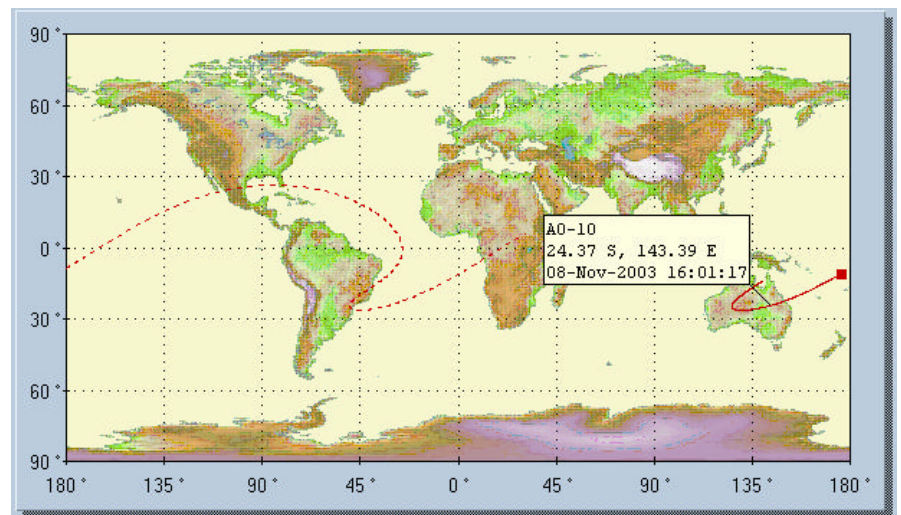# HAM RADIO DELUXE

SATELLITES

A BRIEF INTRODUCTION

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Sponsor:

The IC-703s and IC-7800s used in this project were supplied by Martin Lynch and Sons of London.

Special thanks are due to Chris Taylor for his friendly and efficient service.

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INTRODUCTION

COMPONENTS

There are two components which make up the Ham Radio Deluxe (HRD) satellite tracking support:

1. Data Generation,

2. Tracking.

DATA GENERATION

The data generation takes Kepler data for one or more satellites from text files in the directory of your choice and computes:

- Visibility,

- Azimuth,

- Elevation,

- Rate range.

This information is then made available to other components of HRD and other programs via a DDE server using the Nova format.

Any 3rd party program which requires Nova tracking information can now use HRD instead. Typical examples are rotator controllers.

HRD does not support direct control of a rotator via a COM port, instead the software supplied with your rotator must be configured to use the data supplied by HRD's DDE server.

TRACKING

HRD uses the data generator to compute the Doppler shift which is applied to the transmit and receive frequencies for the current satellite.

SATELLITE TRACKING

To start the Satellite Tracking window select Satellite Tracking from the Tools menu.

SATELLITES

This window lists the satellite data. The default folder is *Satellites* located below the folder where you have installed HRD - for example: *C:\Program Files\Amateur Radio\Ham Radio Deluxe\Satellites.*

To change the folder just press Select .

