Antenna Patterns

Scope

The Tapestry system is a software suite developed by Navigation Laboratories Inc. that provides a modeling and control gateway for the LabPro SCS3500/3510 GPS Constellation Simulator.

The SCS3500/3510, when controlled with the Tapestry system, is capable of outputting 24 channels of L_1 (C/A, P, Y, M), L_2 (C/A, P, Y, M) , L_2C, L_5, and WAAS. Each channel, based upon line-of-sight, is subject to:

- Loss/gain from a User Equipment Antenna Pattern as a function of azimuth and Elevation.
- Loss/gain from a GPS SV Shaped Antenna Pattern as a function of azimuth and Elevation.
- Phase Perturbation from User Equipment Antenna Pattern as a function of azimuth and Elevation.
- $L_1L_2L_5$ Pattern Differences.

This document provides a description of the implementation.

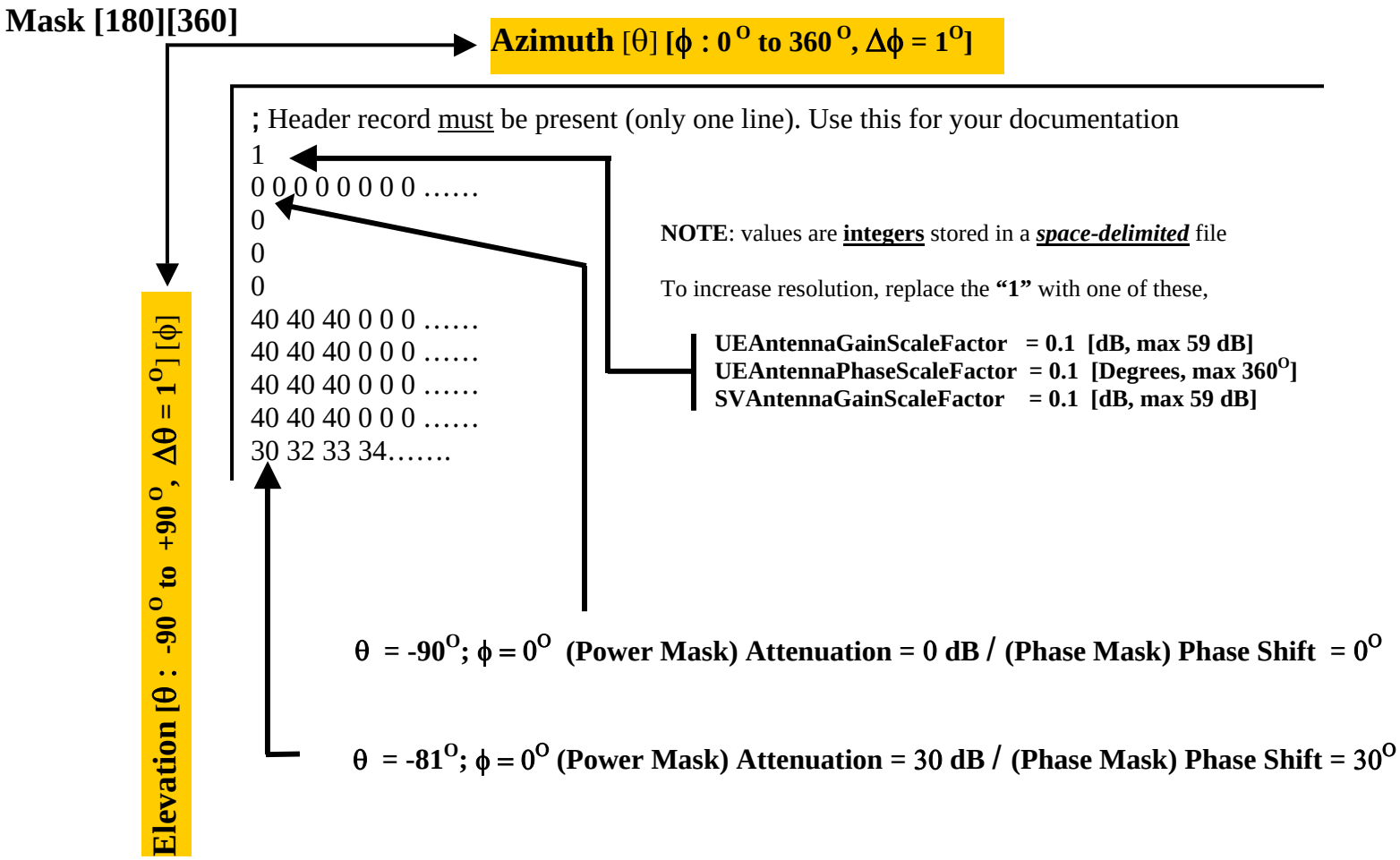
Tapestry provides Antenna Masks as follows: Two (sets of three) for the User Equipment (UE) Antenna providing power and phase effects, and thirty-two (sets of three) masks - one for each GPS-SV -modeling power effects from beam shape. *The set of three Masks refers to there being a mask for L_1, L_2, and L_5 frequencies.* All three Masks are 1^O x 1^O and cover both the TOP and BOTTOM Hemispheres such that back-lobes can be modeled. Masks (patterns) are specified in Vehicle Body (B) Coordinates (and GPS-SV Body). Build Scenario transforms the various line-of-sight vectors into the appropriate Body frame. Using the body-referenced Azimuth and Elevation bins UE Power and Phase and GPS-SV power are applied appropriately to the individual GPS measurements. Additionally measurement power effects from ray-length are also applied.

