

Operating Manual

SATELLITE LINK EMULATOR SLE900

For use with SLE900
Firmware versions 6.907 and later



RF Test Equipment for Wireless Communications

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Preface

This manual contains operation instructions and reference information for the **dBm** SLE900. The SLE900 reproduces link effects found in communications between earth stations and satellites.

This manual is prepared as a reference source for engineers and technicians to use the SLE900 as part of their earth station/satellite transceiver design and testing.

The SLE900 operations manual is divided into the following sections:

- **Section 1: Introduction** shows the SLE900 equipment, control and connector locations, and describes connector functions.
- **Section 2: Local Operation** describes how to operate the SLE900 from the front panel.
- **Section 3: Remote Operation** shows how to operate the SLE900 through the LAN interface.
- **Appendix A: Installation and Troubleshooting** describes installation procedures and lists error messages.
- **Appendix B: Description and Specifications** gives an overview of the SLE900 technical design and provides technical specifications, and verification testing .
- **Appendix C: Maintenance and Warranty** describes the SLE900 warranty and directs how to return the SLE900 for repair or calibration.

Conventions Used in This Manual

Text Conventions

This manual uses the following text conventions:

- *Italic text* indicates new terms, directories and/or filenames.
- Underlined Text indicates SLE900 selections or key presses.
- Monospaced text indicates SLE900 commands entered through remote mode.
- **Bold monospaced text** indicates SLE900 responses through remote mode.

Symbols

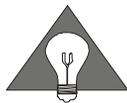
The following symbols appear in the manual.

See also, 

This symbol and its “see also” text is placed next to subject matter in the manual to tell you where to find more information.



*This icon indicates a **warning**. Failure to follow the instructions given here may result in **personal injury** or **damage to the equipment**.*



*This icon indicates a **tip**. Text marked this way may be an optional procedure for accomplishing a task, or a time-saving procedure for advanced or familiar users.*

Contacting dBm

We encourage you to contact us if you want more information or have any questions or concerns about this or any other dBm product or manual. Use any of the following methods:

Mail	dBm 32A Spruce Street Oakland, NJ 07436
Telephone	(201) 677-0008
Fax	(201) 677-9444
E-mail—Technical Support	<i>Info@dbmcorp.com</i>
www	<i>http://www.dbmcorp.com</i>



Introduction Section

Introduction

This section introduces you to the Satellite Link Emulator instrument and describes the physical interface and turn-on procedure.

Topics include:

- Front, rear, and interior views.
- Power and cable connections.
- Startup and shutdown procedures.

General Information

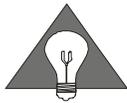
Front panel view

SLE900 reproduces link effects found in communications between earth stations and satellites. A touch sensitive graphics panel is utilized to minimize the number of hard keys that would be required to control the multitude of functions contained in the instrument.



Figure 1-1. Instrument Front Panel View

Front view shows a single channel model. Multiple channel models have two additional Type N (f) connectors for each channel.



For custom SLE900 units, consult additional documentation provided with the instrument.

Rear Panel Connections

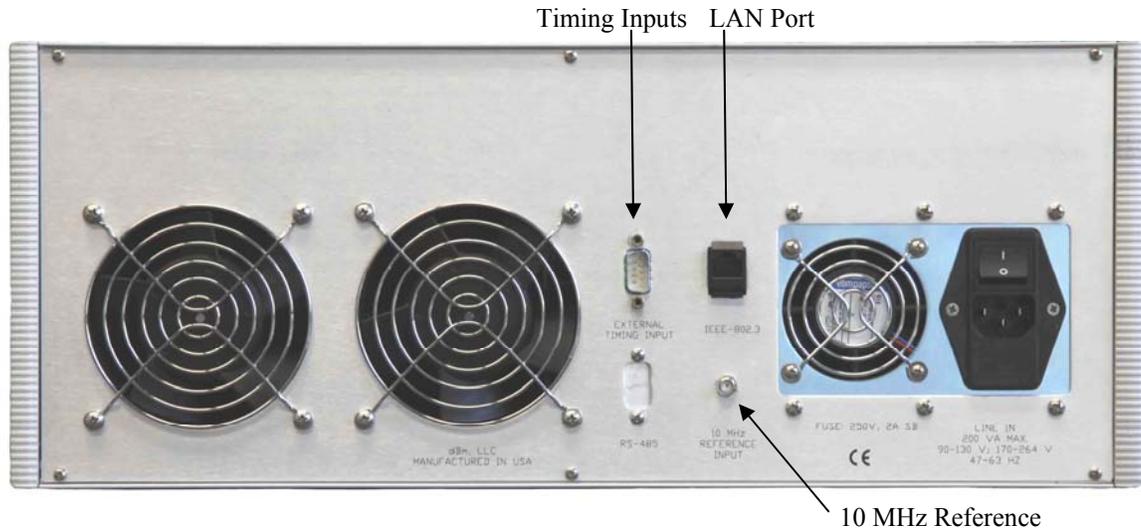


Figure 1-2. Instrument Rear Panel View

Pin #	Timing Control Connector
1	Output, +5V DC
2	Output, RS232 Tx
3	Output, RS232 Rx
4	Input, External trigger, TTL
5	GND (for RS232)
6	GND (for timing signals)
7	Input, External Update Clock, TTL
8	Not used
7	Not used

Figure 1-3 Rear Panel Timing Control Connector

10MHz Ref input: SMA (f) connector, 50 ohms, sine, 0 dBm +/- 3dB
(SLE900 will automatically switch to its internal reference if no external reference is present)



Due to multiple signals present in the Control connector, use of a standard RS-232 cable may damage the equipment.

Instrument Modules

The SLE900 is constructed using modular self-contained sub-assembly trays. Each sub-assembly tray is easily changed in the field.

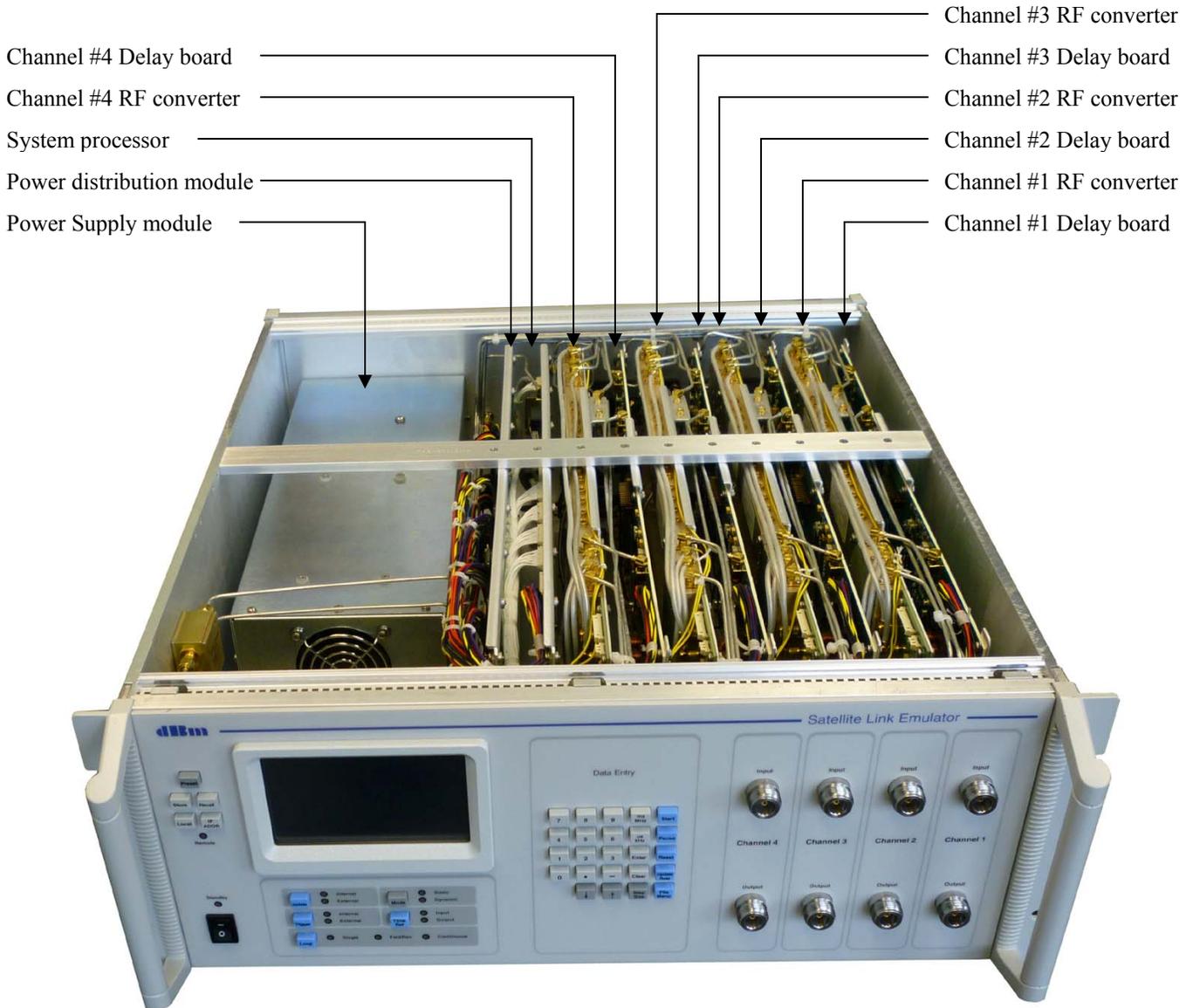


Figure 1-4. Interior view of a 4 channel SLE900

Start and Shutdown Procedures

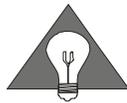
Starting the SLE900

Press the Line on/off switch on the rear panel. The standby indicator should light. If not lighted make sure the power cable is connected properly. Press the power on switch on the front panel. The standby LED turns off and the instrument powers on.

The instrument is usable immediately. However, allow approximately 30 minutes warmup, then press *Preset* for best performance.

Shutting Down the SLE900

Press the standby/on switch to standby. The standby LED illuminates.



If the SLE900 is going to be off for an extended period of time, you may wish to remove the main power by pressing the Line on/off switch on the rear of the instrument.

2

Local Operation Section

Local Operation Overview

The SLE900 is a laboratory instrument designed to apply impairments to an RF signal, simulating the effects that are encountered in a space based wireless channel. The impairments include a) delay, b) frequency offset (carrier Doppler shift), c) attenuation, and optionally d) white noise e) multipath fading, and f) tunable L-Band frequency control. The instrument is controllable from the front panel or remotely via LAN.

Each of the installed parameters can be set to a fixed value. An additional feature is the capability to dynamically each of the parameters. The values of the parameters are controlled by data files that can be generated by the user or via SATGEN, an application that creates the files based on ephemeris satellite data. Delay, carrier Doppler, attenuation, and additive white Gaussian noise can be executed at time intervals ranging from 1 msec to 1000 msec. RF frequency and multipath fading parameters are executed at 1 second intervals. The number of points per file is unlimited, but the total size of all stored files is limited by the SLE memory size. The RF output signal remains phase continuous during all dynamic updates. The time varying delay causes chip rate variations.

During power-up, the PRESET state of the instrument is STATIC mode. The input signal passes through the instrument, and the link effects, as displayed on the front panel, are applied to the signal.

In dynamic mode, the SLE sequentially implements the data values in each parameter file at regular time intervals. The user selects either an internal parameter update rate or applies an external update clock to set the time intervals. Each rising edge of the update clock causes the next point in the data file to be implemented. An external start signal can also be used to accurately trigger the execution of a data file.

The delay and Doppler shift accuracy is directly related to the accuracy of the 10 MHz reference clock. The SLE900 has an internal reference and also accepts an external 10 MHz. To ensure excellent accuracy and synchronicity with other equipment, a common external 10 MHz reference is typically used for the test system.

Operating States

Power up and Reset

Upon power-up or reset, the instrument is set to the default static state. The display will momentarily (3-5 sec) indicate the version of the installed firmware and the model number.

Static

Static (non-varying) values of delay, frequency offset, attenuation are applied to the RF input signal. Additional optional functions include additive noise (AWGN), tunable L-band frequency control, and multipath fading. The signal propagates through the instrument and appears at the output with the impairments applied. The user can modify any of the impairments by entering a new value, or by using the ↑ key or ↓ key to step. The step size is set using the Step Size menu.

Dynamic

Data files can be downloaded into the instrument through the LAN interface and stored on internal flash memory. These files control the values for each of the impairment parameters. Each parameter type in each channel can be loaded with the internally stored parameter data files. Upon receipt of a Start command, the instrument sequentially executes the values in the parameter data files. There are seven file types per channel, and therefore up to twenty-eight files (for a four channel instrument) can be implemented simultaneously and synchronously with the same update clock. At each rising edge of the update clock, the next data point in each file is executed.

When the Start command is issued, the instrument begins executing the data files. A universal start command is simultaneously issued to all channel hardware to insure a synchronous start. If no parameter file is selected for a particular impairment, that parameter will remain at its static value. When the Reset command is received via the LAN or front panel, data implementation is immediately stopped and the instrument returns to the initial data point. When a Pause command is received via the LAN or front panel, data implementation is immediately stopped, parameters are frozen at that point, and the current parameter values are displayed on the front panel of the SLE. When in pause mode the increment \uparrow key or decrement \downarrow key can be used to single step through the parameter files. Pressing the Start key from the PAUSED or READY state begins execution from the current point in the file. The Mode key on the front panel toggles the SLE between Static and Dynamic mode.