Select up to 100 entries from the *Available* list by either double-clicking on individual entries or by highlighting one or more entries and pressing > . By pressing >> all entries (up to a maximum of 100) are moved to the *Selected* list.
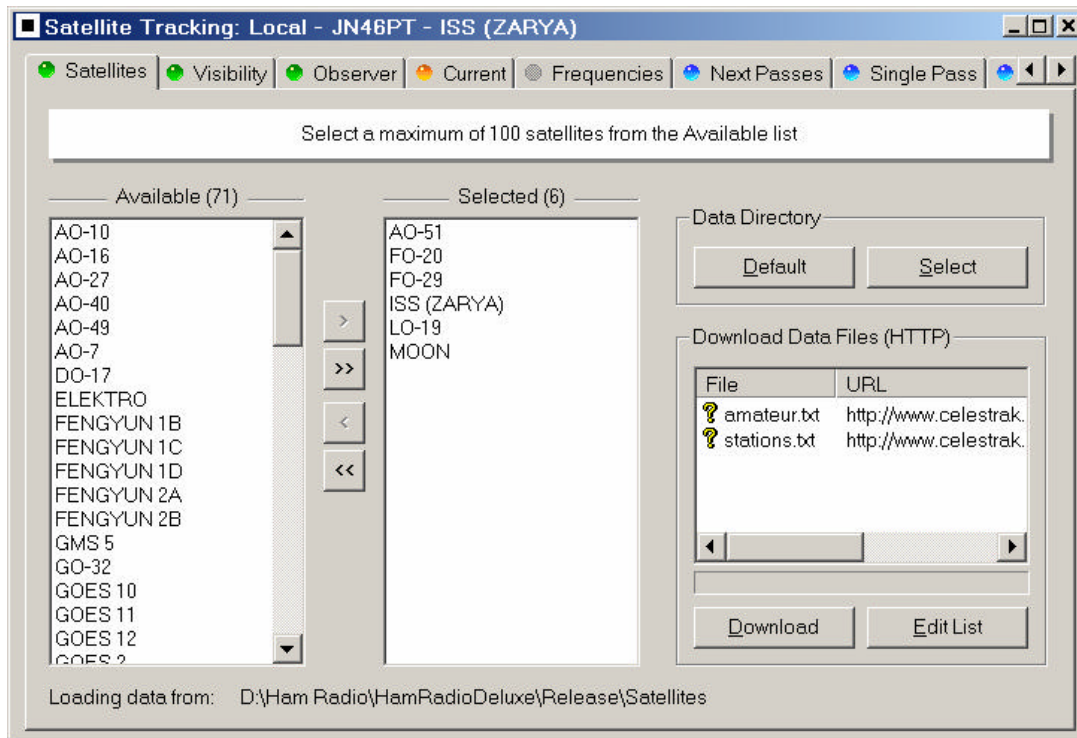
DATA FILES

See the chapter '*Kepler Data Files*' to help to you understand these files.

It is recommended that you update these files when you start using Ham Radio Deluxe as the files shipped in the kits will be out of date by the time you start to use them. These files should ideally be refreshed every day.

To download the latest Kepler data files press Download . The files are downloaded to the folder containing your satellite data.

To edit the list of files press Edit List . The file is *HRD Satellite List.txt* in the folder *Satellites* located below the folder where you have installed HRD - for example: *C:\Program Files\Amateur Radio\Ham Radio Deluxe\Satellites.*

Example:

```
#
#   The entries below are downloaded using the Satellites
#   page in the Satellites data option.
#
#   Entries must start with http://.
#
http://www.celestrak.com/NORAD/elements/amateur.txt
http://www.celestrak.com/NORAD/elements/weather.txt
```

VISIBILITY

The visibility window gives you an overview of the satellites you have selected in the *Satellites* window.

Select the satellites which are displayed:

- All displays all satellites,

- Visible now displays only the satellites which are currently visible,

Visible in next… displays the satellites which are visible at any time in the time period you select, for example the satellites visible in the next 60 minutes.

Press Viewer to display the data with the default text file viewer, usually *Notepad*.

For each entry in this display the columns are:

COLUMN	DESCRIPTION
Vis	Whether the satellite is currently visible.
Satellite	The name of the satellite.
Azimuth	The azimuth of a satellite is the angle between the vertical plane containing it and the plane of the meridian. It is customary to reckon the azimuth of a line from the south point of the horizon around by the west from 0[deg] to 360[deg].
Elevation	The angular distance above the horizon.
AOS	Acquisition of signal is the elapsed time at which the satellite becomes visible and a signal can theoretically be heard. If empty then the satellite is already visible.
LOS	Loss of signal is the elapsed time after which the satellite is no longer visible and the signal can theoretically no longer be heard.
Lon	The satellite's current longitude.
Lat	The satellite's current latitude.
Range	The distance of the satellite from the observer's location measured in kilometers. (A mile is 1.6 kilometers, a kilometer is 0.62 miles.)
Altitude	The altitude of the satellite above sea level measured in meters.
Range Rate	The value required to calculate the Doppler frequency adjustment.