To facilitate development of the various pattern files, Tapestry provides a gateway via the GUI associated with ***Build Scenario***. There are limitations with the GUI due to resolution of the video screen such that only 5^O x 5^O binning can be provided. If you need better resolution then you should develop your various Antenna Masks offline and "import" them into the Scenario.

Importing an Antenna Mask (all types)

Gain Patterns

The Pattern files are ASCII and are organized as follows:



The Build Scenario GUI provides 60 dB of dynamic power range with 1 dB resolution and up to 360^{O} of phase shift with 1^{O} resolution. If you need better resolution (0.1 dB power minimum and 0.1^{O} Phase shift minimum) change the header record from a "1" to 0.1. For example, to input phase shift of "-24.5^{O}" enter "–245" for the value and 0.1 for the scale factor.

File Naming Convention
If you important Antenna files, you must use the following naming conventions:

UE L1 Antenna Gain Pattern[1]

ANTENNA_GL1_PATTERN1_1.SCN [RF #1 [1st Pattern]]
ANTENNA_GL1_PATTERN1_N.SCN [RF #1 [Nth Pattern]]

ANTENNA_GL1_PATTERN2_1.SCN [RF #2 [1st Pattern]]
ANTENNA_GL1_PATTERN2_N.SCN [RF #2 [Nth Pattern]

UE L1 Antenna Phase Pattern

ANTENNA_PL1_PATTERN1_1.SCN [RF #1 [1st Pattern … etc.]]
ANTENNA_PL1_PATTERN2_N.SCN [RF #2 [Nth Pattern]]

Similarly,

UE L2 Antenna Gain and Phase Pattern

ANTENNA_GL2_PATTERN1_1.SCN [RF #1 [1st Pattern … etc.]]
ANTENNA_PL2_PATTERN2_1.SCN [RF #2 [1st Pattern … etc.]]

UE L5 Antenna Gain and Phase Pattern

ANTENNA_PL5_PATTERN1_N.SCN [RF #1 [Nth Pattern]]
ANTENNA_PL5_PATTERN2_1.SCN [RF #2 [1st Pattern]]

GPS SV Antenna Gain Pattern

TRANSMITTERL1_PATTERN_1.SCN [no RF dependency]
TRANSMITTERL1_PATTERN_32.SCN [SVID 32]

Similarly,

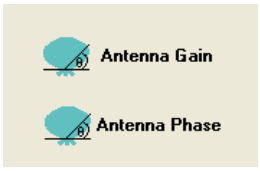
TRANSMITTERL2_PATTERN_1.SCN (… etc.)
TRANSMITTERL5_PATTERN_1.SCN (… etc.)

[1] See time sequencing antenna patterns later in this document

If any of the files are absent, then no masking will be applied for **that** particular RF or SVID. If you want to have the files in the Scenario folder but do not want to use them, the following settings are available in the TapControl.INI under **[GPSCONTROL]**

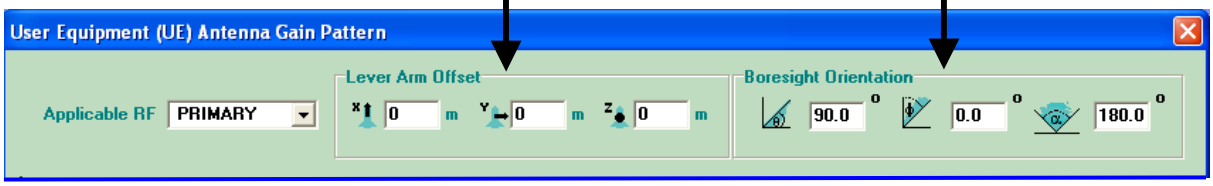
UseUEAntennaGainPatterns = 0/1
UseUEAntennaPhasePatterns = 0/1
UseSVAntennaPatterns = 0/1
UseSlantRangeAtten = 0/1

