Technical Manual

SATGEN SATELLITE
DATA GENERATION PROGRAM

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1. General Information

1.1. Overview of the SATGEN Satellite Data Generation Program

SATGEN is a graphical user interface (GUI)-based program used to generate data files necessary for the Dynamic Mode of dBm's Satellite Link Emulator. The program calculates Doppler, delay, path loss and fading data for a specified satellite orbit and Earth transponder position.

1.2. Features and Functions

This program allows you to simulate a communication path between an orbiting satellite and up to four ground stations. Any orbit or ground position can be entered. Pre-set parameters include:

- nine predefined satellite orbits, and
- ground station coordinates for over forty cities world-wide

You can monitor the progress of the satellite orbit through simulated view of a:

- three dimensional view of the satellite orbiting the Earth,
- ground trace of the satellite orbit over a flat map of the Earth, or
- look angle with respect to the ground station.

Additionally, the generated data is available in both graphical and tabular form.

2. System Requirements and Installation

2.1. System Requirements

This program runs directly on any Windows™ compatible computer with 4MB of RAM, a VGA monitor, and optional mouse.

2.2. Password

To save the data for use with dBm's SLE Satellite Link Emulator, you must enter a password supplied by dBm. You may enter the password from the Help menu, or you will be prompted for the password when you attempt to save the file. The password validation is required only once.

3. Overview

3.1. Window Components

The SATGEN program graphical user interface is provided through four main areas: Title Bar, Menu Bar, Run Bar, and View Bar (see Figure 3-1).

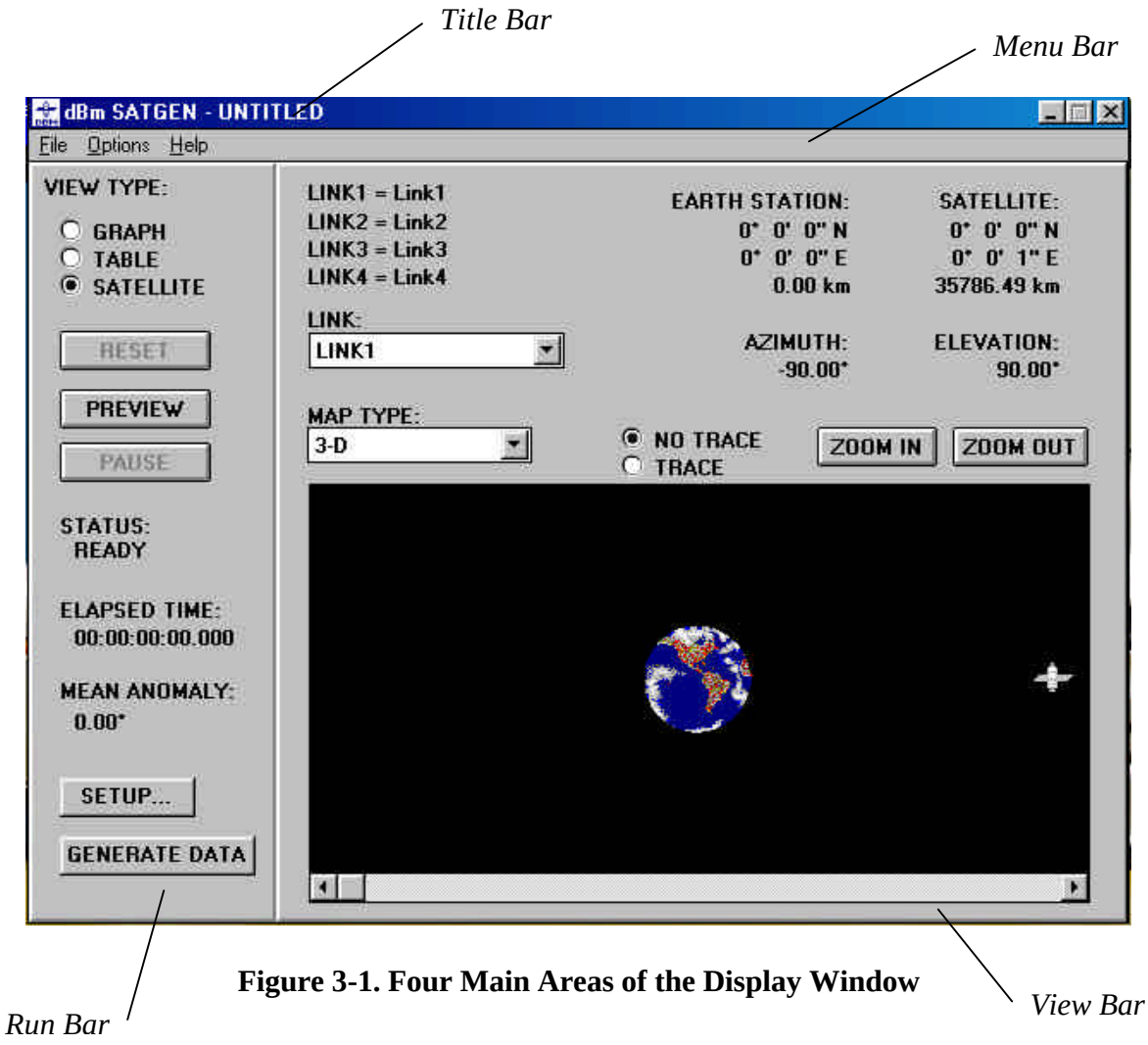


Figure 3-1. Four Main Areas of the Display Window

3.2. Using the Mouse and Keyboard

You may use the mouse, keyboard, or a combination of the two to operate any of the SATGEN controls on any of the display screens

3.2.1. Operating SATGEN with the Mouse

Click the left mouse button once to activate any of the buttons or scroll bars.