Satellite Tracking: Local - JN46PT - ISS (ZARYA)

Satellites | Visibility | Observer | Current | Frequencies | Next Passes | Single Pass

Satellite visibility

Show: ● All ○ Visible now ○ Visible in next [120] minutes   [Viewer]

Vis	Satellite	Azimuth	Elevation	AOS	LOS	Lon	Lat
✘	AO-51	224.65	-50.56	5:46:56	5:59:19	55.85 W	42.17 S
✘	FO-20	196.99	-59.28	4:43:52	4:56:22	45.07 W	73.12 S
✘	FO-29	84.76	-73.35	42:45	47:16	150.34 E	37.00 S
✔	ISS (ZARYA)	80.50	15.33		4:38	22.29 E	47.55 N
✘	LO-19	187.68	-71.19	3:56:49	4:08:56	140.89 W	81.09 S
✘	MOON	70.13	-34.67	3:26:54	14:15:47	136.23 E	12.32 S

OBSERVER

In the Observer window you enter your location and height above sea level in meters. For users more familiar with imperial measurements: 1 metre is 3.3 feet.

Enter your location either:

- By entering your Maidenhead Locator in the *Locator* field and the pressing Convert >> or
- By entering the Latitude and Longitude directly.

You also select the preferred time format; either Local (default) or UTC.

You must press Apply to update the satellite settings.

CURRENT SATELLITE
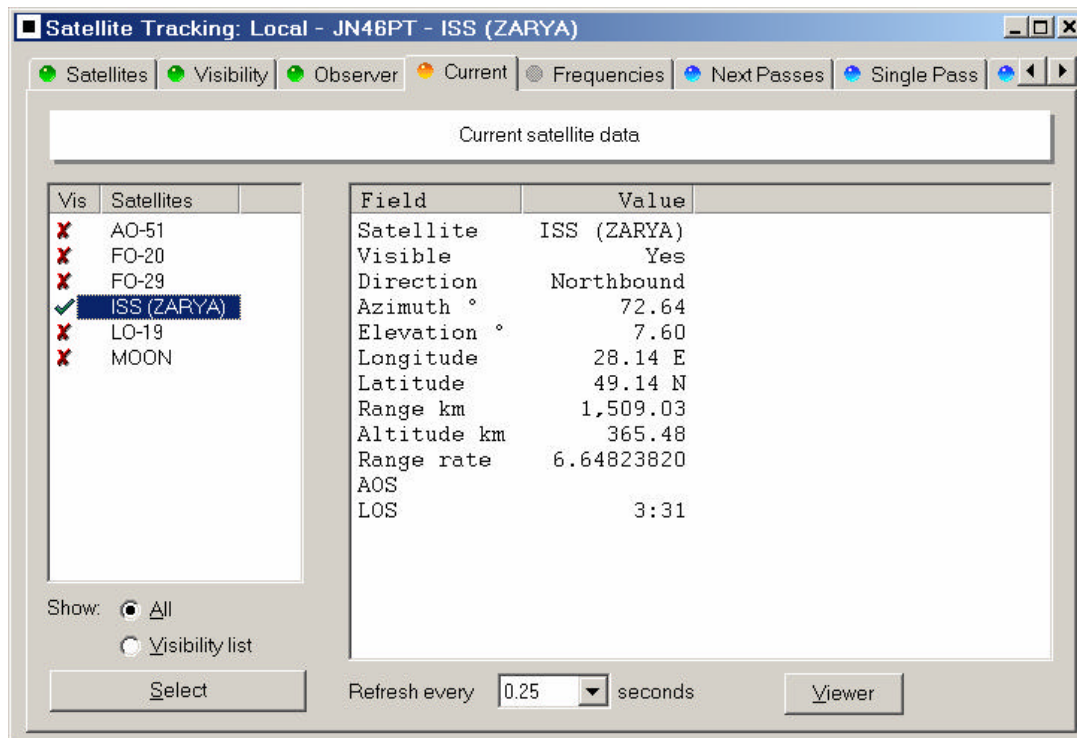
This window shows all information for a selected satellite. This window provides the data for the DDE Server window.