Using the (UE) Antenna Gain Pattern Data Form

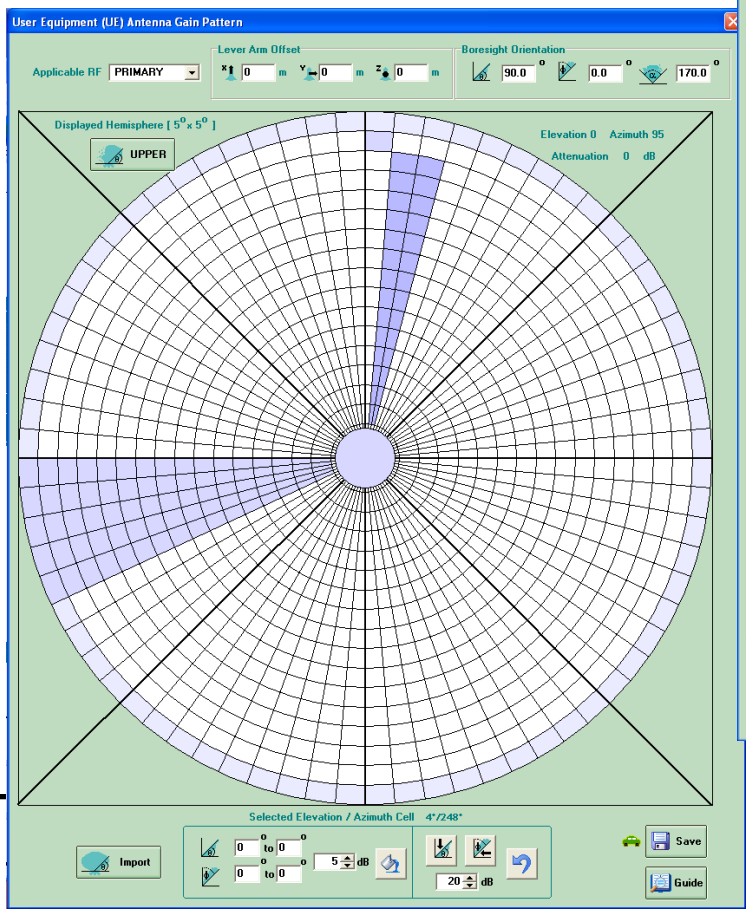


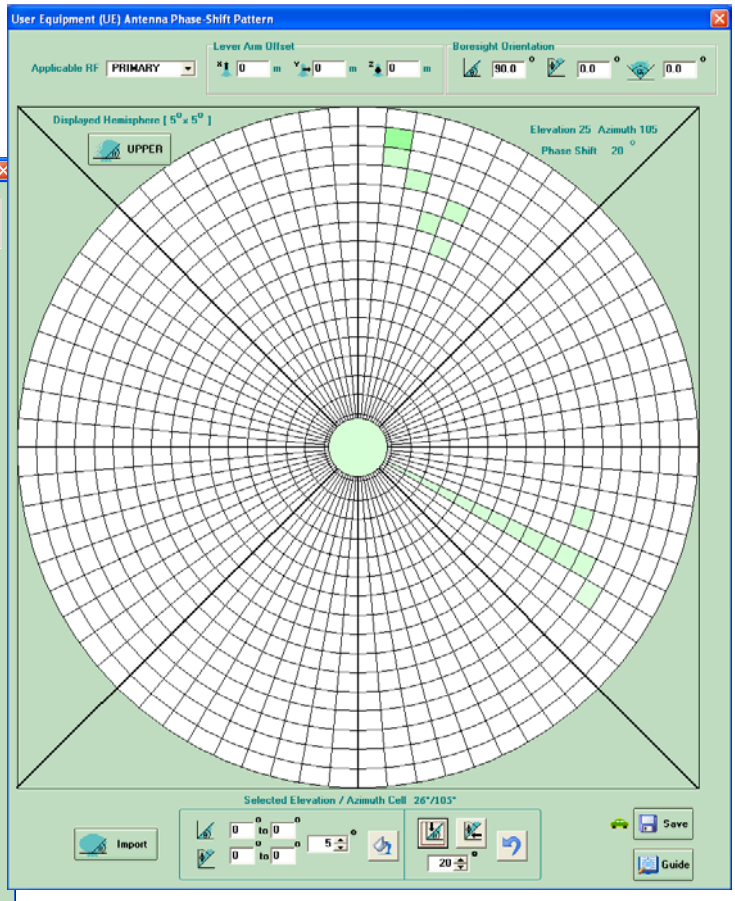
Antenna Lever Arm in Vehicle BODY

Boresight. Nominally pointing UP with 180^{O} field of view



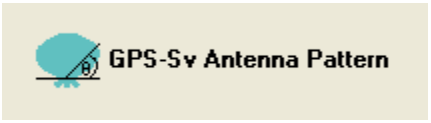
- 5^{O} x 5^{O} Top and Bottom Hemisphere
- Attenuation [0-59 dB]
- Tapestry transforms Body-to-ECEF
- Import User Data
- Can be Time Sequenced





- 5^{O} x 5^{O} Top and Bottom Hemisphere
- Phase Shift scaled to $L_1/L_2/L_5$
- Tapestry transforms Body-to-ECEF
- Import User Data
- Can be Time Sequenced

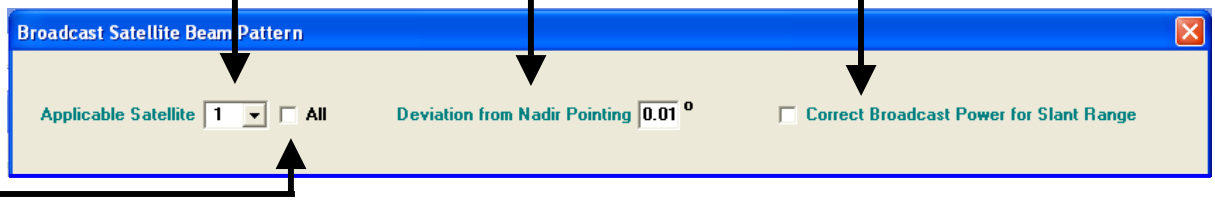
Using the (GPS-SV) Antenna Gain Pattern Data Form