Modify scroll bars by using any of the following techniques (see Figure 3-1):

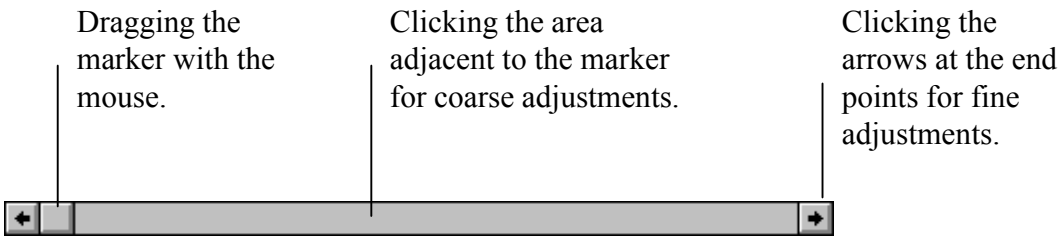


Figure 3-2. Scroll Bar Use

3.2.2. Operating SATGEN from the Keyboard

You many use the mouse, keyboard, or a combination of the two to operate any of the SATGEN controls.

Menu Items

To access the menu commands, hold down the *Alt* key and press one of the following letters:

F File Menu

O Options Menu

H Help Menu

When the drop-down menu appears, use the *Arrow* keys to scroll through the list. Select a command by pressing *Enter*, or leave the menu by pressing *Esc*.

Controls

All control groups can be accessed by *Tab*bing to the control or group of controls. There are six types of SATGEN controls:

Radio Buttons - used to select one and only one option from a group. *Tab* to the group, then use the *Arrow* keys to change which option is selected. The *View Type* buttons are examples of radio buttons.

Push Buttons - used to initiate some type of action. *Tab* to the button, then press the *Space* bar to push. The *Reset, Preview*, and *Pause* buttons are examples of push buttons.

Combo Boxes - used to select one and only one option from a group. *Tab* to the box, then use the *Arrow* keys to cursor through the list. *The Map Type* box in the *Satellite* view is an example of a combo box.

Edit Boxes - used to enter numerical or character data. *Tab* to the box, then type in the data required. Press the *Enter* key to validate the data. The *Number of Samples* box in the *System Setup* dialog is an example of an edit box.

Scroll Bars - used to increment a setting by a preset amount. *Tab* to the bar, then press the *Arrow* keys to increment or decrement the setting. The *3-D* display is an example of a window with scroll bars.

List Boxes - used to select one item from a list of items. *Tab* to the list, then use the *Arrow* keys to cursor through the list. The *Location List* in the *Earth Station* dialog box is an example of a list box.

4. Operation

4.1. Getting Started

You can create the data files for use with the SLE700 by the following steps.

1. *Setup* the desired satellite orbit, earth stations, and path loss models.
2. *Preview* the file to verify that the settings achieve the desired orbit.
3. *Generate* the data and view as graph or table.
4. *Save* the file.

4.2. Initializing SATGEN

4.2.1. Select the Number of Links

At the onset of starting the SATGEN program, the number of links must be selected. A link is defined as a connection between an Earth station and the satellite. Data files will be generated for each link. Up to four links can be enabled, representing four Earth stations. The Earth station locations can be unique, or they can be identical. Identical Earth station locations would be used to simulate a round trip channel (Earth station to satellite, and back to the Earth station).

4.2.2. Select the Link Configuration

The Link Configuration under the Options menu is used to configure how link data will be stored. Default conditions (Link1=link1, Link2=link2, etc.) cause the data files to represent the connection between the satellite and the Earth station defined for that link. Link data can also be combined to simulate a complete forward or reverse channel. For example, a unique Earth station location can be assigned for Link1 and for Link2. Link1 data can be configured to be the sum of the Link1 and Link2 (select the option for Link1=link1 + link2). When the data files are saved, the Link1 data will represent the parameters for the complete channel from Earth station 1 to the satellite and back to Earth station 2.

4.3. Loading Files

4.3.1. Opening Existing Configuration Files

Opening a file causes the system setup and data files that are stored in files to be loaded into the SATGEN application's program. The file name will appear in the *Title Bar*. Since fading and path loss are combined when data is saved, the atn.dat file will be loaded into fading, and no data will be loaded into pathloss.

4.3.2. New Files

Selecting a *new* file causes SATGEN to initialize to preset conditions. The file name will appear as "Untitled" in the *Title Bar*.

4.4. Saving Files

SATGEN saves the system setup and link data in separate files. The system setup is stored with the file extension .gen. The link data file names are specified in *the Earth Station* dialog box. The file format for the link data is compatible with dBm's SleControl program and dll, which interface with the SLE700 Satellite Link Emulator.

4.4.1. Saving a File Under a New File Name

To save a file under a new name, select *File, Save As* from the menu bar; enter the new name and click on Save.

4.4.2. Overwriting an Existing File (Save)

Using the *File, Save* command will store the file on the hard drive under the name that appears in the *Title Bar*. SATGEN automatically appends an extension of .gen to files.

4.5. Editing Files

Before you *run* a file, you need to set up the system parameters. Press the *Setup* button on the *Run Bar* to invoke the *System Setup* dialog box (see Figure 4-1).