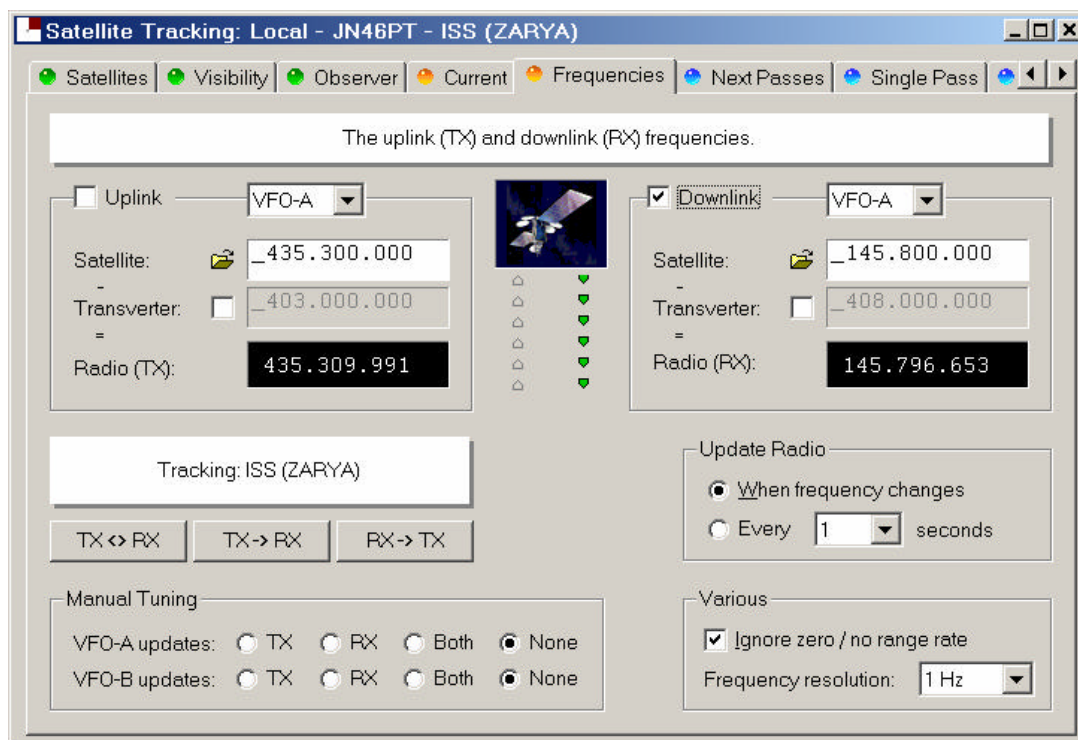Press Viewer to display the data with the default text file viewer, usually *Notepad*.

Select:

All to list all selected satellites in the left-hand selection window, or

Visibility list to list only the satellites listed in the *Visibility* window list.

FREQUENCIES

This window is used to adjust your radio's uplink and downlink frequency. The Doppler Effect is the apparent shift in frequency of a wave due to the relative motion of source and observer. Doppler shift is calculated in accordance with Kepler's laws.

UPLINK

The fields are:

COLUMN	DESCRIPTION
VFO	The VFO used for the uplink.
Uplink	Check the *Uplink* box if the value displayed in the *Radio* field is to be applied to your radio.
Satellite	The satellite uplink frequency. Click to select a new frequency from a popup window containing the Favourites definitions.
Transverter	If you are using a transverter enter your transverter's intermediate frequency here and check the [X] box. If you are not using a transverter either leave this field empty or do not check the [X] box. The Radio frequency is calculated as: *Satellite – Transverter + Doppler shift*.
Radio	The radio frequency as computed by HRD taking Doppler shift into account.

DOWNLINK

The downlink fields are the same as the Uplink fields except you click *Downlink* instead of *Uplink* if the value displayed in the *Radio* field is to be applied to your radio.

MANUAL TUNING

This determines how manual tuning of your radio's frequency is applied to the Satellite frequencies.

- TX – the uplink satellite frequency is set to the new radio frequency.
- RX – the downlink satellite frequency is set to the new radio frequency.
- Both – the uplink and downlink satellite frequencies are set to the new radio frequency.
- None – no action taken – this is the recommended option.

