigonometric series expansion (sine and cosine terms) published in the Astronomical Almanac.

References:

"Astronomical Almanac for the Year 1994", US Government Printing Office, Washington, 1993, p. D46.

"Oscar Zero: An Introduction to EME for the Satellite Operator", Ray Soifer, W2RS, The AMSAT Journal, v. 14, no. 6, November/December 1991, p. 21, and v. 15, no. 4, September/October 1992, p. 19.

Satellite List

SAREX (STS)

SAREX (Shuttle Amateur Radio Experiment) has been carried on many flights of the US Space Shuttle (STS - Space Transportation System) since 1983. Typical operations involve 144/145 MHz NBFM voice or AFSK 1200-baud packet radio operations, or slow-scan TV. A number of frequencies in the 144-145 MHz band have been used. The radio is low-powered (ca. 1 watt) and uses antennas in a window or in the payload bay.

The first SAREX was operated by Owen Garriott, W5LFL, on STS-9, beginning 28 November 1983 (Spacelab mission).

References:

"Well Done, W5LFL!", QST, February 1984, p. 11.

"W5LFL Makes Amateur Radio History", Bernie Glassmeyer, W9KDR, QST, February 1984, p. 79.

"Ham in Space", Sally O'Dell, KB1O, QST, February 1984, p. 79.

"Working the EasySats", Steve Ford, WB8IMY, QST, September 1992, p. 30.

"Amateur Radio Aboard Space Shuttles: T+10 Years and Counting", White, QST, November 1993, p. 22; December 1993, p. 93.

Satellite List

MIR

NASA/NORAD number: 16609

Launch Date: 19 February 1986.

Orbit type: Circular, inclination 51.6 degrees, altitude 400 km.

Frequencies: 145.55 and 145.85 MHz have been reported for both FM voice and FM AFSK packet.

Notes: MIR ("Peace" in Russian) is the Russian (formerly Soviet Union) space station. Replaced the Salyut 7 space station, which was launched 19 April 1982. Many of the cosmonaut occupants are hams, generally operating with callsigns such as U0MIR, or more recently, R0MIR.

References:

Amsat Satellite Report, no. 118, 27 February 1986.

"CQ Earth, This is MIR Calling", UV3DQE, Valery Kondratko, and G3ZCZ, Joe Kasser, The AMSAT Journal, v. 13, no. 2, May 1990, p. 1.

"Working the EasySats", Steve Ford, WB8IMY, QST, September 1992, p. 30.

Satellite List

ARSENE

NASA/NORAD number: 22654

Launch Date: 0056 UTC 13 May 1993, Kourou, French Guiana (Ariane V-56A).

Orbit type: Elliptical, equatorial, altitude 16000/40000 km.

Transponder: Mode B, 145.975 MHz downlink (1200 bps FM AFSK), Mode S (2446.54 MHz downlink).

Notes: Built by French Radio Amateur Club de l'Espace. On-board kick motor. Launched with ASTRA communications satellite. Mode B transponder performance was unexpectedly poor.

References:

"The ARSENE Project", Orbit, no. 5, Jan/Feb 1981, p. 13.

"ARSENE: The First Amateur Radio Satellite of 1993", Steve Ford, WB8IMY, QST, July 1993, p. 94.

"ARSENE - An Orbiting Packet Digipeater", Steve Ford, WB8IMY, QST, February 1993, p. 97.

Satellite List

SARA

Callsign: FX0SAT
NASA/NORAD number: 21578
Launch Date: 17 July 1991, Kourou, French Guiana.
Orbit type: LEO, 770 km.
Beacon: 145.955 MHz downlink (300 bps ASCII FM AFSK - wideshift), 1 watt.

Notes: Satellite for Amateur Radio Astronomy. Launched with UO-22 and others. Monitors "Jovian decameter" radio emissions (planet Jupiter, on 2-15 MHz).

References:

"SARA: A French Amateur Radio Telescope", Patrick Hamptaux, ON1KHP, and Joe Kasser, W3/G3ZCZ, QEX, Dec 1991, p. 15.

Satellite List

Glossary

To be added in a future release.   But try the WinHelp **Search** button anyway.

Help is available on Keplerian Elements.

AMSAT

The Radio Amateur Satellite Corporation. A non-profit, worldwide, volunteer organization devoted to building and operating low-cost, high-tech, public-access communication and experimental satellites. Funded by donations, mostly from interested individuals.