Viewing the Instrument's Hardware Configuration

The hardware configuration and parameter ranges installed in the instrument can be viewed by pressing the About softkey from any of the main menus.

RF Input Frequency	Link Parameters	Multipath Fading	AWGN	RF Output Frequency
Minimum: MHz	Delay: ms			Minimum: MHz
Maximum: MHz	Phase shift: +/-179 deg			Maximum: MHz
IF: MHz	Frequency shift: +/-3 MHz			IF: MHz
	Attenuation: 40 dB			

Figure 2-1. The About menu

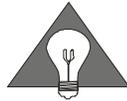
Front Panel Display Navigation

Figure 2-2 illustrates the navigational paths between menus on the front panel. The Mode hard key is used to switch between Static mode and Dynamic mode. When transitioning from Static to Dynamic, two File Menus are automatically invoked. The first file menu allows the user to enter file names for 1) Delay 2) Frequency Offset 3) Attenuation and 4) AWGN. The second file menu allows the user to enter file names for 1) RF frequency and 2) Multipath fading.

Navigation in Static Mode

Soft touch keys are used to switch between four main menus, which are:

- Delay
- RF frequency (key is labeled *RF*)
- AWGN
- Multipath Fading (key is labeled *Fade*)



AWGN and Multipath Fading are optional features. The navigatio keys will be visible even when the feature is not installed.

While viewing the Delay menu, a step size sub-menu can be called using the Step Size hard key.

While viewing the multipath FADE menu, the More Settings softkey invokes a submenu containing K-factor, correlation, and angle of arrival parameters.

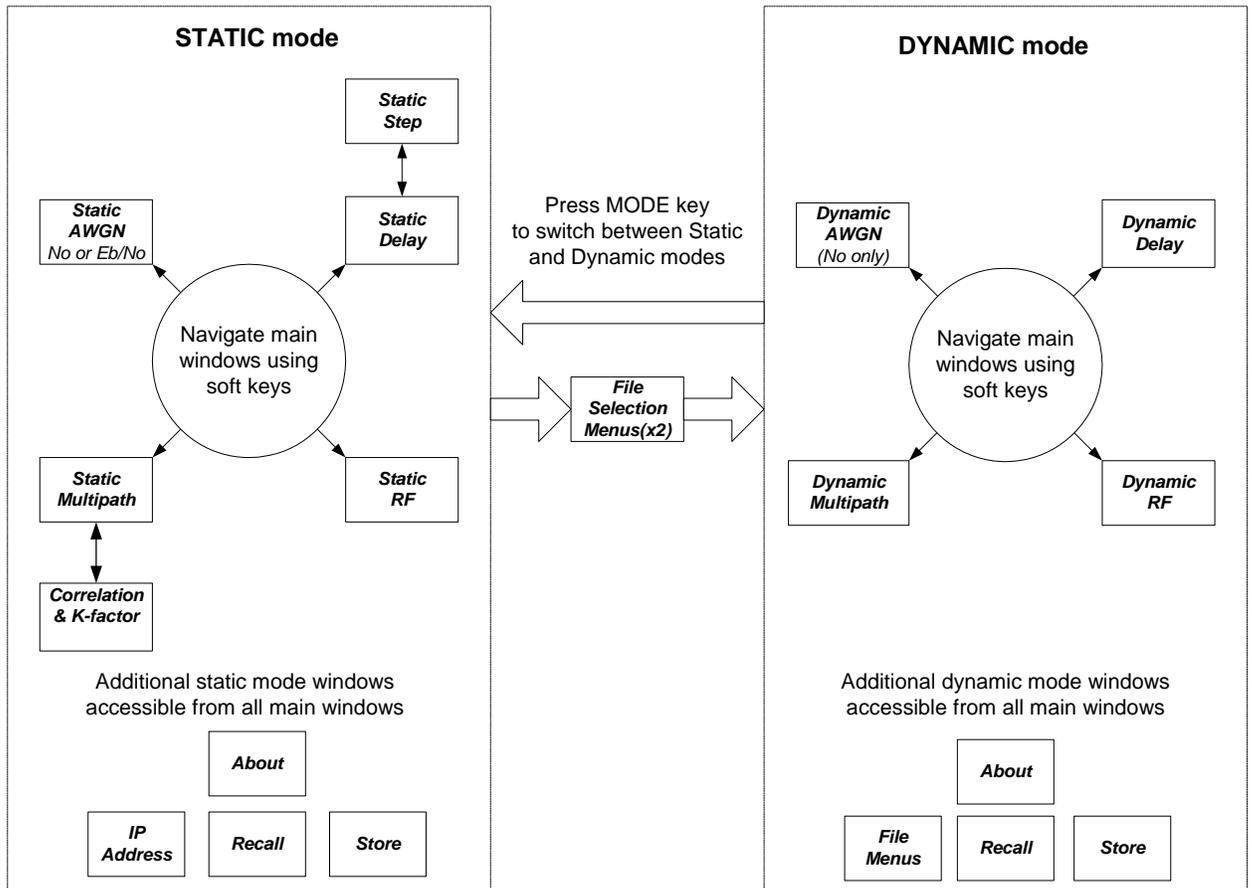


Figure 2-2, Front Panel Display Navigation

The *About* menu can be invoked via a soft key from any of the four main menus.

The *IP Address*, *Recall*, and *Store* menus can be invoked via their respective front panel hard keys.

Navigation in Dynamic Mode

Soft touch keys are used to switch between three main menus, which are:

- Delay
- RF frequency
- Multipath Fading

The *About* menu can be invoked via a soft key from any of the three main menus.

The *File Menu* can be invoked via the File Menu hard key.

The *IP Address*, *Recall*, and *Store* menus can be invoked via their respective front panel hard keys.

Editing Parameter Values

Parameters are selected for editing by pressing the parameter field on the touch sensitive display. When touching a parameter, the instrument responds with an audible beep, and the background of the selected field is highlighted. The user then enters the new numeric value via the keypad, ending the entry with a units key (ms/MHz, us/kHz, or Enter for ns/Hz/dB). After a units key has been pressed, the new value is stored and editing is complete. Anytime a parameter field is highlighted, that field can be edited. If another parameter key is pressed prior to pressing a units key, the highlight immediately moves to the appropriate field and the original parameter is not overwritten.

Units Keys

When the data field to be edited is selected and a numeric value typed, the data must be entered by pressing one of 3 possible units keys. The key assigns the order of magnitude to the data entered as follows:

<i>Key</i>	<i>units</i>
<u>Enter</u>	ns, Hz degrees, dB, dBm, dBm/Hz, ratio
<u>us kHz</u>	us, kHz
<u>ms MHz</u>	ms, MHz

Use of the Clear Key

The Clear key is used to delete a new numeric value prior to pressing an enter key.

Example

- Press delay value to select that delay field. Type a value for delay.
- Press ms/us/Enter. The new value is entered.
- Press Delay and enter a value for delay. The characters appear as the new value is typed.
- Press Clear. The previous delay value appears.

Change the sign of a value

Press “-“ while editing a parameter to change the sign of the entered value. Frequency offset can be a negative value, and noise density is always a negative value.

Utility Functions

Pressing Store or Recall, activates the memory utility display. A storage register contains all Instrument State settings, static parameter values, Update Rate, RF Center frequency, step sizes, and loaded Dynamic file names. It does not retain the current channel selection, Mode, elapsed time, or Start/Reset/Pause status.

To store the instrument settings

1. Press Store. The store utility display appears. Press the number of the desired register to be updated. Store can be invoked from Static or Dynamic modes.
2. Press a number from 0-8, designating a register to store the current instrument settings. Register 0 (labeled Preset State) defines the power up and PRESET state. The register is overwritten and the display reverts to the Static Delay view.
3. Press Return to exit the store utility menu without overwriting any registers. Note: Register 9 is not available to store settings as this always contains the factory defaults.

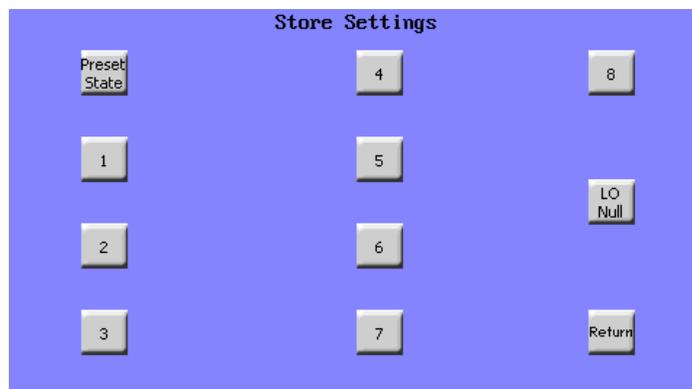


Figure 2-2. Store Menu

Performing Carrier Leakage Calibration

The SLE900 is shipped from the factory with the carrier frequency leakage minimized, and does not normally require any additional action. Over time and temperature this leakage can degrade, and there will be some variation in the level each time the instrument's power is cycled. For cases where lower leakage is required, an optional *LO nulling* calibration is available. The *LO Nulling* calibration can reduce the leakage substantially over the standard nulling which uses correction factors stored at the factory. However, *LO Nulling* has the disadvantage that the user will need to perform the calibration periodically with no input signal applied.

When *LO Nulling* is activated, it is performed automatically when the SLE900 is powered on or Preset. However, the instrument is not likely to be at its operating temperature at turn-on, and so the leakage will degrade as the instrument's internal temperature changes. When the leakage becomes unacceptably large, the user can initiate the calibration using the LO Null button found in the Store Menu. To perform the calibration, first remove all channel input signals. Press the LO Null button and allow 5 seconds to complete the calibration. Normal operation can be resumed after the calibration is completed. If your requirements indicate a need for the improved carrier leakage provided by *LO Nulling*, contact the factory for instructions to activate the feature.

To recall a saved instrument setting

1. Press Recall. The utility display appears. Press the number of the desired register to be loaded. Recall can be invoked from Static or Dynamic modes.
2. Press a number from 0-9, designating a register to recall instrument settings. Register 9 cannot be modified and contains factory defaults.
3. Press Return to exit the recall utility menu without changing the instrument settings. If the recalled register invokes Dynamic file names that are no longer on the SLE internal memory, then a "file missing" error is displayed and those parameters are set to the default value.

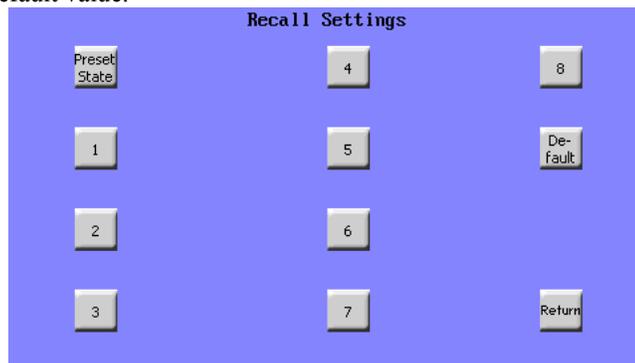


Figure 2-3. Recall Menu

To configure the instrument's LAN port

1. Press IP ADDR hard key. The network utility display appears.
2. Press the IP address data field. Enter the desired IP address and then press Enter, or press Clear to revert to the previous value.
3. Press the Submask address data field. Enter the desired submask value, then press Enter, or press Clear to revert to the previous value.
4. The MAC address is unique for every instrument, and cannot be modified.
5. After editing, press Return to store the new values and return to the main menu.

To set the instrument to local or remote (LAN) control

During remote LAN operation, all keys except Local are disabled. Pressing Local brings the instrument back to the local mode and activates the front panel keys. The Local key toggles the instrument between local and remote.

To enter remote mode from the front panel press Local. The instrument will then switch to remote mode. If a LAN connection is present when the instrument is powered on or the Preset key is pressed, the SLE will automatically go to remote mode.

The instrument must be in remote operation mode before it will accept commands from the LAN connection.

To preset the instrument settings

Pressing Preset causes the instrument to return to the default state which is defined by the contents of the Preset register.

Static Delay Operation

When the Mode key is set to “Static”, each of the link parameters is displayed and implemented immediately upon entering Static mode. The display will indicate that the mode is “Static”. The parameter values in each channel are independent of other channels.

A unique step size can be set for each of the 4 parameters, as well as independently for each channel. The \uparrow and \downarrow keys can change the parameter by its step size value.

When delay is changed, the delay line slews to the new value at a rate of 20us/msec. All other parameters change immediately to the new value.

To edit a parameter, touch the parameter field area in the display. The instrument responds with an audible beep, and the background of the selected field is highlighted. The user then enters the new numeric value via the keypad, ending the entry with a units key (ms/MHz, us/kHz, or Enter for ns/Hz/dB). After a units key has been pressed, the new value is implemented and editing is complete. Anytime a parameter field is highlighted, that field can be edited. If another parameter key is pressed prior to pressing a units key, the highlight immediately moves to the appropriate field and the original parameter is not overwritten.