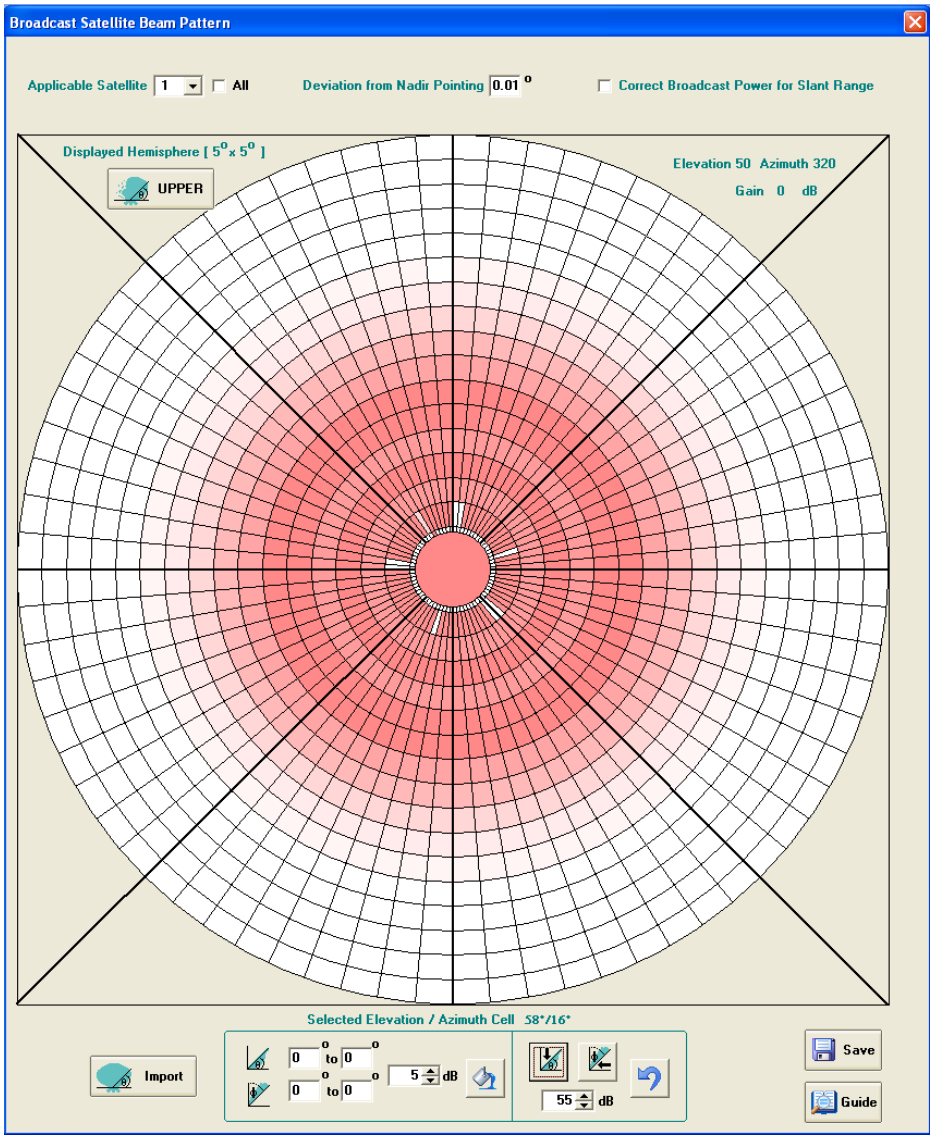


By default SV Boresight continually points to Earth Center. Enter deviation angle here

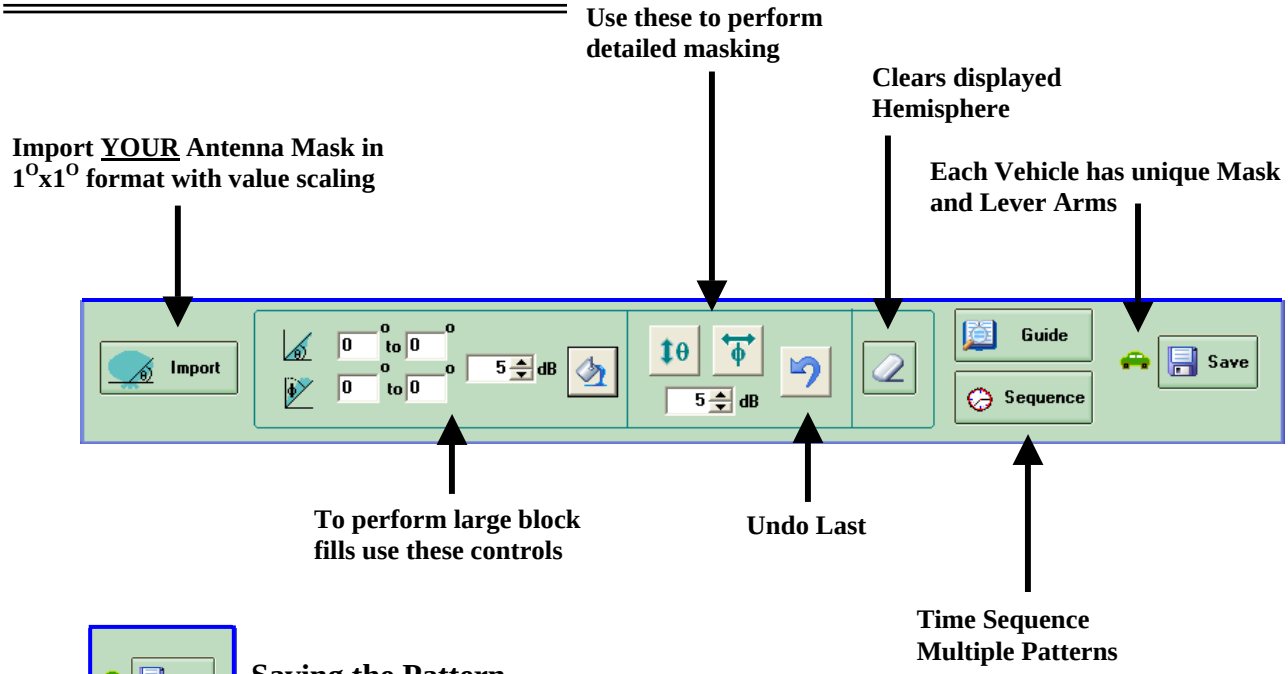
If checked, Ray-Length compensation is made to *received* signal power using R^{-2} scaling.

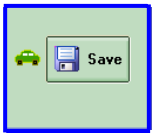
Each SV can have unique pattern or ALL can be the same if checked.