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(Note: AMSAT is not responsible for this program or the contents of these files. K8CG).

Phase III

Phase III is the AMSAT jargon for satellites intended for high altitude, elliptical orbits (*Molniya* type). This includes the ill-fated Phase IIIA, AO-10 (P3B), AO-13 (P3C), and the planned (for 1995 or 1996) P3D, for which funds are currently being raised by AMSAT (via individual contributions). Phase II birds are in the low-earth-orbit class (AO-6, AO-7, AO-8). Phase 4 may be a geosynchronous satellite.

The default satellite in **WinOrbit** is the original Phase III in its transfer orbit, with elements as published in Tom Clark's original article. To see a real satellite, you'll have to Open a 2-line or kep data file, and choose a satellite from the list.

Detailed information is also available about many real satellites

Keplerian Elements

Johannes Kepler (1571-1630) discovered the laws of orbital motion, now called Kepler's laws. A set of 6 parameters, together with the exact time for which they are valid, is required to describe an orbit that obeys these laws. While there are various ways to choose the parameters, the standard set, used by AMSAT (and not coincidentally, the ones published by NASA), follows:

- Epoch Time
- Inclination
- RAAN
- Eccentricity
- Argument of Perigee
- Mean Anomaly
- Mean Motion

Real orbits are not ideal: over time they decay due to atmospheric drag. This deviation from Kepler's Laws is adjusted for by more parameters:

- Decay Rate

For bookkeeping purposes, some descriptive information about the satellite is also included in the published "element sets":

- Catalog Number
- Epoch Revolution

An alternate specification for the size of the orbit, sometimes found in published data, is:

- Semi-Major Axis

The descriptions are in my own words, and may be unclear (or even wrong). If you have a better description, please let me know.

Epoch Time

This is an exact specification of the **date and time** at which the Keplerian element set is valid. The date is given to the left of the decimal point as (year modulo 100)*100 + (day of year), and the time, as a fractional day, to the right. Thus, 94001.5000000 is noon on 1 January, 1994.

Inclination

The tilt angle in **degrees** of the orbital plane with respect to the earth's equatorial plane. Numbers less than 90 degrees represent east-bound satellites, and greater than 90 degrees represent west-bound satellites.

High inclination (more than 50 degrees and less than 130 degrees, say) represents a "polar" orbit. These satellites can be seen from high latitudes. Low inclination (less than 40 or greater than 140 degrees) means the satellite stays near the equator and may not be visible from high latitudes.

RAAN - Right Ascension of Ascending Node

The **Ascending Node** is the point at which the northbound (ascending) satellite crosses the equator.

Right Ascension is a measure of longitude in **degrees**, not with respect to Greenwich, on the rotating earth, but with respect to a fixed point in the sky.

Eccentricity

Orbits are normally elliptical (the circle is a special kind of ellipse). The eccentricity describes how much the orbit deviates from a circle. An eccentricity of zero is a perfect circle, while 1.0 means the orbit resembles the path of a yo-yo (straight line).

Argument of Perigee

There are two special points on the orbit, in addition to the ascending and descending nodes or equator crossings. These special points are *apogee* and *perigee* - the highest (apo) and lowest (peri) altitude points of the orbit. If the elliptical orbit's major axis is rotated away from the equator, then perigee will come at some time other than the ascending or descending node. The angle of this rotation - the angle in **degrees** from the equator to perigee - is the Argument of Perigee.

Don't confuse this with the Right Ascension of Ascending Node.

Mean Anomaly

The Anomaly is an angle which describes the position of the satellite in its orbit, relative to perigee. At perigee, the Anomaly is zero, it increases to 180 degrees at apogee, then back to perigee at 360 degrees.

Since the orbit is not a circle, the measurement of the angle is difficult, so the angle is expressed in terms of a fractional orbit (one orbit = 360 **degrees**).

Mean Motion

Instead of the orbital period (for which there are several possible definitions), the rotation rate (an hence the altitude) of the satellite is expressed in terms of **orbits per day**.

Decay Rate

The rate of change of the Mean Motion, in **orbits per day per day**. Additional parameters are sometimes used, such as the second derivative.

Catalog Number

A unique number assigned by NASA or NORAD to every object in space for bookkeeping. The numbers are assigned in consecutive order of arrival.

Epoch Revolution

The **orbit number** at the Epoch Time.   Orbits may be counted at ascending equator crossings or at perigee.