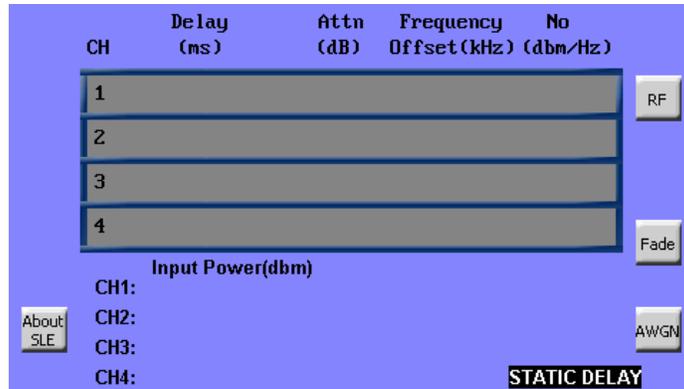


Figure 2-4 Static Delay View

Figure 2-4 shows the front panel display in static mode. Each of 12 parameter fields can be edited by touching near the center of the value. Noise Density cannot be edited from this menu.

Setting Delay Window Parameters

Set Delay

Press a delay field for the desired channel (valid during Static mode only)

Press numeric value of delay

Press ms or us or Enter (units of ns) to enter current value.

Set Frequency Offset

Press the frequency offset field for the desired channel (valid during Static mode only)

Press numeric value (valid range: 0 to +/- 3000 kHz, 0.01 Hz steps)

Press MHz, kHz, or Enter (units of Hz) to enter.

Set Attenuation

Press the attenuation field for the desired channel (valid during Static mode only)

Press numeric value (valid range: 0.0 to 70.0, 0.10 dB steps)

Press Enter (units of dB) to enter.

Set Phase Offset

Press the phase field for the desired channel (valid during Static mode only. Phase control is in the RF frequency menu)

Press numeric value (valid range: 0 to 180 degrees, 1 degree steps)

Press Enter to enter.

Noise Density

Noise density is displayed, but cannot be edited from this menu. Use the AWGN menu to edit the noise parameters.

Input Power

The input signal power is measured and displayed. The range of the measurement is 0 dBm to approximately -50 dBm. The displayed power is a true rms value, that is averaged over a period of approximately 1 second. Avoid the following conditions that will cause an inaccurate measurement:

1. An input signal power greater than 0 dBm
2. A pulse modulated signal. The meter does not correct for duty cycle.
3. A CW signal at exactly the SLE900's IF center frequency. An offset of at least 1 Hz is required.

Set Step Size (Delay, Freq Offset, Attn)

Press the Step Size hard key once to invoke the step menu.

Press the desired parameter field to highlight the parameter. Use the keypad to enter a numeric value (valid ranges and resolutions are same as corresponding parameter).

Press the appropriate units key to enter.

Press the Return soft key to return to the main display.

A unique step size is saved for each parameter type, and each parameter step size can be unique for each channel.

Note that if the entered step size exceeds the realizable limit, the out of range condition will be indicated by displaying the parameter in red.

The following step sizes may be defined

Delay	0.1ns to 20,000ns
Freq Offset	0.01Hz to 3,000MHz
Attenuation	0.25dB to 40dB

↑ and ↓ (up arrow and down arrow)

In Static mode, press the desired link parameter field. Then press ↑ or ↓ and the value changes by the selected Step size amount.

Note: During operation, if ↑ or ↓ forces a parameter out of range, the value will revert to the last valid value and the value will be displayed in red to indicate an out of range condition has occurred.

↑ and ↓ are also used in Dynamic when the mode is READY or PAUSED. These controls then single step through the dynamic files.

In the Dynamic File Menu, ↑ and ↓ are used to scroll through the list of parameter files that are stored in the instrument.

Static RF Operation

Pressing the RF softkey invokes the RF View, which allows modification of the input and output RF center frequencies. For IF instruments, these settings will be fixed at either 70 MHz or 140 MHz. If the instrument is configured to operate at L-band, these settings will control the input and output center frequency of the L-band frequency converters.

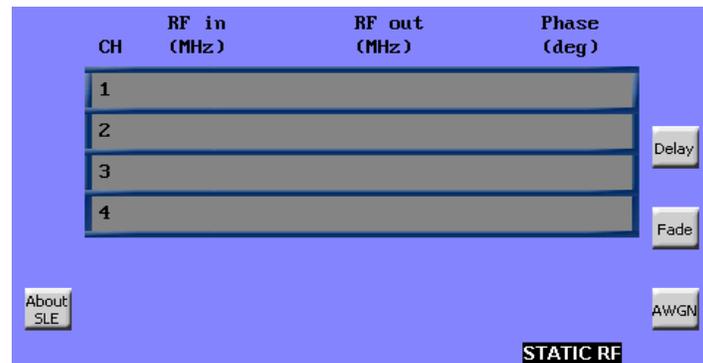


Figure 2-5. RF Frequency View

Setting RF Menu Parameters

Set the L-Band Input Frequency

Press the *RF in* frequency field for the desired channel
 Enter a numeric frequency value (in MHz).
 Press MHz to enter.

Set the L-Band Output Frequency (Option)

Press the *RF out* frequency field for the desired channel
 Enter a numeric frequency value (in MHz).
 Press MHz to enter.

Note that the output frequency is independent of the input frequency only if the instrument hardware is configured as such. Otherwise, the input and output frequencies will track, irrespective of which one has been modified.

Static AWGN Operation (Optional Feature)

The optional AWGN feature adds white Gaussian noise to the user's signal. There are two modes of operation 1) Ratio mode that sets the noise density (N_0) based on an E_b/N_0 ratio, signal power, and bit rate, or 2) Noise Density mode, that sets the noise density by direct entry, irrespective of the signal level. The noise has a constant power spectral density over the operating bandwidth of the instrument. For example, if the instrument has a 72 MHz bandwidth, the noise will occupy the entire 72 MHz.

The ratio mode uses a true rms detector to measure the input signal power. Ratio and Bit Rate settings in combination with this measured power determine the applied noise density, such that the desired Eb/No ratio is achieved. The resultant noise density is displayed.

Mode is used to toggle between the two modes. Pressing the *on* or *off* value alternately enables and disables the noise output.

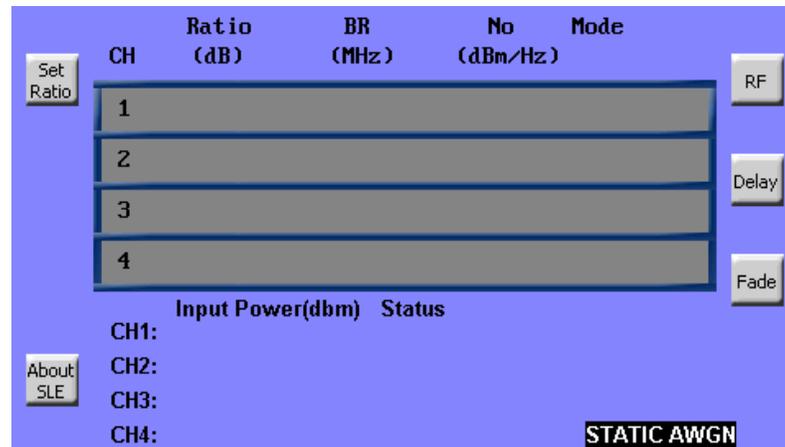
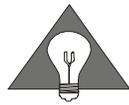


Figure 2-6. AWGN View



To avoid signal clipping, the power of the output signal when combined with awgn must be reduced to less than the instrument's normal maximum output power. When noise is applied, the maximum input signal amplitude (S_{max}) must be reduced to less than:

$S_{max} = 10 * \text{Log}\{1 - 10^{-(P_n/10)}\}$, where $P_n = No + 10 * \text{Log}(NBW)$, and NBW is the noise bandwidth.. With AWGN at full scale, the noise power is typically -16 dBm.

Setting the AWGN Menu Parameters

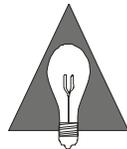
Set Noise Density (Mode = No)

Press the noise density field for the desired channel

Enter a negative numeric value (in dBm/Hz).

Press Enter to enter.

Press on/off to enable/disable the noise.



The range of control for the noise density is 60 dB. However, the usable range may be less, as it is limited by the maximum density the instrument can produce and the intrinsic noise floor of the instrument. Additionally, when AWGN is active, the channel attenuation should be limited to less than 32 dB.

Set Eb/No Ratio (Mode = EbNo)

Press the Ratio field for the desired channel.

Enter the desired ratio value in dB. Press Enter.

Press the Bit Rate field, type the desired value, then press Enter.

Enter the signal's bit rate. Press Enter.

Press the Set Ratio softkey to compute and set the noise density.

Press on/off to enable/disable the noise.

The resulting noise density is displayed, but cannot be modified directly.

The noise density is displayed in red if it is not valid for the current settings.

The EbNo ratio is set immediately each time the Set Ratio key is pressed.

The signal power meter measures a true rms value, that is averaged over a period of approximately 1 second. Avoid the following conditions that will cause an inaccurate measurement:

1. An input signal power greater than 0 dBm
2. A pulse modulated signal. The meter does not correct for duty cycle.
3. A CW signal at exactly the SLE900's IF center frequency. An offset of at least 1 Hz is required.

Static Multipath Fading Operation (Optional Feature)

The optional Multipath Fading feature applies up to 6 paths of multipath fading. Rayleigh and Rician distributions are available, as well as line of sight (Doppler shifted CW). Each path has control for the amount of spreading (via Doppler), path loss, path delay, and Angle of Arrival. Rician K-factor can be adjusted as well as correlation between paths.

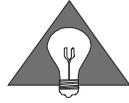
From the Delay, RF, or AWGN views, pressing the Fading soft key will invoke the Multipath Fading view. Likewise, Delay, RF, or AWGN can be invoked from the Multipath Fading view by pressing the appropriate soft key.

For Static mode, the multipath display will appear as in the example figure below. Each of the Type, Doppler, Loss, and Delay parameters can be modified by pressing the touch sensitive display in the appropriate field.

CH	Path	Type	Doppler (Hz)	Loss (dB)	Delay (us)	RF
	1					
	2					
Next Menu	3					Delay
	4					
	5					
All off	6					AWGN

CH STATIC FADE

Figure 2-7. Typical main display for Static Multipath Fading



To avoid clipping when fading is enabled, the power of the signal under fading conditions must be reduced to less than the instrument's normal maximum power. When fading is enabled, the input signal must be limited to less than -6 dBm, and the faded output signal power will be less than -19 dBm (dependent upon the path loss settings).

Setting the Multipath Fade Menu Parameters

Soft Keys

CH: To view settings for other channels, press the CH button to cycle through all installed channels. The current channel number is displayed at bottom left of the display.

Next Menu: Rician K-factor, Angle of Arrival, and correlation between channels can be adjusted by pressing this button to invoke the Fading submenu.

All on/off: toggles between multipath fading active or bypassed

Delay: go to Delay view

RF: go to RF Frequency view

AWGN: go to AWGN view

Grid Parameters

Press the appropriate field, type in the desired value, followed by the **Enter** key.

Path #: hard coded in background bitmap

Type: displays fading type: RAY, RICE, CW, or Off.

Doppler: 0-10 kHz in 1 Hz steps.

Loss: 0 – 30dB in 0.1 dB steps.

Delay: 0 – 20 usec in 1 nsec steps.

Multipath Submenu View

The multipath fading submenu is an extension of the fading main menu to provide the additional controls for Rician K-factor, Angle of Arrival, and path correlation.

Any path can be correlated to any other path by a percentage ranging from 0%(totally uncorrelated) to 100% (fully correlated). All paths can be correlated to each other by chaining the correlation, for example, correlate 2 to 1, then 3 to 2, then 4 to 3, etc.

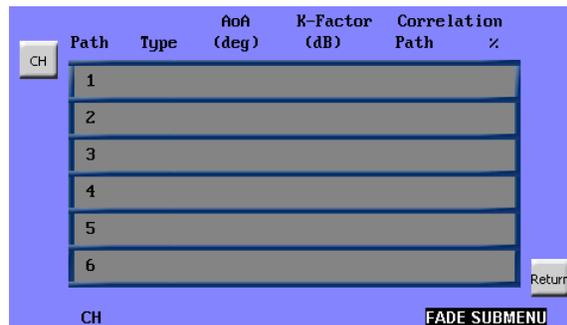


Figure 2-8. Typical display for the Static Fading Submenu

Soft Keys

CH: To view settings for other channels, press the CH button to cycle through all installed channels. The current channel number is displayed at bottom left of display

Return: go to the main Fading view

Grid Parameters

Type: displays fading type: RAY, RICE, CW, or Off. The Type cannot be changed from this menu.

K-factor: +20 to -10 dB in 1 dB steps. Only valid for RICE fading.

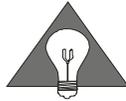
Angle of Arrival: 0 to 90 degrees. Determines the frequency of the line of sight component relative to the path Doppler. The LOS frequency is computed as $\cos(AoA) * Doppler$. AoA applies to CW and Rician path types.

Correlation Path: indicates the path to which the selected path is correlated.

Correlation %: 0 – 100% in 1% steps.

Dynamic Mode

Dynamic Mode Controls



Blue hard keys are specific to Dynamic mode

From the Static Delay menu, press the gray Mode key to invoke the Dynamic File menu.

Change Update Rate

Press the Update Rate key to select the update interval field. The pointer appears at the update rate field.

Type a value for update period.

Press Enter. The new value is entered and the pointer disappears.

Valid values are 1, 2, 5, 10, 20, 50, 100, 200, 500, and 1000 ms. Invalid entries are rounded to the nearest valid number.

File Menu

The File Menu appears automatically when entering Dynamic Delay mode. Press File Menu to invoke the file display while already in Dynamic mode. Each of the dynamic parameter values is replaced with file names for that parameter. Selecting and de-selecting dynamic files is done from this menu.