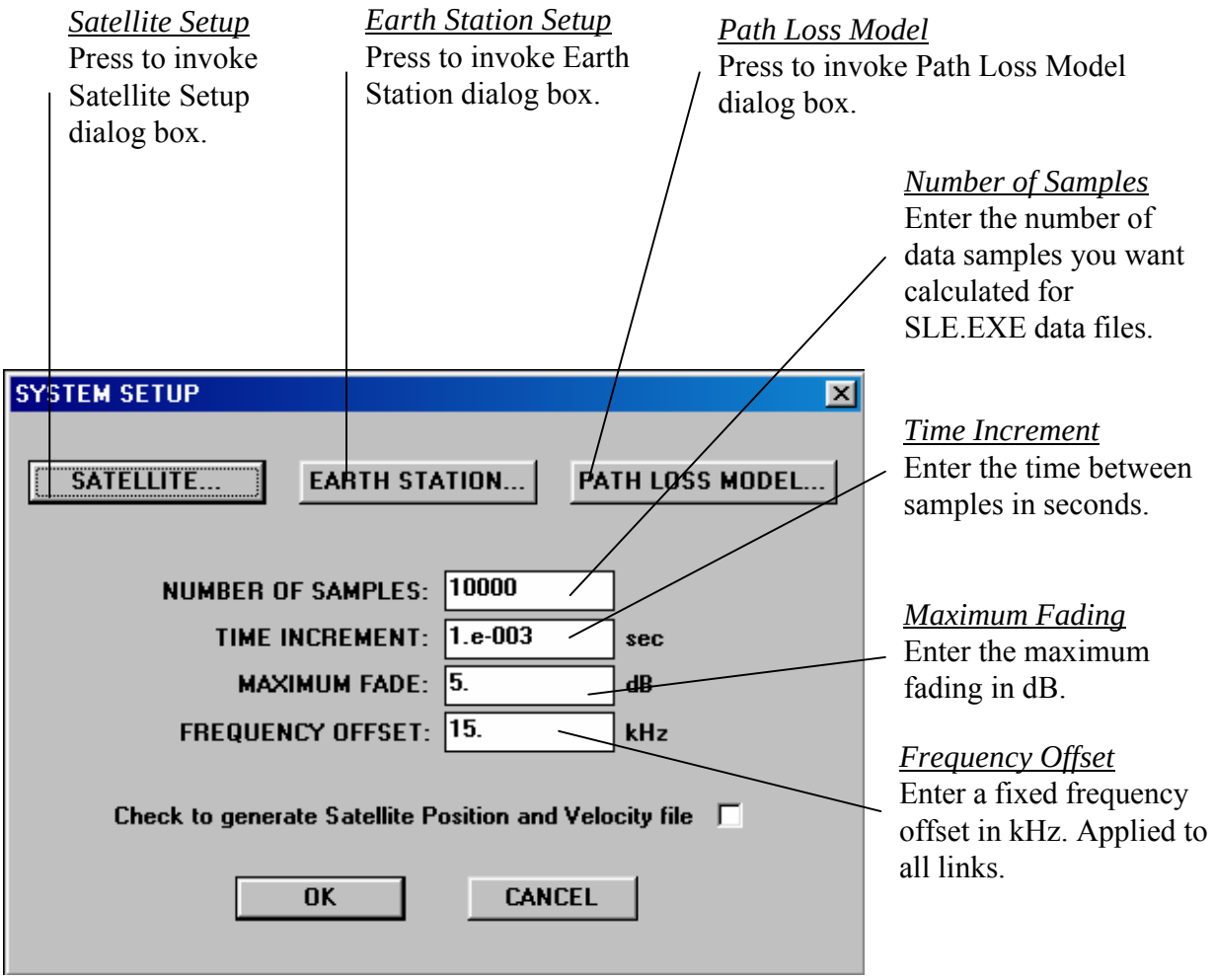


Figure 4-1. System Setup Dialog Box

4.5.1. Satellite Setup

Click the *Satellite* button on the *System Setup* dialog box to invoke the dialog box for setting the satellite type and orbit (see Figure 4-2). See the *Glossary of Terms* section for a detailed description of the orbital parameters.