Semi-Major Axis

This is an alternate expression of the size of the orbit, or altitude of the satellite, and can be derived from the Mean Motion and the Eccentricity. If the orbit is a circle, the semi-major axis is the radius of the circle. If it is an ellipse, the *major axis* is the longest diameter, while the *minor axis* is the shortest. The semi-major axis is half the major axis, in **km or mi**.

Note that for elliptical orbits, the earth is at one **focus**. These points (the *foci*) are not centered in the ellipse, so the semi-major axis does not directly describe the altitude at perigee.

Orbital Prediction Algorithms

Models (jargon for a set of equations and the computer program that computes them, sometimes called an *algorithm*) are used to predict the position of the satellite at any time, given the keplerian elements (also called the *model parameters*). **WinOrbit** allows choosing from 4 different models (each of which can incorporate or neglect a drag or decay term):

Ideal Keplerian Model (Ideal): This model assumes that the Earth is a point in space, and that the sun, moon, etc. have no influence. The satellite orbit is then a perfect ellipse whose orientation in space is fixed forever, while the earth rotates underneath.

Basic Model (Basic): The original Clark algorithm (with a name borrowed from the original article title). Similar models have been published by Karl Meinzer (DJ4ZC) and James Miller (G3RUH), I believe. Real orbits drift slowly with time because the earth is not a sphere. This is called *precession*. Both the orbital plane (represented by the right ascension of the node) and the orientation of the orbit in that plane (represented by the argument of perigee) change with time. The rate of change is influenced by the eccentricity and inclination of the orbit. The earth is represented as a simple ellipsoid, and other bodies (sun, moon) are ignored. (The elliptical representation of the earth refers to its gravitational effects, not to the location of the observer on the surface, which is a second issue).

Simplified General Perturbation Model (SGP): this series of models is the most accurate one that I am aware of. There are several levels (SGP, SGP4, SGP8, and "deep space" versions SDP4 and SDP8). The *perturbations* of the title are due to the influence of the sun and moon, as well as to more complicated distortions of the earth's gravitational field. **WinOrbit** incorporates both SGP and SGP4 at this time. Both models were adapted from the FORTRAN listings provided by Tom Kelso in the **SpaceTrack** documentation.

Mode T

21 MHz uplink, 145 MHz downlink.

Mode S

435 MHz uplink, 2400 MHz downlink.

Mode L

1269 MHz uplink, 435 MHz downlink.

Mode KT

21 MHz uplink, simultaneous 29 and 145 MHz downlinks.

Mode KA

simultaneous 21 or 145 MHz uplinks, 29 MHz downlink.

Mode K

21 MHz uplink, 29 MHz downlink.

Mode JD

145 MHz uplink, 435 MHz downlink (opposite of Mode B) with digital repeating.

Mode JA

145 MHz uplink, 435 MHz downlink (opposite of Mode B), linear transponder. Also called Mode J.

Mode J

145 MHz uplink, 435 MHz downlink (opposite of Mode B), linear transponder. First used on FO-12, hence mode "J" for Japan.

Mode B

435 MHz uplink, 145 MHz downlink, linear transponder (repeater).

Mode A

The original satellite mode, 145 MHz uplink, 29 MHz downlink, linear transponder (repeater).

Maidenhead Grid Locators

Among Amateur Radio operators, a popular way of describing one's location is to give the 4 or 6-character *grid square* designation. Each grid square is 1 degree of latitude by 2 degrees of longitude (4-character) or 2.5 by 5 minutes (6 character), and has a unique designation. A variation of this system was first devised in Maidenhead, UK, hence the name.

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"Measure AO-13 Squint Directly", James Miller, G3RUH, The AMSAT Journal, v. 16, no. 1, January/February 1993, p. 20.

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Ground-Station Equipment

See the discussion of Beacons and Telemetry modes

"Computer Interface for Kenpro KR-5400A", QEX, May 1987, p. 7 and June 1987 p. 7.

Periodicals- AMSAT

Amsat membership publications over the years have gone through several formats:

- Amsat Newsletter: published sporadically until 1979
- Orbit (magazine): replaced the Newsletter, publishing 19 issues from Mar/Apr1980 through Nov/Dec 1984.
- Amsat Satellite Journal: replaced Orbit with 7 bimonthly issues from Jan/Feb 1985 through Jan/Feb 1986. Merged with QEX in October 1986. Discontinued in June 1989.
- Amsat Satellite Report (ASR): replaced the Satellite Journal beginning with issue #126/127, June 24 1986, through #192, Dec 15, 1989. [This newsletter started in March 1981 as a weekly; in 1986 it also became the official Amsat periodical. In 1990, it was taken over as Oscar Satellite Report by R. Myers, W1XT, and is still being published.]
- The Amsat Journal: became the official publication beginning with the May 1989 issue, vol 12 #1, continuing through the present.