Characteristics of each file are displayed when the parameter is selected by touching the parameter field. Scroll through the stored file names using the up/down arrow keys. Pressing the Done soft key loads the displayed files and returns to the main dynamic display.

Scroll Down

Once the file menu is displayed, the ↓ key will cause the displayed file name to scroll downward through the list of file names that are valid for that parameter and are currently stored on the internal storage medium.

Scroll Up

Once the file menu is displayed, the ↑ key will cause the displayed file name to scroll upward through the list of file names that are valid for that parameter and are currently stored on the internal storage medium.

Mode

Press Mode to toggle between Static and Dynamic modes. When exiting the Dynamic mode, parameter values retain the last Dynamic value. When entering Dynamic mode, parameter values become the 1st point in each respective data file, or retain the values from the Static mode if no file is loaded.

The Mode key is enabled only in Static, and in Dynamic when the status on the front panel display shows “Ready”.

Update

Press Update to toggle between an internally and externally applied update signal. LED's on the SLE front panel indicate the selection. When set to internal, the update clock is generated internally. The internal clock is derived from an internal timer. The accuracy of the internal timer is based on the accuracy of the 10 MHz reference clock. When set to external, the instrument executes one parameter datum on each external rising clock edge, after a START signal is received. The external clock is a TTL logic level signal that is applied at the external timing input connector at the rear of the instrument. The Update key is enabled only in Dynamic when the status on the front panel display shows “Ready”.

Loop

Press Loop to toggle between “Single”, “Continuous”, and “Forward/Reverse”. In “Single”, parameter files are run from beginning to end, and then execution stops, and the mode changes to DONE. In “Continuous”, files are repeatedly run from beginning to end. Mode remains at RUN. Files can only be run in Continuous looping if the first data point and the last data point in the file are identical. If Continuous is selected, and all selected parameter files do not have matching end points, Loop will automatically revert to “Single”. All selected files must indicate “Loop:Continuous” in order for “continuous” to be active. In “For/Rev”, files are repeatedly run from beginning to end, and then from end to beginning. The Loop key is enabled only in Dynamic when the status on the front panel display shows “Ready”. If files of unequal lengths are run, the last point of the shorter file(s) is held until the last point of the longest file is executed.



For/Rev and Continuous looping functions are not available when using dynamic multipath fading or dynamic RF frequency.

Trigger

Press Trigger to toggle between “Internal” and “External”. LED’s on the SLE front panel indicate the current selection. When set to “Internal”, file execution begins when a Start command is received from the front panel or via an Ethernet command. Latency of the software generated command can cause start time uncertainty when using this type of trigger.

When set to “External”, the Start command arms the instrument, and file execution begins on the 2nd update clock after the receipt of the rising edge of a TTL trigger signal applied to the trigger input on the External Timing Control connector on the rear panel of the instrument. Once triggered, parameter changes are executed on the rising edge of the update clock applied to the External update clock input (pin 7) on the External/timing input connector on the rear panel of the instrument. Latency from trigger to actual implementation of the 1st data point is equal to two update clock periods.

The Trigger key is enabled only in Dynamic, and when the status on the front panel display shows “Ready”.

Time Reference

Press Time Ref to toggle between “Input” and “Output”. When set to “Input”, all link parameters are executed simultaneously. When set to “Output”, the execution of Attenuation and AWGN is held off in time by an amount equal to the current delay file data point, such that these 2 parameters are implemented when the RF signal sample reaches the output of the delay line.

The Time Ref key is enabled only in Dynamic when the status on the front panel display shows “Ready”.

Start

Press Start to begin Dynamic file execution at the current interval rate. The displayed status on the front panel display changes to “Run”. If Trigger = External, then the status on the front panel display changes to “Armed”, and data is implemented only after an external trigger signal has been received. The status on the front panel display will change to “Run” after receipt of the external trigger. Start is disabled when the status on the front panel display shows “Run” or “Done”. Start is also used to re-start after Pause. Pressing Start after Pause causes execution to continue from its current point.

Reset

Press Reset to stop Dynamic file execution and reset each parameter to the 1st point in the current link parameter files. ET (elapsed time) display is reset to zero. Reset must also be used to re-initialize the data files after a single run is complete and the status on the front panel display shows “Done”. Reset is disabled when the status on the front panel display shows “Ready”.

Pause

Press Pause to stop Dynamic file execution and hold elapsed time at its current value. The displayed parameter values match the actual data implemented in hardware. Parameters are not reset. ↑ and ↓ keys may

be used from the Paused state to single step through the dynamic files. Pressing Start causes execution to continue from its current point. Pause is disabled when the status on the front panel display shows "Ready", "Done" or "Paused". When the update interval is set to a longer value, there will be a noticeable delay after Pause is pressed until the parameters stop changing. During this interim period, the status will indicate "Halting" before changing to "Paused".

Dynamic States

When Dynamic is selected, the instrument will be in one of 5 states, which are displayed on the bottom right corner of the front panel display.

Ready

The instrument is initialized, and dynamic execution can begin.

Run

The instrument is currently executing dynamic files. The elapsed time counter will be incrementing.

Armed

The trigger has been set to external and the instrument will begin file execution upon receipt of a hardware trigger signal.

Paused

The instrument is paused during a dynamic run. The currently implemented parameter values are displayed. Pressing the \uparrow key or the \downarrow key will single step through the files. Pressing Start from this point will continue execution. Pressing Reset from this point will cause the instrument to initialize the current dynamic files.

Done

The instrument has finished execution of a single dynamic run. The last value of each parameter file is implemented in hardware.

Initiating Dynamic Operation

Dynamic mode operation is initiated by pressing the Mode hard key. The SLE900 automatically invokes File Menu #1 followed by File Menu #2. Parameters will be controlled by the dynamic files that are selected in the File Menus. To select or change a file, press the parameter field to highlight the file name, and use the \downarrow and \uparrow arrow keys to scroll through possible choices. A selection of "None" will leave the parameter at its last setting. A description of the currently highlighted file is shown at the bottom of the display. Once all desired files have been selected, press the Done softkey to return to the Dynamic delay view.

CH	Delay	Attn	Frequency Offset	AWGN
1				
2				
3				
4				

Name:
 Initial value:
 Loop type:
 # of points:

Done

FILE MENU 1

Figure 2-9. File Menu #1

CH	RF in	RF out	Multipath
1			
2			
3			
4			

Name:
 Initial value:
 Loop type:
 # of points:

Done

FILE MENU 2

Figure 2-10. File Menu #2

Once the file loading sequence is complete, the display returns to the main dynamic window, and the 1st point of each file is pre-loaded by the hardware. The delay line requires a period of time, typically a few seconds, to initialize. The background color in the delay field will be white during this initialization. Once a dynamic run is started by pressing the Start hard key, implementation of subsequent data points in each file begins.

While running, the displayed elapsed time counter (labeled *Time* on the display) increments. Parameter values are changed at the update rate, which is selectable from 1 sample per second up to 1 sample per millisecond. Parameters that are changing will have a white background. Parameters, for which no dynamic file is loaded, will retain the normal background color.

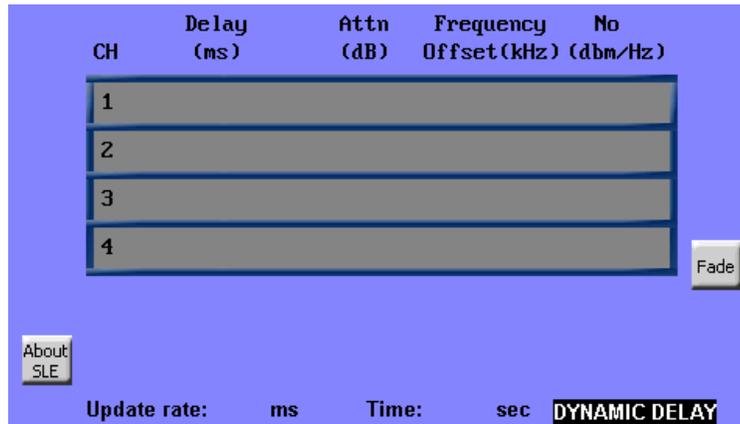


Figure 2-11. Dynamic Delay Menu

Dynamic Delay, Attenuation, Frequency Offset and AWGN

Each of the four parameters, Delay, Attenuation, Frequency Offset, and AWGN are changed synchronously at the selected update rate. When multiple parameters are being controlled by dynamic files, data point #n in each file is updated on the same update clock edge. Delay is not changed instantaneously; rather it slews linearly from the initial point to the final point over one update period. The slew rate can be calculated as (change in delay)/(update period). Note that a file can be run at various update rates, which will result in different slew rates. An example is given below:

Delay data value	Rate of change at 1 msec update	Rate of change at 20 msec update
10.200000		
10.200010	10 usec/sec	500 nsec/sec
10.200110	100 usec/sec	5 usec/sec
10.200010	100 usec/sec	5 usec/sec

AWGN dynamic files provide direct control of the noise density output power. Note that the SLE900 cannot calculate Eb/No ratio in dynamic mode.

Dynamic RF Operation

When the SLE900 hardware is configured with internal L-band frequency converters, the center frequency can be changed dynamically. The rate of change is fixed at 1 second, irrespective of the selected update rate. The same file type (RFF.dat) is used for both input and output frequency control.

The RF dynamic parameter file can be designated in File Menu #2.

Dynamic Multipath Fading Operation

When the SLE900 hardware is configured with optional multipath fading, a six tap fading model can be changed dynamically. The rate of change of tap values is fixed at 1 second, irrespective of the selected update rate. Only one file is required to control the entire 6 tap model. Parameters that can be dynamically changed are Doppler, path loss, delay and Angle of Arrival. Each path is independently controllable. Ricean k-factor, correlation, and path type cannot be changed dynamically.

The multipath parameter file can be designated in File Menu #2.

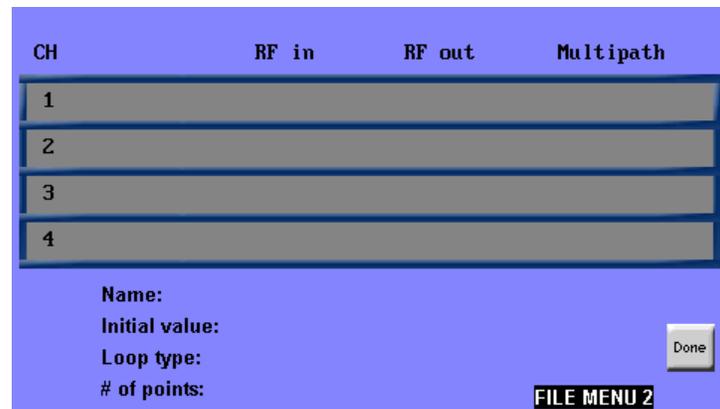


Figure 2- 12. File Menu #2

Dynamic Data Files

Dynamic File Names

The SLE distinguishes parameter file types by the first three letters in each file name. File names can be up to 10 alphanumeric characters, as follows:

- DLYxxxxxxx - designates a delay file
- FRQxxxxxxx- designates a frequency offset file
- ATNxxxxxxx - designates an attenuation file
- WGNxxxxxxx - designates an awgn file
- RFFxxxxxxx – designates an RF frequency file
- MPFxxxxxxx – designates a multipath fading file

Data files consist of ascii characters. The first line in the data file must be the number that represents the exact number of sample points in the file. Each subsequent line in the file is the data for one sample.

Dynamic File Formats

The parameter data files should be generated in ASCII format as a sequential data list with a carriage return <CR> separating the parameter fields. File names must begin with "DLY", "FRQ", "ATN", "WGN", "RFF", or "MPF" and end with ".DAT" When the files are converted to a compressed format for the SLE900, the generated files have the same prefix, but the suffix becomes ".SLE". The converted files are then transferred over the LAN interface, and stored in flash memory. The converted files are in binary format (to optimize storage) with an ASCII header (so that information can be displayed on the front panel).

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 (Multipath files have a different format. See the Multipath file section). 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 conversion program. The SATGEN II 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 should be one of DLY, FRQ, ATN, WGN, RFF, or MPF to represent delay, frequency offset, attenuation, awgn, RF frequency, and multipath fading files. Up to 7 alphanumeric characters can follow the first three letters in the file name.

Data File Description

Delay Files

Delay can be varied with resolutions as fine as 0.5 ps per step. Achievable resolution is based on the selected update rate. The range of delay step size as a function of update rate is given in the table below. The SLE900 computes the required delay slew rate from point to point such that there is constant linear change that occupies the entire update period. For example, if the update rate is 10 msec, and the change in delay values is 10 nsec, then the resulting delay slew rate will be {10 nsec/10msec} or 1 usec/sec. If the same data file is operated at a 100 msec update rate, the resulting slew rate will be 100 nsec/sec. In all cases, the delay change does not cause phase discontinuities.