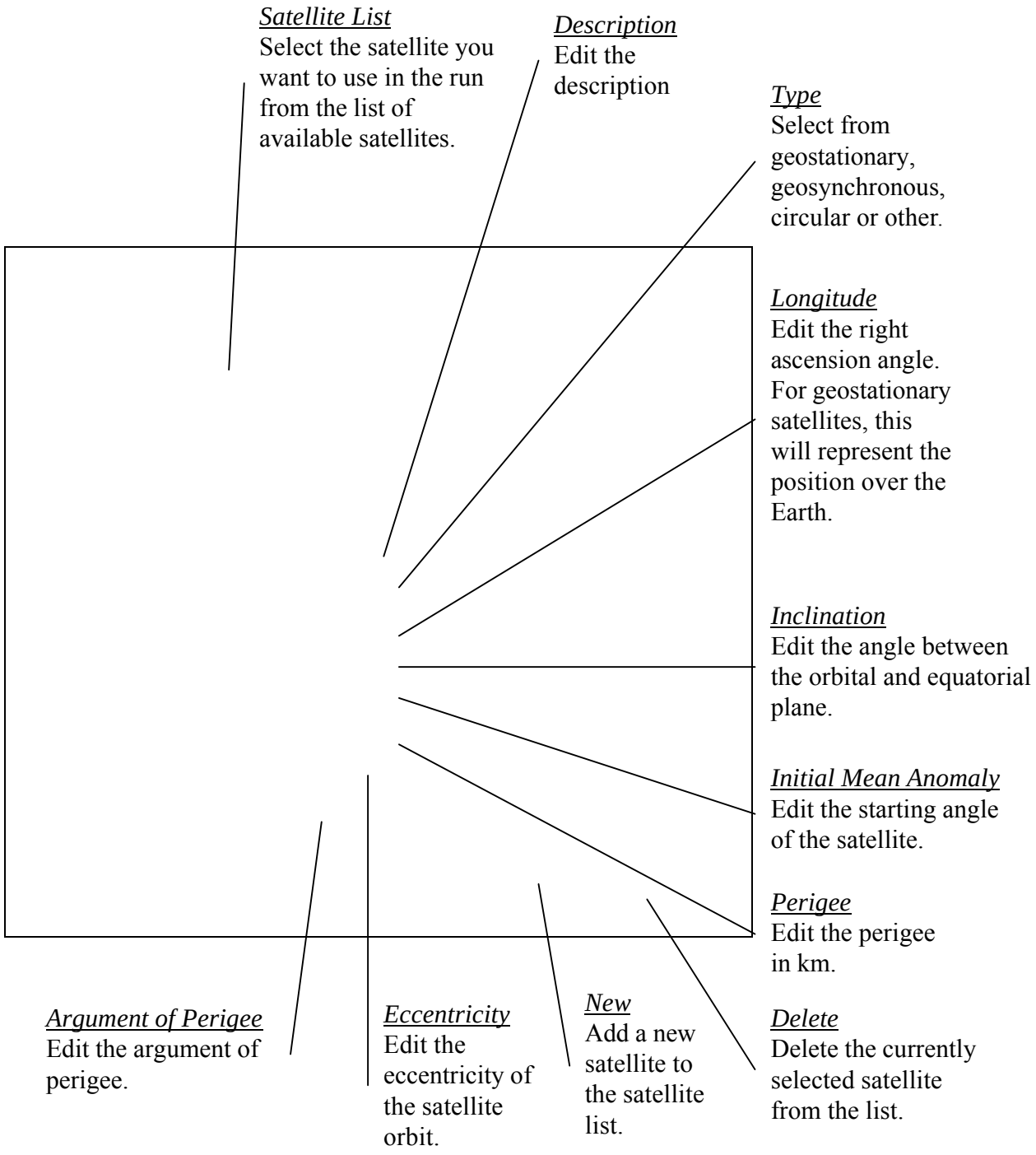
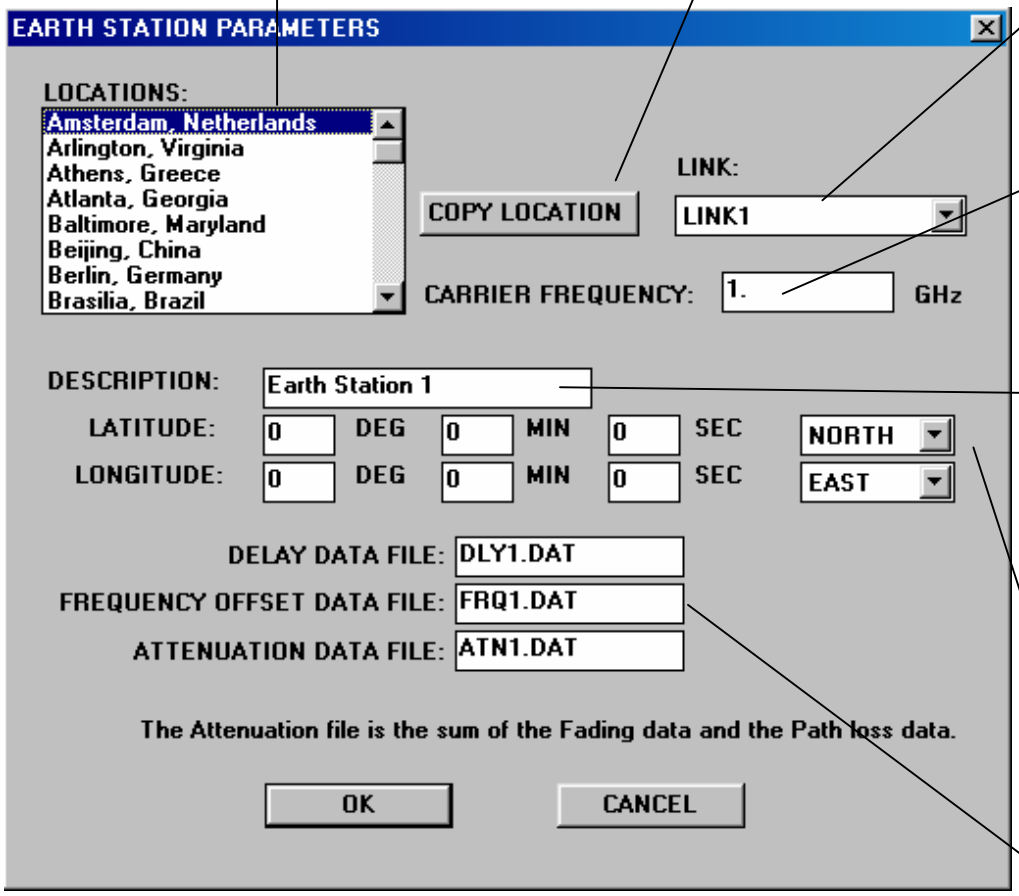


Figure 4-2. Satellite Setup Dialog Box

4.5.2. Earth Station Setup

Press the *Earth Station* button on the *System Setup* dialog box to invoke the dialog box for setting the ground stations and data file names (see Figure 4-3).



Locations
Select from the list of preset locations.

Copy Location
Press to copy settings for selected location.

Link List
Select the number of the link to view and edit.

Center Frequency
Used to calculate Doppler.

Description
Edit the description of the Earth Station transponder.

Latitude and Longitude
Select the latitude and longitude for the Earth Station.

Data File Names
Edit the file names for the link data.

Figure 4-3. Earth Station Setup Dialog Box

4.5.3. Path Loss Model Setup

Press the *Path Loss Model* button on the *System Setup* dialog box to invoke the dialog box for setting the atmospheric heights and losses (see Figure 4-4).