- 5^{O} x 5^{O} Top and Bottom Hemisphere
- Attenuation [0-59 dB]
- Tapestry transforms Body-to-ECEF
- Import User Data
- Cannot be time sequenced
- Applies to Both RF Outputs





Saving the Pattern

When saving the displayed Pattern, ***Build Scenario*** saves the current pattern with the same name as it was opened with or starts the naming sequence

[Vehicle 1 / RF #1]

ANTENNA_GL1_PATTERN1_1.SCN	[RF #1 – L1 [1st Pat Gain]]
ANTENNA_PL1_PATTERN1_1.SCN	[RF #1 – L1 [1st Pat Phase]]
ANTENNA_GL2_PATTERN1_1.SCN	[RF #1 – L2 [1st Pat Gain]]
ANTENNA_PL2_PATTERN1_1.SCN	[RF #1 – L2 [1st Pat Phase]]
ANTENNA_GL5_PATTERN1_1.SCN	[RF #1 – L5 [1st Pat Gain]]
ANTENNA_PL5_PATTERN1_1.SCN	[RF #1 – L5 [1st Pat Phase]]

[Vehicle 2 / RF #2]

ANTENNA_GL1_PATTERN2_1.SCN	[RF #1 – L1 [1st Pat Gain]]
ANTENNA_PL1_PATTERN2_1.SCN	[RF #1 – L1 [1st Pat Phase]]
ANTENNA_GL2_PATTERN2_1.SCN	[RF #1 – L2 [1st Pat Gain]]
ANTENNA_PL2_PATTERN2_1.SCN	[RF #1 – L2 [1st Pat Phase]]
ANTENNA_GL5_PATTERN2_1.SCN	[RF #1 – L5 [1st Pat Gain]]
ANTENNA_PL5_PATTERN2_1.SCN	[RF #1 – L5 [1st Pat Phase]]

If one of these files exists, ***Build Scenario*** will prompt for Overwrite.

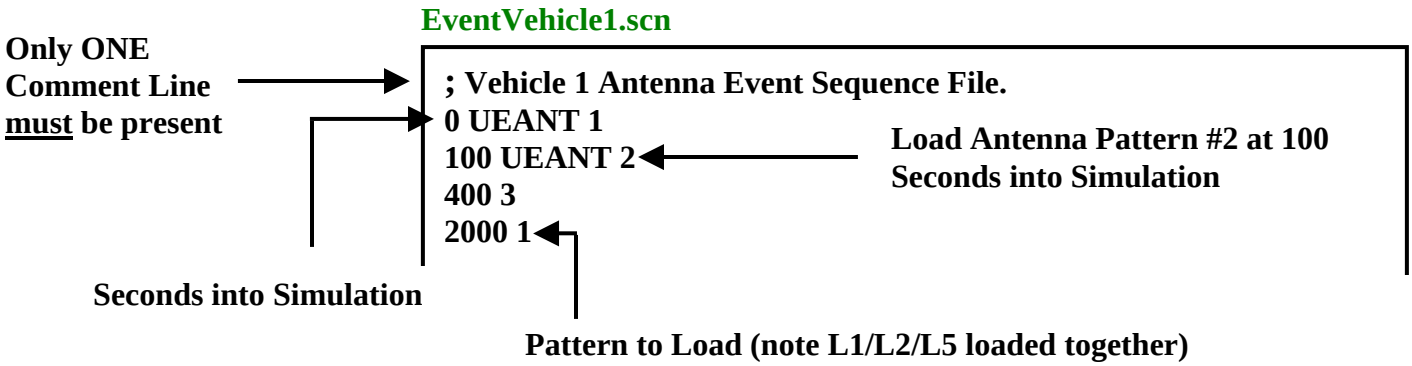
Time Sequencing UE Antenna Patterns

You can develop and use Multiple Antenna Patterns for the User Equipment by either using the GUI supplied by ***Build Scenario*** or creating your files with the correct naming convention (Do this before the Scenario is opened by ***Build Scenario***).

Pressing the **Sequence** button opens the Event File for the Current Vehicle:

EventVehicle1.scn or **EventVehicle2.scn**

To sequence your Antenna Patterns, enter the following formatted line into the Event file at the appropriate time.



For the above example, for Vehicle #1 (RF #1) [Because the open file is **EventVehicle1.scn**] Pattern #1 is loaded at simulation start time (the default) and then 100 seconds into the simulation #2 is loaded and so-on-and-so-forth.