- Each data line consists of 10 to 14 characters, depending on resolution, including a decimal point

- Range is 0.1ms minimum. The maximum is SLE model dependent. Resolution is 0.5 ps.
- The maximum delay change between any two adjacent points equals the maximum slew rate times the update rate (see table below).
- Units are ms

Update Rate		Range of Achievable Slew Rates				
1000ms	Min	1ns/sec	0.1ns/sec	0.01ns/sec	1ps/sec	0.5ps/sec
1000ms	Max	32.767us/sec	3.2767us/sec	0.32767us/sec	32.767ns/sec	16.384ns/sec
500ms	Min	2ns/sec	0.2ns/sec	0.02ns/sec	2ps/sec	1.0ps/sec
500ms	Max	65.535us/sec	6.5535us/sec	0.65535us/sec	65.535ns/sec	32.767ns/sec
200ms	Min	5ns/sec	0.5ns/sec	0.05ns/sec	5ps/sec	2.5ps/sec
200ms	Max	163.84us/sec	16.384us/sec	1.6384us/sec	163.84ns/sec	81.92ns/sec
100ms	Min	10ns/sec	1.0ns/sec	0.1ns/sec	10ps/sec	5ps/sec
100ms	Max	327.67us/sec	32.767us/sec	3.2767us/sec	327.67ns/sec	163.84ns/sec
50ms	Min	20ns/sec	2.0ns/sec	0.20ns/sec	20ps/sec	10ps/sec
50ms	Max	655.35us/sec	65.535us/sec	6.5535us/sec	655.35ns/sec	327.67ns/sec
20ms	Min	50ns/sec	5.0ns/sec	0.5ns/sec	25ps/sec	25ps/sec
20ms	Max	1638.4us/sec	163.84us/sec	16.384us/sec	1638.4ns/sec	819.2ns/sec
10ms	Min	100ns/sec	10ns/sec	1.0ns/sec	100ps/sec	50ps/sec
10ms	Max	3276.7us/sec	327.67us/sec	32.767us/sec	3276.7ns/sec	1638.4ns/sec
5ms	Min	200ns/sec	20ns/sec	2.0ns/sec	200ps/sec	100ps/sec
5ms	Max	6553.5us/sec	655.35us/sec	65.535us/sec	6553.5ns/sec	3276.7ns/sec
2ms	Min	500ns/sec	50ns/sec	5.0ns/sec	2500ps/sec	250ps/sec
2ms	Max	16384us/sec	1638.4us/sec	163.84us/sec	16384ns/sec	8192.0ns/sec
1ms	Min	1000ns/sec	100ns/sec	10.0ns/sec	5000ps/sec	500ps/sec
1ms	Max	20000us/sec	3276.7us/sec	327.67us/sec	32767ns/sec	16384.0ns/sec
Data format		ms.123456	ms.1234567	ms.12345678	ms.123456789	ms.1234567890

Attenuation Files

- Each data line consists of five characters in a “xx.xx format.
- Range is 0 to 70 dB in 0.10dB steps
- Step size between any two adjacent points can be up to 40 dB
- Units are dB

Frequency Offset Files

Frequency offset is typically used to impose the carrier Doppler shift that occurs as a result of time varying path length change. Note that dynamically changing delay in the SLE900 causes a frequency shift proportional to the frequency offset from the instrument’s nominal center frequency. For example, if the SLE900 is a 140 MHz model, a frequency component at 140 MHz will experience no shift with changing delay, whereas frequency content above and below 140 MHz will shift away from the 140 MHz when delay is decreasing. Therefore chip period variations as a function of Doppler are emulated correctly, irrespective of the actual signal carrier frequency. Carrier Doppler shift

however must be computed based on the actual carrier frequency, and applied using a Frequency Offset file.

- Each data line consists of eight or 10 characters, depending on resolution, including a decimal point
- Range is 0 to $\pm 3000\text{KHz}$ in 1 Hz or 0.01Hz resolution
- Step size between any two adjacent points can be up to $\pm 32,767$ times the resolution.
- Units are kHz

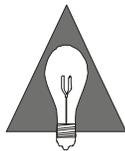


In Dynamic mode, Frequency offset resolution is 0.01 Hz if there are 5 decimal places in the first data point in a frequency offset file, eg. x.12345 will invoke 0.01 Hz resolution. Otherwise, resolution will be 1 Hz.

AWGN Files

When noise density is enabled in static mode (either by direct entry or via Eb/No calculation), the noise will remain enabled at that level when the SLE900 mode is changed to dynamic. If awgn is not desired in dynamic mode, it must be set to off in static mode. When a dynamic awgn file is loaded, awgn is automatically enabled, irrespective of whether it was on or off in static mode. Once enabled in dynamic mode, awgn cannot be disabled without returning to static mode. Dynamic awgn is driven by data files containing the value of absolute noise density (for example, -95.23 dBm/Hz). The AWGN update rate is the same as that selected for delay, frequency offset, and attenuation.

- Each data line consists of seven characters in a “-xx.xxx” format
- Range is 60 dB in 0.01 dB steps. The largest absolute noise density value is instrument dependent.
- Step size between any two adjacent points is unlimited
- Units are dBm/Hz



The range of control for the noise density is 60 dB. However, the usable range may be less, as it is limited by the maximum density the instrument can produce and the intrinsic noise floor of the instrument. Additionally, when AWGN is active, the channel attenuation should be limited to less than 32 dB.

RF Frequency Files (With L-band Converter Option)

When L-band frequency converters are installed in the SLE900, the tuned center frequency can be varied dynamically. Depending on the hardware configuration, the input and output frequency are either independently tunable, or are slaved together.

- Each data line consists of eight or 10 characters, depending on resolution, including a decimal point
- Range is 800 to 2600 MHz in 1 MHz steps.
- Step size between any two adjacent points is limited only by the total frequency range.
- Units are MHz

Multipath Fading Files

All six paths in a multipath channel can be driven dynamically by a single data file. The files contain values for path Doppler, path loss, path delay and Angle of Arrival (AoA). The file also designates path type, K-factor and correlation values, but these parameters remain constant throughout a dynamic run.

```

1000
CW 2 0
OFF 3 0
RICE 4 0 3
RAY 5 0
OFF 6 0
OFF 1 0 6
;3535 7.166 29.9 84 ;4275 5.127 5.9 75 ;5825 0.542 19 62 ;6900 6.033 26.3 41 ; ;
;3823 14.888 14.1 82 ;4420 5.66 3 72 ;5319 7.307 14.3 65 ;6931 17.874 25.6 43 ; ;

```

Figure 2- 13. An example of a Dynamic Multipath file. Two out of 1000 data lines are illustrated.

Line 1: designates the total number of time increments included in the file. This number must exactly match the number of data lines.

Lines 2 -7: Represents paths 1 through 6 respectively. The format for these lines is:

```
Type    Correlation Path  Correlation %    K-factor
```

In each line, the path type is followed by the correlation path and then the correlation percentage. k-factor is required for Rician paths, and can optionally appear for other path types. Path type is one of

```
CW
RAY
RICE
OFF
```

Each subsequent data line contains the dynamic path parameter values. The format for the path data is:

;Doppler (Hz) Delay (usec) Loss(dB) AoA(degrees)

Path data is delimited by a semicolon. Each data line must contain six semicolons. The first semicolon is followed by path #1 data, the second semicolon is followed by path #2 data, etc. AoA can optionally appear for Rayleigh paths, but is required for Rician and CW paths. When no path data is required, the semicolon must still be present. A path that is OFF can have path data in the file, and the data will be ignored.

Each line in the file is ended with a carriage return. Spaces are allowable.

Dynamic File sizes

Parameter data file sizes are unlimited, however the total of all downloaded files is limited by the SLE900 memory capacity.

LED Functions

This section describes how the front panel LED's function.

Standby	Illuminated while main power switch is in the off position, to indicate that power is applied to the instrument. This LED is controlled by hardware.
Remote	Illuminated when SLE has been put into remote by the <u>Local</u> key. All front panel controls except <u>Local</u> are disabled when in remote.
Update	Two LED's to indicate whether the current selection is Internal or External.
Loop	Three LED's to indicate Single, Continuous, or Forward/Reverse sequence of executing Dynamic files
Trigger	Two LED's to indicate whether the current selection is internal or external.
Mode	Two LED's to indicate whether the SLE is in Static or Dynamic mode
Time Ref	Two LED's to indicate whether RF parameters are implemented relative to the signal being at the input of the delay line, or when the signal appears at the output of the delay line.

3

Remote Operation Section

Remote Operation Overview

The SLE900 can be controlled remotely using its LAN interface. The instrument can be connected to any IEEE-802 network. It uses TCP/IP, and achieves transfer rates up to approximately 5 MBPS. All front panel controls are also implemented in the SLE900 LAN client application called *SLEControl*. In addition, parameter files may be downloaded into the SLE900 or deleted from the SLE900 memory through the LAN interface.

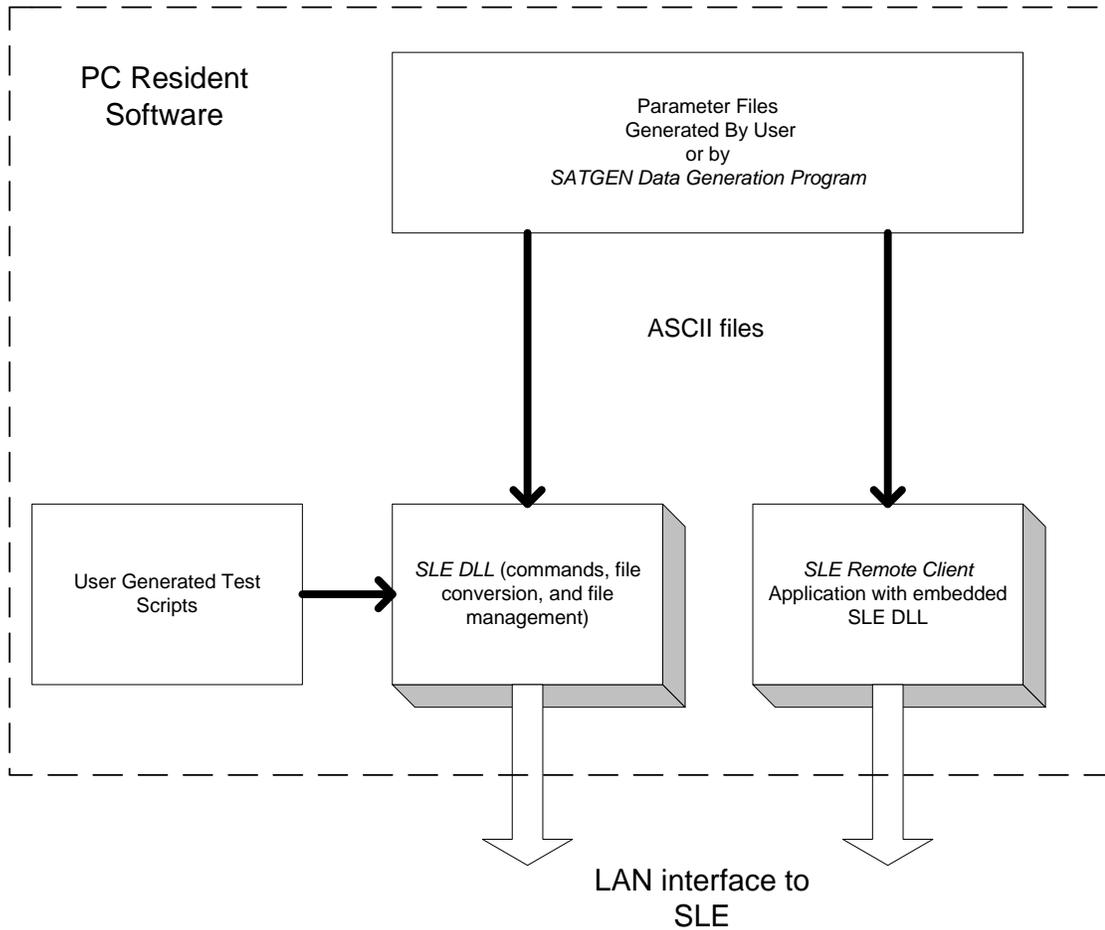
Programming control of the SLE900 can be implemented by two means: 1) Using *SLEControl* provided by dBm or 2) by creating a test script, which makes calls to the DLL provided with the instrument. A complete description of *SLEControl* and the SLE900 DLL are given in this manual.

SLEControl provides a graphical user interface to manipulate parameter files, and to control and monitor the SLE, both in Static and Dynamic mode. The DLL is embedded in *SLEControl*, so that DLL functions can be exercised within the application through the GUI.

The SLE900 DLL contains numerous utilities including:

- Exercise of all front panel key functions for Static and Dynamic modes
- SLE900 mode and setup controls
- File conversion (ASCII format to compressed format)

- File download into the SLE900 memory
- File deletion from the SLE900 memory
- LAN setup and controls
- SLE900 status reporting
- SLE900 error reporting



The SLE900 can be controlled remotely using dBm's DLL or SLEControl

Figure 3-1

Setting the SLE900 IP Address

To set or view the SLE900 IP address, press IP ADDR key. Enter the desired IP address. Press the Enter hardkey. Press the Return softkey.

Remote Control via LAN

The SLE is configured as a network server, and can communicate with a network client. The client can download and delete dynamic parameter files on the mass storage device in the SLE.

All front panel Static and Dynamic commands can be initiated with the LAN interface. While in remote all front panel controls except the Local button are disabled.

Description of the SLE900 Remote Client Application Program *SLEControl*

SLEControl provides a graphical interface to control the SLE900 from a PC via a LAN connection. The client application provides Static Controls, Dynamic Controls, allows download, deletion and selection of parameter files in the SLE900, and displays the parameter file data in graphical form.

SLEControl provides several functions:

1. Imports ASCII based data files such as those generated by SATGEN.
2. Provides real time control of all Static and Dynamic SLE900 functions, including Start, Pause, and Reset in the Dynamic mode.
3. Converts the ASCII parameter files to a format compatible with the SLE900, and provides simple controls for downloading files into the SLE900 memory.
4. Allows selection and deletion of files in the SLE900 memory.
5. Provides a graphical representation of the parameter files, and a real time cursor to indicate execution progress during a Dynamic run.