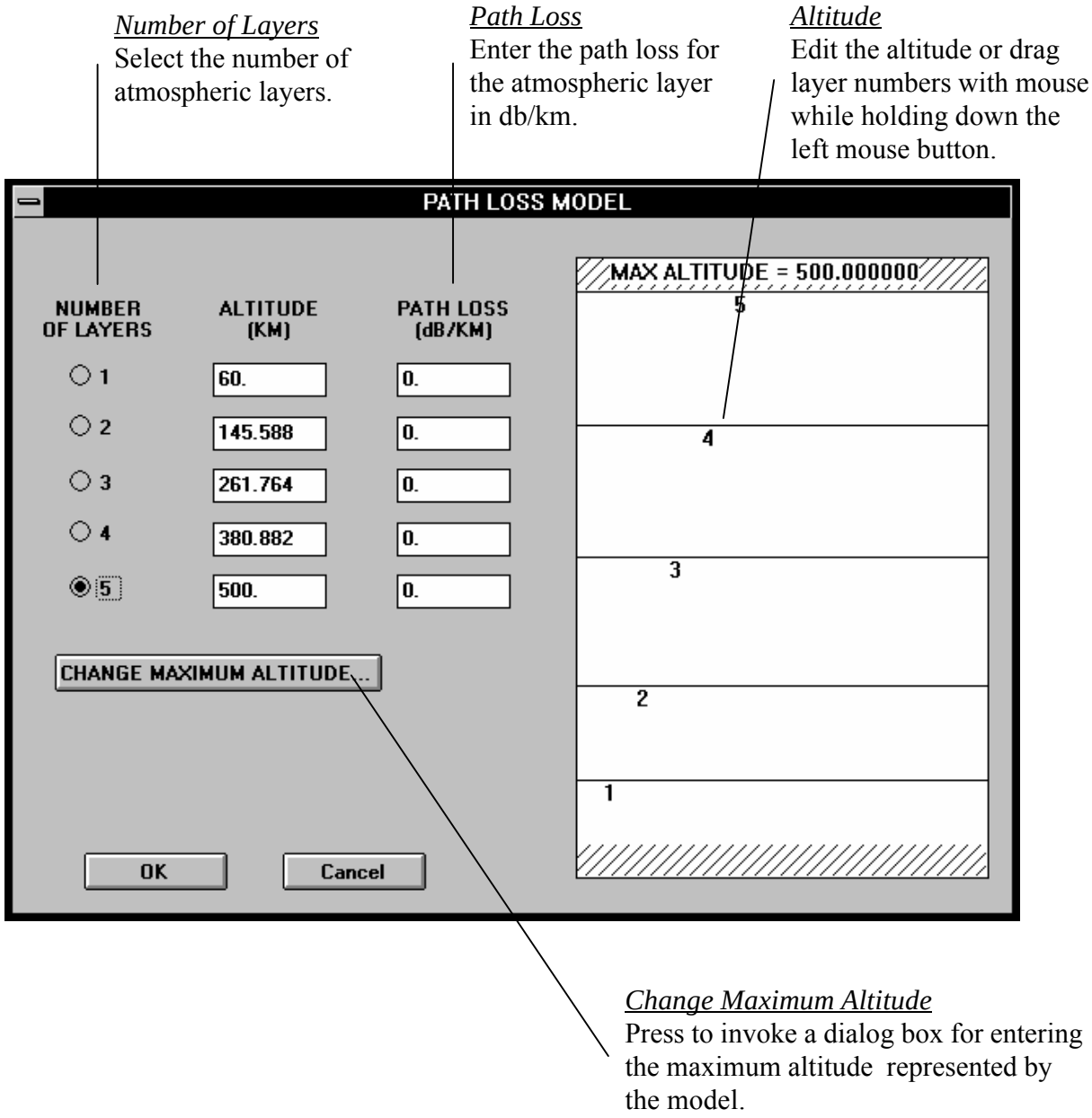


Figure 4-4. Path Loss Model Setup Dialog Box

4.6. Previewing a Simulation

4.6.1. Previewing a File

Once all parameters have been set to their desired values, you can preview a simulation by pressing the *Preview* button, which appears on the *Run Bar* (see Figure 4-5). The *Status* display will change from READY to RUNNING and the timers will increment as the simulation runs. Previewing the simulation shows the orbit path and satellite parameters. Previewing the file does not generate data for the *Table* view or *Graph* view, and data will not be saved for use with SLE700.

View Type
Select Satellite to preview. Select Graph or Table to view the data.

Reset, Preview, Pause
Control the preview through these buttons.

Preview Displays
The preview status, elapsed time and mean anomaly are displayed.

Setup
Press to invoke the System Setup dialog box.

Generate Data
Press to calculate the Doppler, delay, path loss and fading for each sample.

Figure 4-5. Run Bar

4.6.2. Pausing a File

You can pause a file during a preview run by pressing the *Pause* button, which appears on the *Run Bar*. The Status display will change from RUNNING to

PAUSED and the timers will stop incrementing. Click the *Preview* button to resume the run.

4.6.3. Resetting a File

You can reset the file to its initial conditions by pressing the *Reset* button.

4.6.4. Data Generation

After you have the desired satellite orbit settings, press the *Generate Data* button to calculate the Doppler, delay, path loss and fading for each data sample. This data will appear in the *Table* view and *Graph* view, and can be saved for use with SLE700.

4.6.5. Data Triggering

Data triggering is selectable via the Options menu. Using the default condition of All Data, data is generated on all links for the total number of sample points.

To trigger data generation based on a line of sight link, select Line of Sight Trigger from the Options menu. If checked, the program begins to generate data when the satellite is in the line of sight of the Earth station and stops generating data when the satellite goes out of the line of sight. The sample number and initial mean anomaly of the setup are changed to match this duration.

Selecting Single Line of Sight causes all links to start and stop simultaneously based on an existing line of sight for link 1. Selecting Multiple Line of Sight causes data generation to begin when any of the links have an existing line of sight. Once data generation has started, it will continue until the total number of samples has been created.

4.7. Viewing Data

You can change the view on the *View Bar* by selecting the *View Type* on *the Run Bar*. You can view the data for different transponder links by selecting the *Link* combo box on the *View Bar*. The *Link* combo box is only available for the 4 transponder link version of this program.

4.7.1. Graph View

This view displays the data that was generated by pressing the *Generate Data* button in a graphical format (see Figure 4-6). Use the scroll bar to scroll the data in the window. To see the data values at any point in time, drag the vertical cursor across the graph to the desired location.