VARIOUS

These fields are:

COLUMN	DESCRIPTION
Ignore zero / no range rate	Some programs, such as Satscape, do not return data if the satellite is not visible. (HRD and Nova always return the correct range rate even if the satellite is not visible.) If you want the last valid settings to be maintained when data is no longer returned because a satellite is not visible *you must* select this option.
Frequency resolution	Select your radio's frequency resolution. Typically Yaesu radios have a resolution of 10 Hz whereas ICOM have a resolution of 1 Hz. It is important that you select 10 Hz if your radio only has a 10 Hz resolution otherwise internal auto-tuning logic in HRD will not function properly. If in doubt set this to 10 Hz.

UPDATE RADIO

Select how often the radio frequency is compensated for Doppler shift:

- When frequency changes (when new data is received from the DDE server) or

- Every *n* seconds where *n* is a value between 0.5 and 60.

The first option will usually be acceptable; the only reason for selecting the second option is if your computer or radio cannot keep up with rapid changes of frequency.

OTHER

The other options are:

- TX > RX – copy the Uplink satellite frequency to the Downlink satellite frequency.

- RX > TX – copy the Downlink satellite frequency to the Uplink satellite frequency.

- TX <> RX – exchange the Uplink and Downlink satellite frequencies.

NEXT PASSES

This window shows up to 1,000 passes for a selected satellite. Note: do not select more than 100 passes unless you have a very powerful computer, minimum CPU frequency of 2 GHz is recommended.

Press ⌷Plot⌷ to plot a selected pass in the *Single Pass* window.

Press ⌷Viewer⌷ to display the data with the default text file viewer, usually *Notepad*.

Select:

- ⌷All⌷ to list all selected satellites in the left-hand selection window, or

- ⌷Visibility⌷ list to list only the satellites listed in the *Visibility* window list.

SINGLE PASS

This window plots a single pass for the satellite selected in the *Next Passes* window. The elevation is plotted on the left y-axis, time is on the x-axis. Select *Azimuth*, *Altitude* or *Range* to be plotted on the right y-axis.