Installing *SLEControl* on a PC

SLEControl and the SLE DLL can be copied from the provided CD to a directory on a PC. Create a directory, for example c:\SLE900 Client, and copy the following files into the directory:

SLEControl.exe
 SLEDLL.dll
 SLEDLL.lib
 SLEDLL.h

Connecting to the SLE900

To establish a connection from the PC to the SLE900, connect the two devices to a local area network, or connect them directly using an ethernet crossover cable.

Press the Local button on the SLE900 to illuminate the remote LED if it is not already on. Pressing Preset or performing a cycling AC power with a LAN connection present also places the instrument in remote mode.

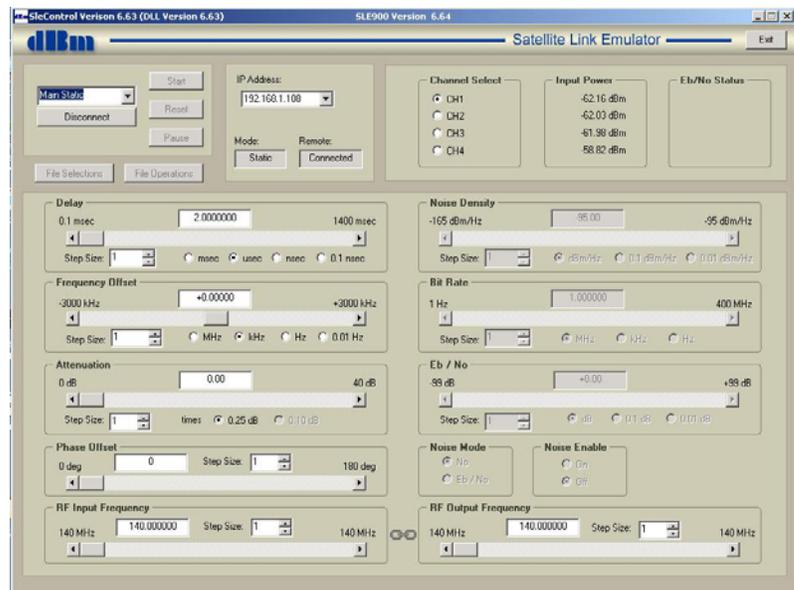


Figure 3-2. SleControl Main Static Window

In the client's Main Static window, enter the IP address to match the SLE900 IP address.

Press Connect. When the link is established, the same button will indicate "Disconnect" and the status menu labeled "Remote" will also indicate "Connected".



When connecting the SLE900 to a PC via a crossover cable, the PC must be configured with a static IP address that matches the SLE900 IP address as indicated by the subnet mask.

Mode Control

The drop box at the upper left corner of the window provides the selection of either Main Static mode or Main Dynamic mode. If the SLE900 has multipath fading installed, two additional choices for Multipath Static and Multipath Dynamic will be available. Once the desired mode is selected, the appropriate client window appears, and the SLE900 will automatically change to that mode.



While in remote mode, the SLE900 front panel display window may not necessarily correspond with the SleControl application window.

Main Static Controls

Select the desired channel with the Channel Select radio buttons.

Parameters are displayed for one channel at a time except the measured input signal power is displayed simultaneously for all installed channels.

Each control value can be changed in one of four ways:

- Drag the slide bar with the mouse.
- Click on the end of the scroll bar.
- Click inside the scroll to change the value by a larger amount.
- Type a new value in the text box and press "Enter".

Delay can be set by entering the desired value in milliseconds, or by moving the slide bar. The step size and resolution controls below the slider determine the magnitude of change when the end pointers of the Delay slide bar are pressed. The maximum delay value is dependent on the SLE900 hardware configuration.

Frequency Offset can be set by entering the desired value in kiloHertz, or by moving the slide bar. The step size and resolution controls below the slider determine the magnitude of change when the end pointers of the Frequency Offset slide bar are pressed.

Attenuation can be set by entering the desired value in dB, or by moving the slide bar. The step size control below the slider determine the magnitude of change when the end pointers of the Attenuation slide bar are pressed.

Phase Offset can be set by entering the desired value in degrees, or by moving the slide bar. The step size control determines the magnitude of change when the end pointers of the Phase Offset slide bar are pressed.

RF Input Frequency and RF Output Frequency can be set by entering the desired value in MHz, or by moving the slide bar. The step size resolution is fixed at 1 MHz. A chain icon appears between the input and output controls if the SLE900 hardware is configured such that these values are always linked together. If the input and output frequency are independently controllable, the chain icon does not appear. If the SLE900 does not have installed RF frequency converters, the input and output frequency are fixed at the SLE900's IF operating frequency.

The AWGN controls will be active only if AWGN has been licensed in the SLE900. Select either No or Eb/No with the Noise Mode radio buttons. Turn the AWGN output on or off with the Noise Enable radio buttons.

With noise density (*No*) mode selected, Noise Density can be set by entering the desired value in dBm/Hz, or by moving the slide bar. The step size and resolution controls below the slider determine the magnitude of change when the end pointers of the Noise Density slide bar are pressed.

With Eb/No mode selected, the Noise Density display can no longer be edited directly. The noise density will be computed based on 1) the measured input power 2) the Bit Rate and 3) the Eb/No ratio. Set the Bit Rate and Eb/No ratio as desired. Press the Set Ratio button and the instrument will immediately attempt to adjust the noise density value. Each time the Set Ratio button is pressed, the required noise density is re-computed and set. If an out of range condition exists, an error status message will appear.

Multipath Static Controls

Select the Multipath Static mode from the drop box in the upper left corner of the GUI.

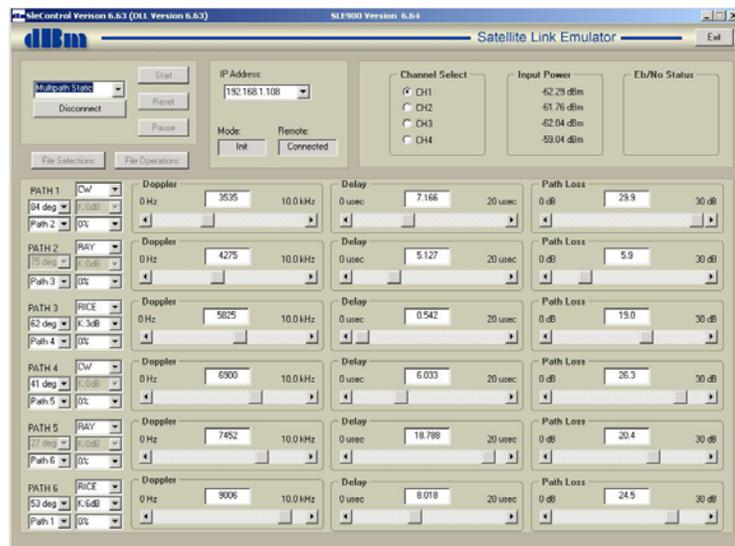
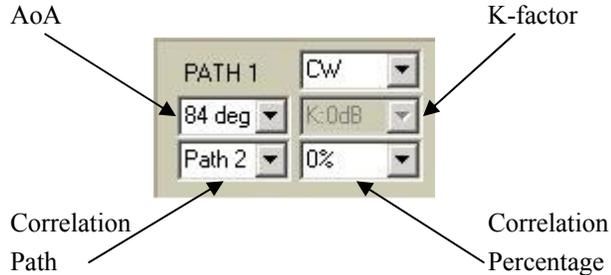


Figure 3-3. SLE900 Multipath Static Window

Select the desired channel with the Channel Select buttons. For each of the six paths, set the path type. When CW or Rician are selected, the Angle of Arrival box becomes active. When Rician is selected, K-factor becomes active. Correlation settings are applied to Rician and

Rayleigh paths only. Set the path Doppler, Delay, and Path Loss using the slider bars, or by typing into the associated text box.



Main Dynamic Controls

Select the Main Dynamic mode drop box at the upper left corner of the GUI. If transitioning from Static mode to Dynamic mode, the File Selection window will automatically appear prior to the Main Dynamic window.

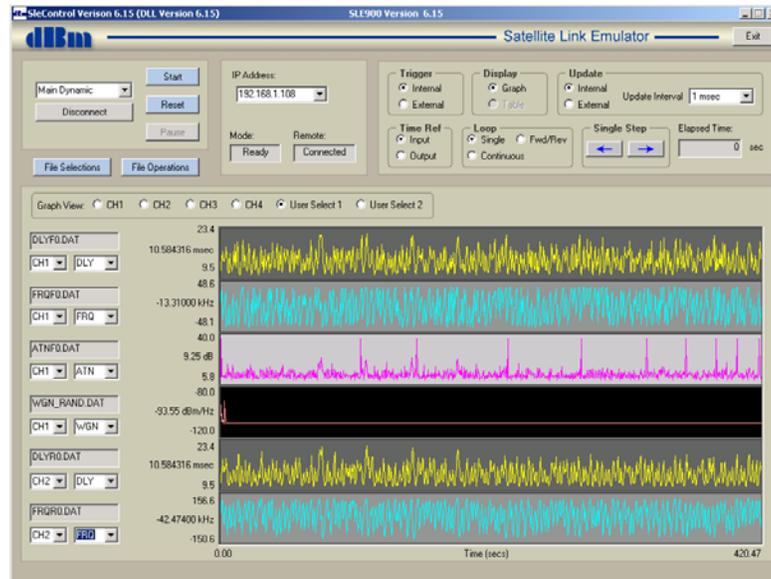


Figure 3-4. SleControl Main Dynamic Window

The Dynamic controls at the upper right of the display (Trigger, Time Ref, Loop, Update, and Update Interval) can be exercised and the SLE900 will respond immediately. All controls can be modified while the SLE900 is in the *Ready* state.

Use the Graph View buttons to view all parameters for a single channel, or by choosing User Select, any combination of channels and parameters can be viewed on the six graph bars.

Note that Single Step and the Graphing functions are not valid until parameter files have been selected in the SLE900.

Multipath Dynamic Controls

Select the Multipath Dynamic drop box at the upper left corner of the GUI. If transitioning from Static mode to Dynamic mode, the File Selection window will automatically appear prior to the Main Dynamic window.

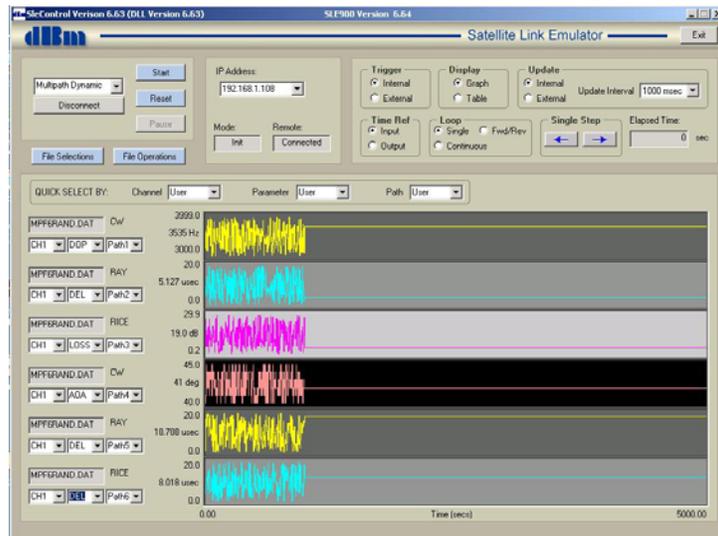


Figure 3-5. SleControl Main Dynamic Window

The Dynamic controls at the upper right of the display (Trigger, Time Ref, Loop, Update, and Update Interval) can be exercised and the SLE900 will respond immediately. All controls can be modified while the SLE900 is in the *Ready* state.

Note that Update Interval applies to non-multipath functions. Multipath parameters are updated at a 1 Hz rate irrespective of the update interval setting.

Use the Quick Select buttons to view all parameters for a single channel, a single path, or by choosing User Select, any combination of paths and parameters can be viewed on the six graph bars.

Downloading Files into the SLE900 Memory

Parameter files that are resident in the PC can be downloaded into the SLE900. The file must be in proper ASCII format, have a ".dat" extension, and have the appropriate file name.

From either Main Dynamic or Multipath Dynamic, press the File Operations button.

Browse to the PC directory where the desired ASCII files are located. Files with the appropriate prefix and .dat extension will be visible.

Highlight the desired file(s) for download. Multiple files can be selected by clicking on multiple file names. The selected files will appear with an alternate color background to indicate they are ready for download.

Press Download. All of the selected files will be sequentially downloaded. Progress of the download is indicated on the SLE900 display. Once a file has been downloaded, the background color for that file will return to normal.

Once downloading is complete, the files will now appear in the lower box labeled "SLE Resident Files".

The List All button is used to read the SLE900 resident file directory.

Press Close in the File Operations window.



If a file is downloaded, and has the same name as a file already resident in the SLE900 memory, the previous file will be overwritten.