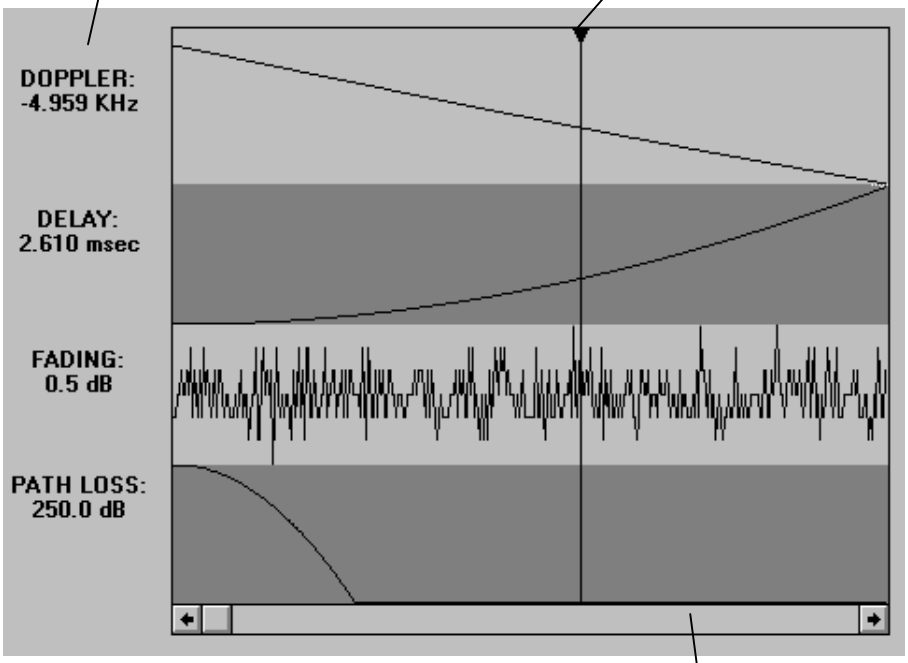


Figure 4-6. Graph View

4.7.2. Table View

This view displays the data that was generated by pressing the *Generate Data* button in a table format (see Figure 4-7). Use the scroll bar to scroll the data in the window.

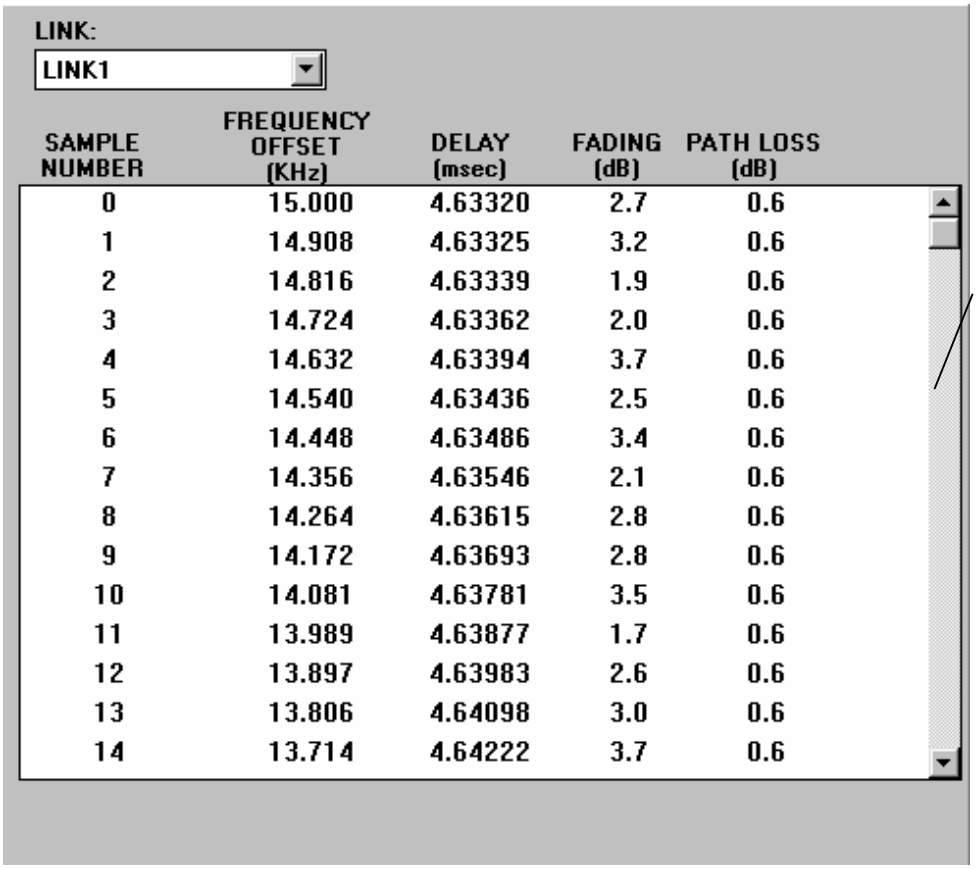
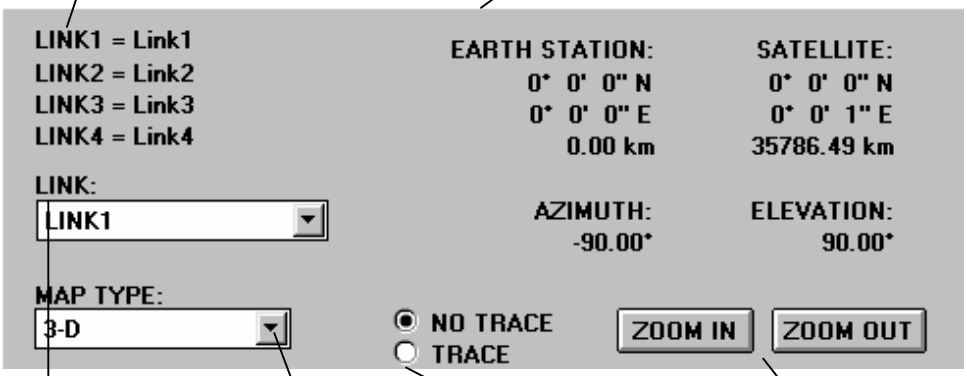


Figure 4-7. Table View

4.7.3. Satellite View

The top of this view displays the link configuration, Earth station position, and satellite position (see Figure 4-8).