If Popup info is checked a vertical dashed marker line is displayed which either tracks the current time or is positioned by clicking on the chart with the left mouse button.
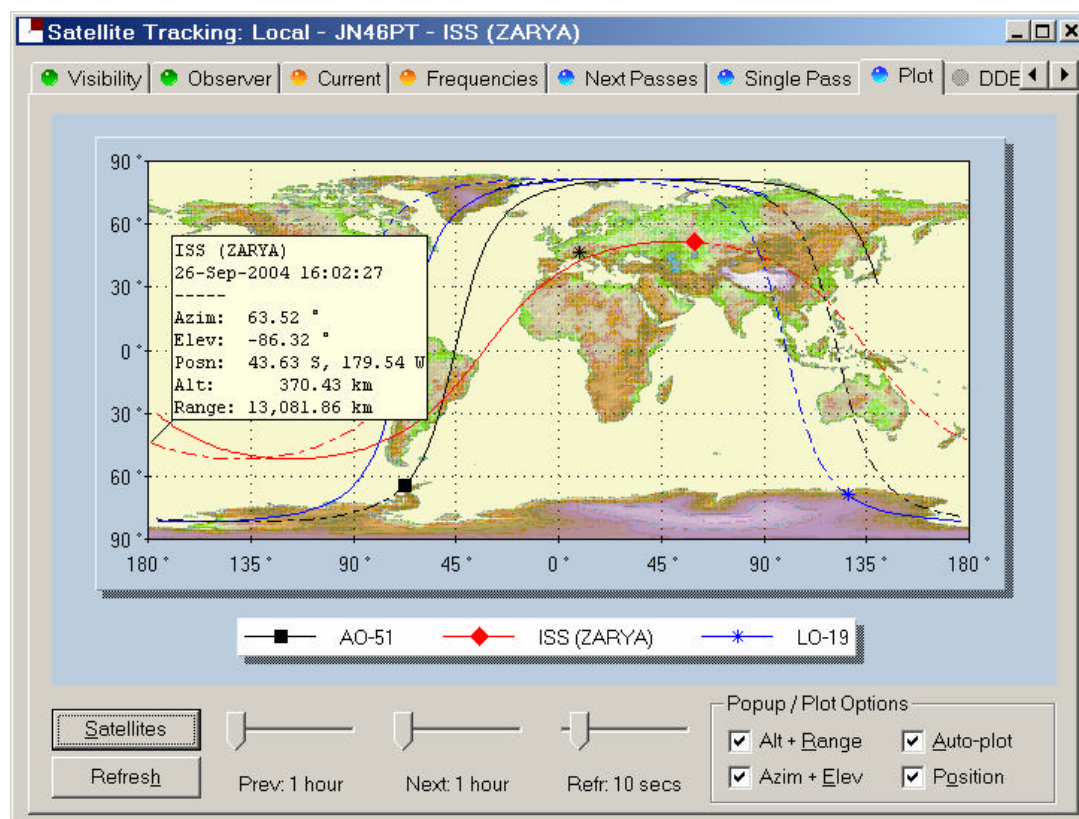
As the marker position changes, the azimuth, elevation, altitude and range are displayed in the Marker fields.
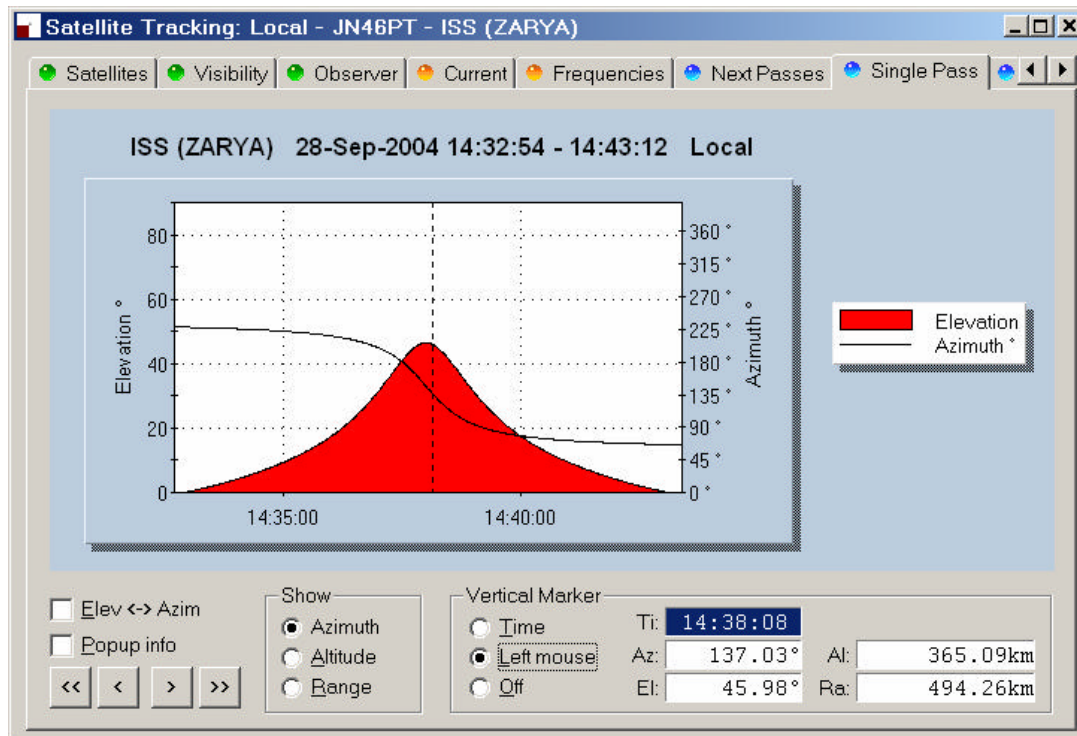
WORLD TRACK

This window shows the position of one to four satellites above the surface of the planet.

The previous satellite track up to the current time is plotted with a solid line; the current position is indicated with a symbol (square, diamond, circle or star) and the track from the current time into the future with a dotted line.

Use the Auto-plot option to update the chart automatically as you change any of the options such as satellite names.

The Refresh slider adjusts the auto-refresh interval. Be careful with this; if you have a slower system (< 1 GHz), updating the display over a timeframe of more than a few hours can use considerable CPU resources.

As you move the mouse over the map a small popup window attaches itself to the nearest satellite track and displays *satellite name*, *location* and *time*.