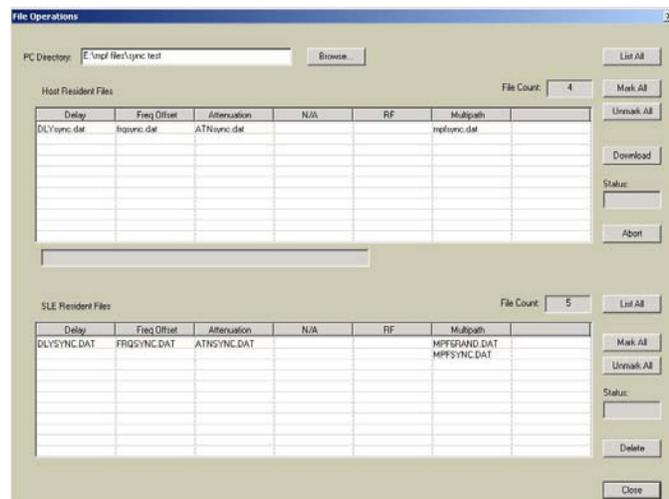


Figure 3-6. SLEControl File Operations Window

File Selection

Once files have been loaded into the SLE900 memory, they must be selected to indicate which files are to be included in a Dynamic run.

From either the Main Dynamic or Multipath Dynamic window, press the File Selections button.

For each channel/Parameter type grid, use the drop down box to view and select a file. These files will be used when a Dynamic run is initiated. If "None" is selected, the parameter value will not be changed from its existing value.

Once the file names have been designated, the SLE900 must initialize using the selected files. There is the option to generate graphs of the files. Under most conditions, it is desirable to generate the graphs to be viewed on the PC monitor. This is done by pressing the "Select Files and Build Graphs" button.

For very large parameter files, it can take several minutes to build a graph. Under this condition, to avoid the delay in execution, press the "Select Files without Building Graphs". The SLE900 will function normally but the graphic display of the parameter file data will not be available on the PC.

Once either of the Select Files buttons has been pressed, the menu will close and the SLE900 will be initialized with the first point of each selected file.

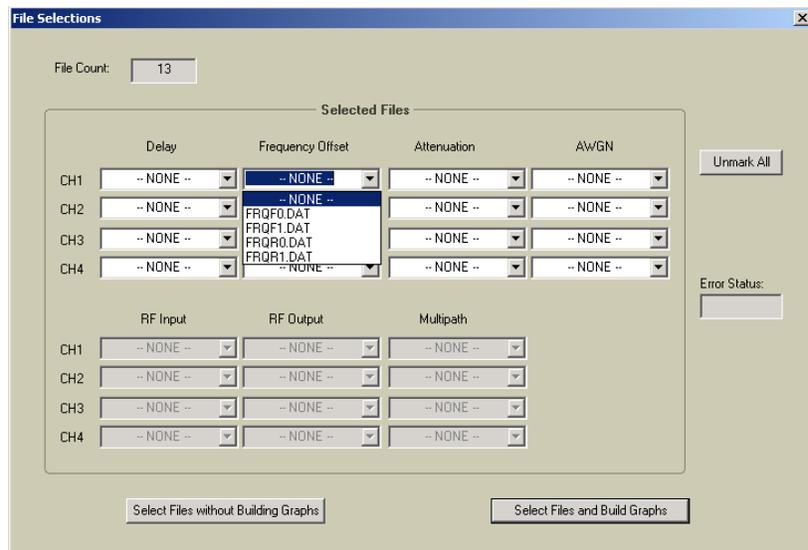
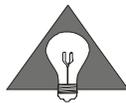


Figure 3.7. File Selection Menu



If a file in the SLE900 memory is selected, and the corresponding .dat file is not resident in the PC, the file will automatically be uploaded into the PC and subsequently will be graphed.

Deleting Files from the SLE900 Memory

If it is desired to remove parameter files from the SLE900 memory, it can only be done using *SLEControl* or the SLE DLL.

Press the "File Operations" button.

Press the "List All" button associated with the SLE Resident Files to list all existing files in the SLE900 memory.

Select the files to be deleted from the listing of SLE900 resident files by clicking on the file name. Alternatively, press "Mark All" to mark all files for deletion.

Press the "Delete" button to clear the SLE900 memory.

Press "Close" to close the File Operations menu.

Starting a Dynamic Run

From the main display, press Start. The Mode will change to Run, and the Elapsed Time counter will increment. If graphs have been selected, the cursor will increment, and the parameter values at the left hand edge of the graph will change in real time.

Press Pause. The instrument will stop at the current parameter value. Those values will be displayed on the graph, and the cursor will indicate the location.

Single Step can be used to manually increment or decrement through the data files.

Pressing Start while being Paused will cause the SLE900 to continue execution from the current point.

Press Reset to return to the initial data point. The instrument status returns to "Ready". Single Step can also be used in the "Ready" state.

Graphical File Display

Up to six parameter files can be graphically displayed simultaneously. The Graph View buttons determine if the graphs will be for a single channel only, or by pressing "User Selectable" any combination of channel and parameter file type can be displayed.

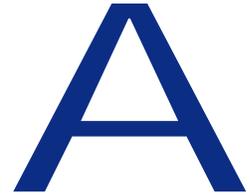
For each graph, choose the channel number, and then the parameter file type. The file name corresponding to those chosen in the File Selection menu will appear.

In the case where files of unequal length have been selected, the time scale is adjusted to accommodate the longest file. The final data point of the shorter files is held to the last point of the longest file.

The vertical scale of the graphs is automatically adjusted to accommodate the maximum and minimum data point of the displayed file.

When execution begins by pressing Start, the cursor increments to indicate the file execution, and the current parameter data values are displayed at the left end of each graph.

When execution is halted by pressing Pause, the cursor and displayed data value indicate the actual parameter value.



Installation and Troubleshooting

Installation and troubleshooting

If your SLE900 unit does not appear to be performing as expected, verification tests can determine whether the unit is functioning properly.

This section describes installation instructions, SLE900 verification tests and provides a checklist for results.

Topic includes:

- System Installation
- Error messages

Installation

Unpacking the SLE900

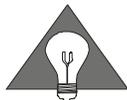
Remove the SLE900 materials from the shipping containers. Save the containers for future use.

The standard SLE900 shipment includes:

Quantity	Description
1	Satellite Link Emulator
1	CD with application programs
1	AC power cord
1	SLE900 User Manual

Initial Inspection

Inspect the shipping container (s) for damage. If container is damaged, retain it until contents of the shipment have been verified against the packing list and instruments have been inspected for mechanical and electrical operation.



If the SLE900 appears to have been damaged during shipping, do not install the unit. Contact **dBm** immediately.

Applying power

1. Place the SLE900 on the intended workbench and connect the AC power cord to the receptable on the rear of the unit.
2. Press the Line on/off switch on the rear panel. The standby indicator should illuminate
3. Press the power on switch on the front panel. The standby LED should turn off and the instrument should power on.

System verification

The following section provides procedures to verify that the SLE900 is functional. These tests do not necessarily verify full performance.

Required Equipment

You should have the following equipment (or equivalent) available for verification testing.

- HP8566 Spectrum Analyzer
- HP8341B Synthesized RF Generator
- HP5370B Frequency/Time Counter
- HP3325A Pulse Generator
- TEK2465B Oscilloscope
- TRILITHIC CD-50 RF Detector (2 PCs)
- EPM 441A Power Meter
- HP5340A RF Frequency Counter

Attach a main AC power cord and set the rear panel main power switch to the up position. The front panel standby LED will illuminate.

Turn on the front panel power switch. The model number and software version will appear in the display, followed by the Instrument State display.

Passband Flatness testing

1. Connect the equipment as shown in Figure A-1. The SLE900 should be in static mode, with delay set to 2 ms and all other parameters set to 0.

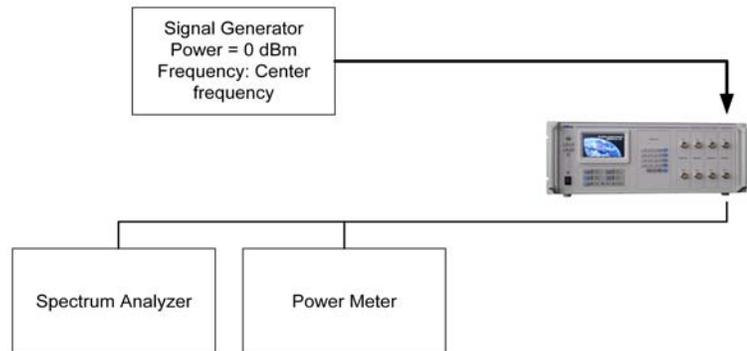


Figure A-1 Frequency Range Test Configuration

2. Measure the power; required output is $-10\text{dBm} \pm 3\text{ dB}$. Using the spectrum analyzer, sweep frequency over the passband. The

spurious response to the signal should be less than or equal to -45 dBc.

3. Set the spectrum analyzer to 1 dB/div and sweep frequency over the passband. The flatness should be less than or equal to ± 1.0 dB.

Attenuation testing

1. Connect the equipment as shown in Figure A-1. The SLE900 should be in static mode, with delay set to 2 msec and all other parameters set to 0.
2. Set signal and delta markers of the spectrum analyzer.
3. While monitoring the output of the spectrum analyzer, increase the attenuation parameter in 0.10 dB steps until you reach 70 dB.
4. For each step, the output signal should decrease by the corresponding amount, within ± 0.10 dB.

Frequency Offset testing

1. Connect the equipment as shown in Figure A-1, with the frequency counter replacing the spectrum analyzer. Set the SLE900 to static mode, with delay set to 2 msec and all other parameters set to 0.
2. Set the Doppler parameter to the settings in Table A-1. After each setting, use the frequency counter to verify that the signal has been offset by the indicated frequency.

Frequency shift (KHz)
0.001
3000
-0.001
-3000

Table A-1

Delay testing

1. Connect the SLE900 and testing equipment as shown in Figure A-2.
2. Set the SLE900 to static mode, with delay set to 0.1 ms and all other parameters set to 0.

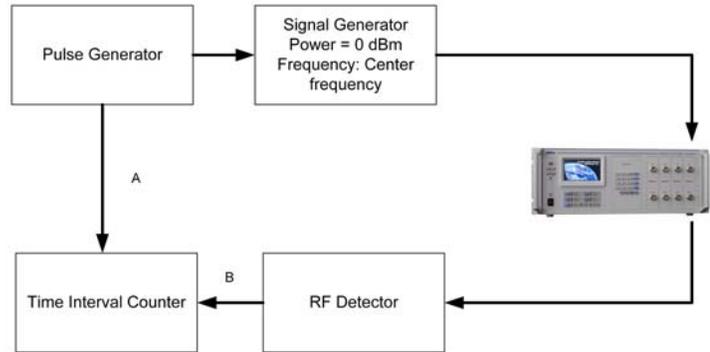


Figure A-2 Delay Test Configuration

2. Set the counter to time interval (A-B) mode.
3. Measure the delay to the output pulse.
4. Increase the SLE delay setting by 1 nanosecond. Measure the delay change.
5. Set the delay on the SLE to the maximum value and measure the delay.
6. Note: The SLE Static mode delay slew rate is 20 us/ms

Noise Density Testing

1. Connect the equipment as shown in Figure A-1, with the signal source disabled. The SLE900 should be in static mode, with delay set to 2 msec, attenuation set to 0, frequency offset set to 0.
2. Enable the noise density at -100 dBm/Hz for the desired channel. Measure the noise density and verify the measurement matches the set value with 1 dB.

Error Messages

Error messages are suppressed during remote operation.

File Missing

Appears when an instrument state register is recalled, and the stored file names no longer exist on the SLE900 internal storage.

Limit

Appears when a parameter value has exceeded the valid operation range.

B

Description and Specifications Section

Description and Specifications

This section describes the SLE900 technical details and specifications. Topics include:

- Functional description of the instrument
- Instrument setting limitations
- Specifications

Functional Description

Delay Line Functions

The main function of the Digital Delay Line hardware is to delay an incoming analog signal by a desired time amount using a digital technique. To provide a relatively large amount of signal delay, the Digital Delay Line samples and converts an incoming analog signal into a 12-bit digital data stream, and stores the data in sequence into a large dynamic random access memory (DRAM) subsystem. After a desired amount of time is passed, the Digital Delay Line reads the stored data from the memory in sequence, and converts the digital data stream back to an analog signal.

For Dynamic operation, the magnitude of the delay is varied in real time by offsetting the clock that writes out of the delay line, relative to the fixed clock that reads into the FIFOs. The magnitude of the clock offset determines the rate of change of delay.

Delay Slew Rate and Resolution Limits

The maximum rate of change of delay is limited, but the achievable rate of change is quite large compared to the realistic rates for satellite orbits. In static mode, the default slew rate is 20 μ s/ms. If the user selects a delay change exceeding this value in Static mode, then multiple update intervals are used to achieve the total desired delay change. The minimum delay slew rate in Static mode is 0.1ns/sec.

Delay resolution in the Dynamic mode is determined by the number of characters to the right of the decimal place in the *first* data value in a dynamic file. There are 5 possible resolution cases for delay:

Case #1:	ms.123456 invokes 1 nsec resolution
Case #2:	ms. 1234567 invokes 0.1 nsec resolution
Case #3:	ms. 12345678 invokes 0.01 nsec resolution
Case #4:	ms. 123456789 invokes 1 psec resolution
Case #5:	ms. 1234567890 invokes 0.5 psec resolution

Each resolution has a limited range of delay slew rate, and therefore a limited change in delay that can occur during each update period. That range of slew rates for a given update rate spans 32,767:1. See the slew rate table in the *Dynamic Data Files* section to compute the maximum achievable delay change as a function of update rate.

Specifications

Specifications are at IF unless otherwise noted.