Link Configuration
Displays the selections made in the Link Configuration option.

Earth Station and Satellite Positions
Display in coordinance form and look angles.

Link
Select the link data you want to display.

Map Type
Select map type for satellite perspective.

Trace
Select Trace to draw path of satellite.

Zoom
Zoom in or out of current display. Not valid for ground trace view.

Figure 4-8. Top of Satellite View Bar

The bottom of this view can display one of three perspectives:

3-D - shows the Earth and satellite in motion.

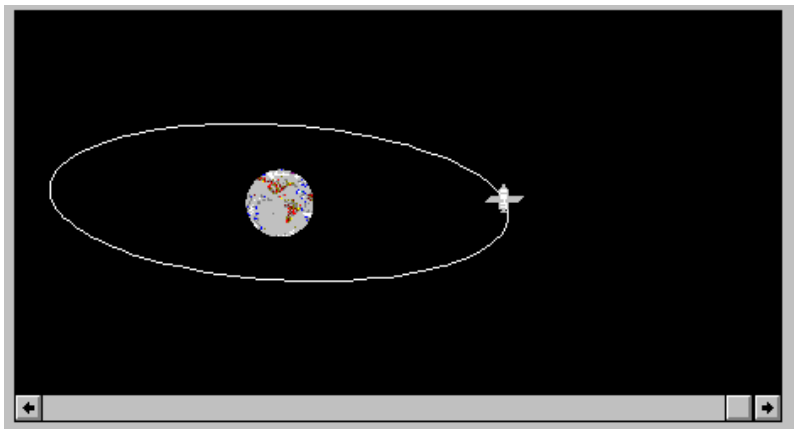


Figure 4-9. 3-D Display of Satellite Bar

Ground Trace - shows the satellite and Earth transponder position displayed on a rectangular map of the Earth according to longitude and latitude.

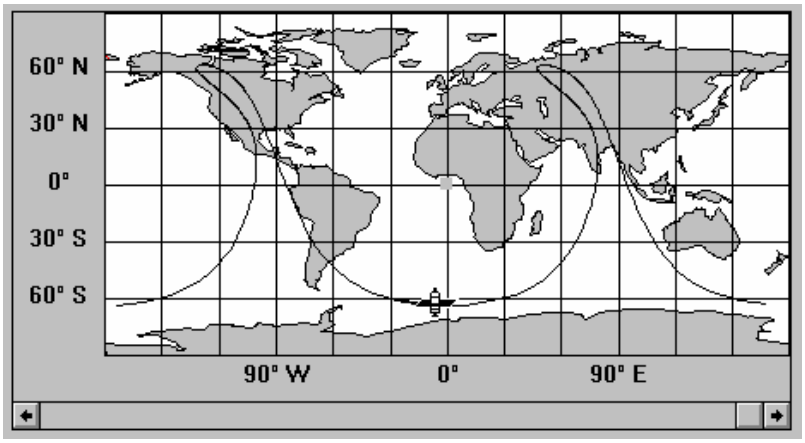


Figure 4-10. Ground Trace Display of Satellite Bar

Horizon - shows the satellite position from the Earth transponder perspective according to azimuth and elevation.

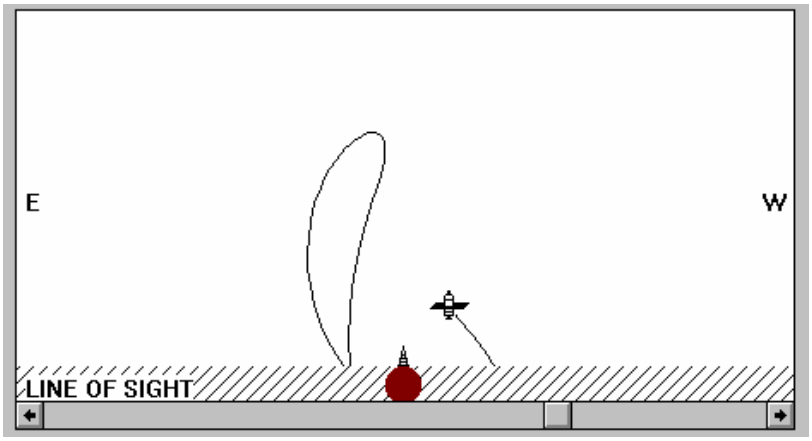


Figure 4-11. Horizon Display of Satellite Bar

Use the scroll bar on any of these displays to step through the run.

Parameter Data File Descriptions

All parameter file names are limited to 10 characters. The first 4 (or 5) characters are predetermined as defined below. Up to 5 (or 6) characters can be added to the name. For example, DLY1.dat can be modified to DLY1abcdef.dat. DLY12.dat can be modified to DLY12abcde.dat.

The data in the stored files is dependent on the selected Link configuration.
The default link configuration is for the stored files to be equal to the values calculated for that link. Example: Link1 data = Link1. The data files would be called DLY1.dat, FRQ1.dat, etc.
If two links are combined, the values from those two links are added and the data file is created from the sum.
Example #1: Link1 data = Link1+Link2. The computed values for link1 and link2 are summed and the resultant file would be called DLY12.dat, FRQ12.dat, etc.
Example # 2. Link 3 data = Link1+Link3. The computed values for link1 and link3 are summed and the resultant file would be called DLY31.dat, FRQ31.dat, etc. Note that the "3" comes first in the file name because this becomes the Link3 data.