BACKGROUND PICTURE

The background picture is loaded from the folder *Satellites* located below the folder where you have installed HRD - for example: *C:\Program Files\Amateur Radio\Ham Radio Deluxe\Satellites.*

The filename is WorldMap.bmp. A low-resolution 256-colour map is shipped with HRD; you can download a high-resolution 24-bit colour map from the Ham Radio Deluxe website http://www.hb9drv.ch/. Just unpack into the *Satellites* folder and restart HRD.

DDE

This window controls the DDE server. If you want to use HRD's data with another program you must start HRD's DDE Server.

Select the DDE format: currently only *Nova* is supported.
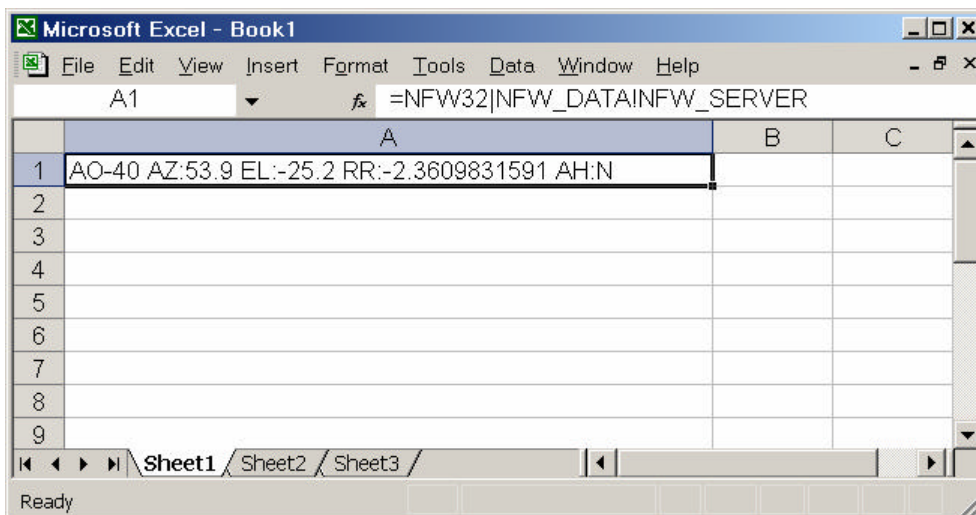
Press Start .
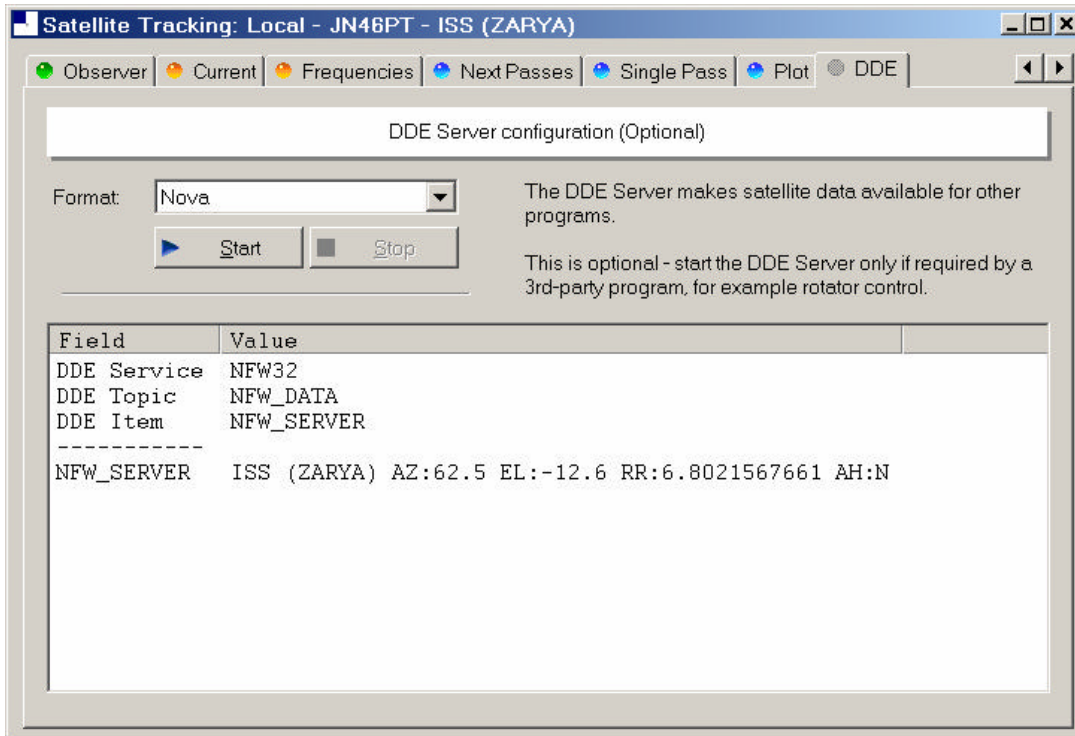
Use Microsoft Excel to check that data is available. Start the Excel Help and enter *DDE* in the help Index for an example.