ASR and Amsat Journal were started independently to serve special interests within AMSAT, but later absorbed the general membership newsletter function. All of these publications have had considerable technical content over the years.

Periodicals- Other

Several Amateur Radio publications carry material of interest to satellite enthusiasts. Some can be found in public libraries:

QEX - ARRL Experimenter's Newsletter (monthly). ARRL, 225 Main St. Newington, CT, USA. Annual index in February issue (through 1993), later in December issue. Incorporated Amsat Satellite Journal from October 1986 through June 1989.

QST - official journal of ARRL (monthly). Annual index in December issues.

ham radio - (monthly) ceased publication in 1990 after being absorbed by CQ

CQ - (monthly)

Transponder Modes and Modems

Transponder Modes

To be written.

Beacon/Telemetry Modes

Beacons are autonomous transmitters on the satellite (they do not repeat ground-station transmissions). Generally, they send either pre-programmed messages ("HI" in the early OSCARs, synthesized voice greetings on the UoSATs and DOVE, and so on), or *telemetry*. Telemetry is typically engineering data (temperatures, voltages, status values) encoded as text. To decode this information we need to consider the modulation format (hence the type of modem required), the code (to convert from the binary modem output to text), and the telemetry conversion format (to convert from text - decimal, hexadecimal, or alphanumeric - to *engineering units*).

Modulation Schemes

CW (Continuous-Wave). Also known as On-Off-Keying (OOK), the binary form of AM (amplitude modulation). Normally uses International Morse Code. A signal at a single radio-frequency (the carrier) is turned on and off. Typical reception involves conversion (heterodyning) to an arbitrary audio frequency such as 800 Hz for demodulation and decoding by the human ear.

FSK (Frequency-Shift Keying). The binary form of FM (Frequency Modulation). Typically used with standard asynchronous teleprinter codes such as ASCII or Baudot. Two different radio-frequencies are selected alternately to represent mark (on) and space (off) binary values. Typical reception involves heterodyning to a standard pair of audio frequencies, and demodulation by a phase-locked-loop, filter/rectifier/comparator, or DSP techniques such as cross-correlation, followed by decoding of the binary information.

AFSK (Audio Frequency-Shift Keying). A variation of FSK where two audio frequencies are alternately used to frequency-modulate an rf carrier. Sometimes used with asynchronous teleprinter codes (ASCII: UO-9, UO-11), more often with synchronous coding (HDLC, AX.25, etc. as in the various microsats). Reception requires a standard FM receiver, the audio output of which is applied to the same sort of modem and decoder as used for FSK. The commonly-used standard is called "Bell 202".

PSK (Phase-Shift Keying). A binary (or m-ary) form of PM (Phase Modulation). The phase of a radio-frequency carrier is shifted depending on the information bits. Almost always used with synchronous codes. Reception involves heterodyning to audio frequencies, and detection by a synchronous modem or DSP, followed by decoding.

RTTY (Radio TeleTYpe). A generic term for digital communication of text. Most often used in the Amateur Radio community to refer to Baudot-coded FSK or AFSK transmissions.

Telemetry Decoding

Once the telemetry information is received, it must be decoded - converted to engineering units such as temperature, voltage, etc. A wide variety of formats has been used. Here are some references.

"Amsat Oscar 10 RTTY Format", anonymous, Amsat Satellite Journal #1, Jan/Feb 1985, p. 13.

"The Telemetry Formats of JAS-1b/Fuji-OSCAR 20", JR1NVU, The AMSAT Journal, v. 13, no. 4, Sep 1990, p. 20.

"Decoding RS-12/13 Telemetry", Keith Bergland, WB5ZDP, The AMSAT Journal, v. 15, no. 1, January/February 1992, p. 13.

Telemetry/Beacon Index

AFSK - 1200 baud ASCII code - UO-11

AFSK - 1200 baud AX.25 code - DO-17

400 baud PSK - AO-10/AO-13

1200 baud PSK - AO-16, LO-19, FO-12, FO-20

9600 baud - UO-14

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