File Format
Parameter data files must be generated in ASCII format. The first line in the file is a value that represents the number of sample points in the file. Each subsequent line will contain one data value. Lines are separated by a carriage return. An example of a delay file with 3 points is:

3
12.456789
12.456788
12.456787

The ASCII parameter files must have a file extension of ".dat" in order to be recognized by the SleControl program and SLE700 dll. The SATGEN satellite data generation program automatically generates the correct file extension. User generated files should be created with the .dat extension also. The first three letters of the file name must be one of DLY, FRQ, ATN, or PHA to represent delay, frequency offset, attenuation, or phase offset files. Up to 7 alphanumeric characters can follow the first three letters in the file name.

Delay File Data Format

- Each data point consists of ten characters including a decimal point
- Range is 0.1ms to 697ms in 1ns increments

- Valid change (Delta) between any two adjacent points must not be greater then 20us
- Units are ms

Attenuation File Data Format
The attenuation file generated by SATGEN represents the sum of the link fading plus the link path loss. Although SATGEN displays fading and pathloss separately, they are combined into the atn.dat file when saved.

- Each data point consists of five characters including a decimal point
- Range is 0 to 40 dB in 0.25dB steps
- Step size between any two adjacent points can be up to 40 dB
- Units are dB

Frequency Offset Data Format
The frequency offset file generated by SATGEN represents the sum of the link Doppler plus the fixed Frequency Offset. Note that the Frequency Offset value is applied to all links. This value defaults to zero. SATGEN displays the sum of Doppler fading and the Frequency Offset, and the sum is saved in the frq.dat file.

- Each data point consists of eight characters including a decimal point
- Range is 0 to ± 3000 kHz
- Step size between any two adjacent points can be up to ± 3000 kHz
- Units are kHz

Data File Sizes
Parameter data files can contain up to 1.8 million data points.

5. Glossary of Terms

Argument of Perigee: The angle in the orbital plane between the line of nodes and the perigee of the orbit. Shown as **w** in Figure 5-2.

Azimuth: The angle between true north and the direction of the satellite measured in the clockwise direction.

Eccentricity: The ellipticity of the orbit, calculated as

$$e = \sqrt{1 - \left(\frac{b}{a}\right)^2}$$

where a is the semi-major axis and b is the semi-minor axis of the elliptical orbit (see Figure 5-1).

Elevation: The angle from the horizon to the satellite.

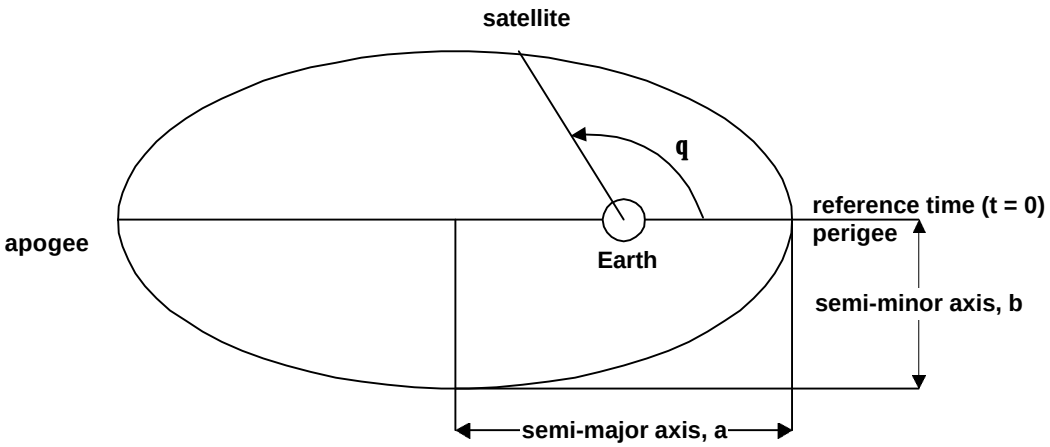
Inclination: The angle between the orbital plane and the equatorial plane. Shown as i in Figure 5-2.

Initial Mean Anomaly: The initial angle from the perigee of the satellite.

Mean Anomaly: The angle from the perigee that the satellite would traverse in at any given time. Shown as **q** in Figure 5-1.

Right Ascension: The angle between the X-axis and the ascending node. Shown as **w** in Figure 5-2.

Perigee: The point of orbit closest to the Earth.



Figure

Figure 5-1. Parameters in an Elliptical Orbit.

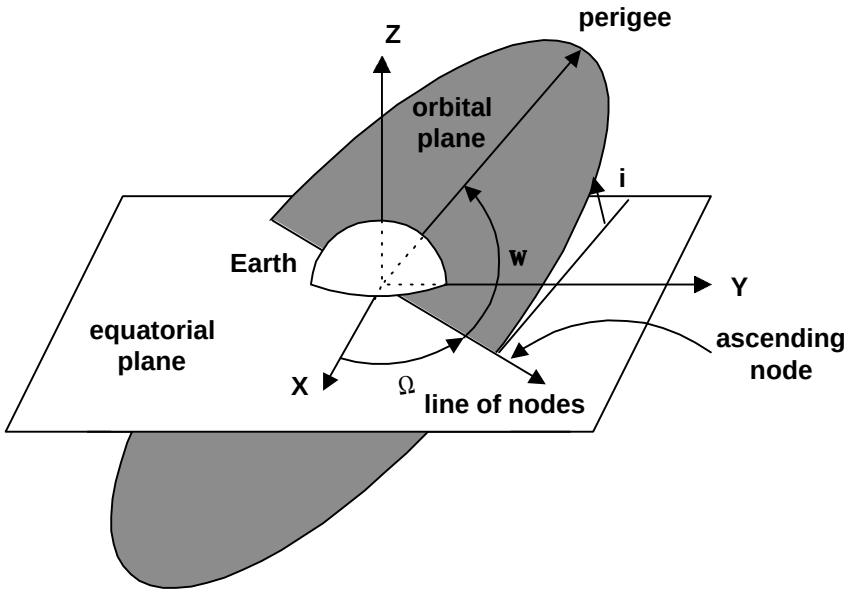


Figure 5-2. Orbital parameters