Select a cell.

Enter the formula =NFW32|NFW_DATA!NFW_SERVER

Press Enter .

DUAL RADIO SUPPORT

Configuring Ham Radio Deluxe for dual radio support is very easy, just follow these steps to use Radio A for the downlink (RX) and Radio B for the uplink (TX).

Downlink

1. Start the first instance of HRD

2. Start Satellite Tracker

3. Select the satellite

4. Start Satellite Tracker

5. Enter the downlink frequency

6. Check the Downlink [X] option.

You have now configured the downlink.

Uplink

1. Start the second instance of HRD

2. Start Satellite Tracker

3. Select the satellite

4. Start Satellite Tracker

5. Enter the downlink frequency

6. Check the Uplink [X] option.

You have now configured the uplink.

EXAMPLE: LO-19

This example helps you set up your radio to receive the LO-19 CW beacon on 437.125 MHz. Make sure you have read the previous chapters before you try this.

SATELLITE DATA

Once you have started the Satellite Data display:

PAGE	ACTION
Mandatory	
Satellites	Make sure LO-19 is selected. Make sure your Kepler data is has been updated today.
Observer	Enter your location.
Current Satellite	Select LO-19; click [All] to display all selected satellites if necessary.
Optional	
Next Passes	Shows you the next passes for a selected satellite; if necessary click [All] to display all selected satellites so that you can select LO-19.
Single Pass	See whether you stand a chance of receiving the satellite. Consider the elevation and azimuth – will the satellite be hidden by a mountain or your local brewery? If the satellite is too far away the signal will be very weak – with the HB9DRV FT-817 and 70 cms vertical antenna it can be heard at a range of 1,500 km. Any further away and some sort of beam is needed.
Frequencies	The receive frequency is configured with the *Downlink (RX)* fields. • Select VFO A • Check Active • Make sure the Transverter field is empty and not checked • Enter 437.125.000 in the Downlink (RX) Satellite field. Set the frequency resolution to the rig's resolution.

With HB9DRV's FT-817 the mode is set to USB. The FT-817 has a 10 Hz frequency resolution.

If you are using a transverter you enter the transverter's intermediate frequency in the Transverter field and check the [X] box.

The audio pitch of the CW beacon will not change during the satellite pass if the Kepler data is correct.

KEPLER DATA FILES

Keplerian elements are the inputs to a standard mathematical model of spacecraft orbits.

In the Satellites window you select the folder where the satellite data files are stored.

New satellite data files can be downloaded from the internet, for example from http://www.celestrak.com/maintained by T.S. Kelso or from http://www.amsat.org/ maintained by The Radio Amateur Satellite Corporation (AMSAT).

The only supported file format is two-line element sets, for example:

```
AO-7
1 07530U 74089B   03265.96753648 -.00000029  00000-0  10000-3 0  2356
2 07530 101.7328 311.4393 0012255  21.1784 338.9793 12.53565904320301

AO-10
1 14129U 83058B   03265.06525444 -.00000148  00000-0  10000-3 0  9658
2 14129  26.3223 129.7582 5974698  27.0721 354.5394  2.05868478124501
```

The verbose format is **not** supported, for example amsat.all or nasa.all from http://www.amsat.org/amsat/keps/menu.html .

If you look at http://www.celestrak.com/NORAD/elements/ you will see many files which can be downloaded. Just download these files and save them in the *Satellites* folder selected previously.

For more information about the contents of these files browse http://www.celestrak.com/.

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