Center Frequency	
IF	70 or 140 MHz
RF (option L)	800 MHz -2600 MHz, 1 MHz resolution
1 dB RF bandwidth(model dependent)	20 MHz/72 MHz/125 MHz/250 MHz
Number of independent channels	1, 2, 3, or 4
RF input power	0 dBm max.
RF output power	0 dBm max. @ 0 dB attenuation
In-band spurious suppression	-55 dBc typ, -45 dBc max.
Noise floor	< -140 dBm/Hz
Group delay variation	< 5 nsec p-p
Passband Amplitude ripple	< 0.5 dB p-p
VSWR	1.5:1 max into 50 ohms
Delay	
Range	0.1 ms to: 2000 msec @ 20 MHz BW 1400 msec @ 72 MHz BW 890 msec @ 125 MHz BW 420 msec @ 250 MHz BW
Resolution	0.1 ns Static mode, 0.5 psec Dynamic mode
Slew rate	3×10^{-15} sec/sec up to 20 us/ms
Relative accuracy	± 1 ns plus 10 MHz reference
Frequency Offset	
Range	± 3.0 MHz
Resolution	0.01 Hz
Absolute accuracy	based on 10 MHz reference
Relative accuracy	± 0.1 Hz
Attenuation	
Range	0 dB to 70 dB
Resolution	0.10 dB
Slew rate	>70 dB/ms
Accuracy	± 0.20 dB
Phase Offset	
Range	0 to 180 degrees
Resolution	1 degree
Accuracy	< 1 degree
Additive White Gaussian Noise	
Crest Factor	> 16 dB
Repetition Interval	>24 hrs
PDF accuracy	< 1 % from theoretical Gaussian over 6.66σ
Noise Bandwidth	same as signal passband
Spectral Density Flatness	< 0.1 dB p-p max
Noise Density Amplitude Range	-95 dBm/Hz typ., to instrument noise floor
Noise Density Amplitude Resolution	≤ 0.01 dB
Noise Density Amplitude Accuracy	± 0.2 dB

Specifications (cont'd)

Multipath Fading	
# of Paths	6
Path Characteristics	
Dynamic Profile update rate	1 second, affecting Doppler, delay, AoA, and attenuation
Distribution Types	CW, Rayleigh, Rician, and off
Spectral Distribution Shape (Ray, Rice)	$\{\text{SQRT}\{1-(f/f_d)^2\}^{-1}$ with 6 dB peak @ f_d
PDF	within 0.5 dB of theoretical from 10 dB above to 30 dB below mean
Level Crossing Rate	<+/- 2.5% from theoretical
Attenuation Range	0 to 30 dB
Attenuation Resolution	0.1 dB
Doppler Spread	0 to 10 kHz
Doppler Resolution	1 Hz
Delay Range	0 to 20 usec
Delay Resolution	1 ns
Ricean K factor	-10 to 20 dB
K factor Resolution	1 dB
Correlation	0 to 100%, 1% steps
Angle of Arrival Range	0 to 90 degrees
Angle of Arrival Resolution	1 degree
Dynamic Mode	
Profile Update Rate	1, 2, 5, 10, 20, 50, 100, 200, 500, and 1000 msec.
Dynamic Parameters	Delay, Frequency Offset, Attenuation, AWGN, Multipath Fading, RF frequency <i>note: update rate for multipath fading and RF frequency (option L) is fixed at 1000 msec.</i>
Update rate accuracy	based on 10 MHz reference
Triggering	Front panel keypad, LAN, or external signal
Triggering accuracy	synchronized to begin on the 2 nd update clock after trigger
Dynamic data file memory size	> 50 Mbytes

Specifications (cont'd)

Control and Interface	
Local	Front panel
Remote	RJ45, IEEE-802.3
Internal Frequency Reference error	< 2.5 PPM
Primary power	
Voltage	90 – 264 VAC autoranging
Frequency	48 – 66 Hz
Consumption	300 VA max.
Fuse	4A slow-blow
Operating ambient temperature	+10°C to +40°C
Dimensions	17"W x 7.0"H x 21"D
Weight	
1 channel	32lbs, with option L: 35 lbs
2 channel	33lbs, with option L: 39 lbs
4 channel	35lbs, with option L: 47 lbs



Maintenance and Warranty Section

Maintenance and Warranty

This section describes the SLE900 maintenance procedures and warranty information.

- Maintenance Information.
- Warranty Information.

Maintenance Information

Adjustments and Calibration

To maintain optimum measurement performance, the SLE900 should be calibrated every year. It is recommended that the SLE900 be returned to **dBm** or to an authorized calibration facility. For more information please contact our Customer Service Department at (201) 677-0008.

Repair

The SLE900 should only be serviced by **dBm** service personnel or trained customer maintenance personnel using the **dBm** Service Manual for the SLE900.

For instruments requiring service, either in or out of warranty, contact **dBm** Customer Service Department at (201) 677-0008 for pricing and instructions before returning your instrument. When you call, be sure to have the following information available:

- Model number.
- Serial number.
- Full description of the failure condition.

Note: Model and serial number can be found on the rear of the SLE900 unit.

Equipment Returns

All instruments returned to **dBm** for repair must be shipped prepaid. Instruments that are eligible for in-warranty repair will be returned prepaid to the customer. For all other situations the customer is responsible for all shipping charges. An evaluation fee may be charged for processing units that are found to have no functional or performance defects.

For out of warranty instruments, **dBm** will provide an estimate for the cost of repair. Customer approval of the charges will be required before repairs can be made. For units deemed to be beyond repair, or in situations which the customer declines to authorize repair, an evaluation charge may be assessed by **dBm**.

Warranty Information

All **dBm** products are warranted against defects in material and workmanship for a period of one year from the date of shipment.

dBm will, at its option, repair or replace products that prove to be defective during the warranty period, provided they are returned to **dBm** and provided the preventative maintenance procedures are followed. Repairs necessitated by misuse of the product are not covered by this warranty. No other warranties are expressed or implied, including but not limited to implied warranties of merchantability and fitness for a particular purpose.

dBm is not liable for consequential damages. Please refer to the previous section for contact information and procedures to return the instrument to **dBm**.

D

SLE900 DLL Version 6.907

Description of the SLE900 DLL Application Program Interface Version 6.907

Overview:

The Dynamic Link Library (DLL) has been designed to provide the interface to an application program. This manual documents the commands available to the application programmer. The DLL creates the network connection between the application and the SLE. From that point the SLE is controlled solely by the DLL functions called by a client application. The DLL is a multitasking program designed to run on the Windows operating system. It will maintain the interface with the client application while controlling the SLE. Some of the functionality provided by the DLL is as follows:

1. Connect and Disconnect to the network
2. Obtain both SLE status or local DLL status
3. Convert ASCII data files to SLE compressed file format
4. Download/Delete files to/from SLE flash memory
5. Select/Deselect files to run in Dynamic mode
6. Issue keypad or button commands
7. Update parameter settings in static mode
8. Monitor data point position while running in Dynamic mode

The DLL has been designed to minimize the efforts to a client application, removing many of the details involved with controlling the SLE hardware. This manual assumes the reader is familiar with the capabilities, operation and control of the SLE product.

Linking C Programs with DLL:

There are three files of interest:

SleDll.h	Must be included in source code.
SleDll.dll	Must be installed in target directory.
SleDll.lib	Must be inserted in project builds to obtain DLL exported variables and functions.

DLL Data Types:

Data types used with all structures and SLE functions.

typedef void	VOID;	
typedef char	CHAR;	8 bits signed
typedef short	SHORT;	16 bits signed
typedef long	LONG;	32 bits signed
typedef unsigned char	UCHAR;	8 bits unsigned
typedef unsigned short	USHORT;	16 bits unsigned
typedef unsigned long	ULONG;	32 bits unsigned
typedef double	DOUBLE;	64 bit float

DLL/SLE Error Codes:

#define SLE_NO_ERR	0	No error. Function or command completed normally
#define SLE_OPEN_ERR	1	SLE already open
#define SLE_SOCKET_ERR	2	Unable to find usable WinSock DLL, network communication error
#define SLE_THREAD_ERR	3	Not able to create application timer thread, DLL inoperative
#define SLE_SYSTEM_ERR	4	General programming or operating system error
#define SLE_CLOSE_ERR	5	SLE already closed
#define SLE_CONNECT_ERR	6	Unable to connect to SLE
#define SLE_ALREADY_CON_ERR	7	Already connected, must first disconnect
#define SLE_ALREADY_DISC_ERR	8	Already disconnected, must first connect
#define SLE_SWRITE_ERR	9	Write on network socket operation to SLE failed
#define SLE_SREAD_ERR	10	Read of network socket operation from SLE failed
#define SLE_SPARE1_ERR	11	spare error, not defined
#define SLE_TIMEOUT_ERR	12	DLL timed out waiting for acknowledgement from SLE
#define SLE_SPARE2_ERR	13	spare error, not defined
#define SLE_ARG_ERR	14	Bad passed in argument to DLL function
#define SLE_FILE_ERR	15	DLL not able to open specified file
#define SLE_OP_ERR	16	DLL sent command to SLE properly however, SLE failed to perform operation. This could be for a variety of reasons, no room for file, file too large, SLE failed loading flash, SLE not functioning properly, etc.
#define SLE_FREAD_ERR	17	File read operation failed
#define SLE_FWRITE_ERR	18	File write operation failed
#define SLE_SPARE3_ERR	19	spare error, not defined
#define SLE_FILE_FMT_ERR	20	File format not as expected
#define SLE_FRANGE_ERR	21	File data point is not within expect range

DLL Keypad Definitions:

Many DLL functions execute by mimicking the front panel keypad commands. These defines may be used as arguments to the functions where a key value is required.

#define KEY_NONE	0	
#define KEY_PRESET	1	
#define KEY_INC	2	
#define KEY_DEC	3	
#define KEY_SCROLLUP	4	
#define KEY_SCROLLDOWN	5	
#define KEY_START	6	
#define KEY_RESET	7	
#define KEY_PAUSE	8	
#define KEY_UPDATE	9	
#define KEY_TIME_REF	10	
#define KEY_LOOP	11	
#define KEY_TRIGGER	12	
#define KEY_CHANNEL	13	
#define KEY_MODE	14	
#define KEY_LOCAL	15	
#define KEY_STEP	16	
#define KEY_FACTORY	17	Factory use only
#define KEY_CONFIG	18	
#define KEY_STORE	19	
#define KEY_RECALL	20	
#define KEY_FILE MENU	21	
#define KEY_DISPLAY FILE	22	
#define KEY_SELECT FILE	23	
#define KEY_FREQCENTER	24	
#define KEY_DELAY	25	
#define KEY_FREQ OFFSET	26	
#define KEY ATTN	27	
#define KEY_UPDATE INTERVAL	29	
#define KEY_FREQLO	30	Factory use only
#define KEY_FREQHI	31	Factory use only
#define KEY_NEG	32	
#define KEY_DECIMAL	33	
#define KEY ENTER	34	
#define KEY CLEAR	35	
#define KEY KHZ	36	
#define KEY MHZ	37	
#define KEY ZERO	38	
#define KEY ONE	39	
#define KEY TWO	40	
#define KEY THREE	41	
#define KEY FOUR	42	
#define KEY FIVE	43	
#define KEY SIX	44	
#define KEY SEVEN	45	

#define KEY_EIGHT	46	
#define KEY_NINE	47	
#define KEY_REMOTE	48	

DLL API Function Argument Definitions:

SLEtestpattern(), SLEdownloadfile() function arguments - "Action" argument:

```
#define DNLD_START           0  start download
#define DNLD_STOP           1  stop download
```

SLEcvtSATGENfile() function arguments - "FileType" arguments:

```
#define TYPE_DLY             0    Delay File
#define TYPE_FREQ          1    Frequency File
#define TYPE_ATTN         2    Attenuation File
#define TYPE_WGN          3    Noise File
#define TYPE_RFINPUT      4    RF Input/Output File
#define TYPE_MULTIPATH    7    Fading File
"InFileName" - xxx.dat file, complete path
"OutFileName" - xxx.sle file, complete path
```

DLL API Toggle Key Function Argument Definitions:

Update Clock toggle key Command

```
#define CLK_INT             0  internal clock
#define CLK_EXT             1  external clock
```

Mode toggle key Command

```
#define MODE_STATIC        0  operate in static mode
#define MODE_DYNAMIC     1  operate in dynamic mode
```

Loop toggle key Command

```
#define LOOP_SINGLE        0  single time
#define LOOP_CONTINUOUS    1  continuous
#define LOOP_FWD_REVERSE  2  forward/reverse
```

Trigger toggle key Command

```
#define TRIGGER_INT        0  internal
#define TRIGGER_EXT        1  external
```

Channel toggle key Command

```
#define CHAN1              0
#define CHAN2              1
#define CHAN3              2
#define CHAN4              3
```

TimeRef toggle key Command

```
#define TIMEREF_OFF        0  off
#define TIMEREF_ON         1  on
```

Mode Status Definitions (0= Static, >=1 are all dynamic modes)

```
enum MODE_STATUS
```

```

{
    M_STATIC, M_DYNAMIC, M_READY, M_RUN,
    M_ARMED, M_PAUSE, M_DONE, M_INIT
};

```

SLE ParamCode Definitions:

SLEparam() function arguments - "ParamCode" argument

```

#define PARAM_DELAY                1
#define PARAM_FREQOFFSET           2
#define PARAM_ATTEN                 3
#define PARAM_PHASEOFFSET          4
#define PARAM_FREQUENCY            5
#define PARAM_UPDATEINTERVAL       6
#define PARAM_STEP_DL              15  step delay
#define PARAM_STEP_FO              16  step frequency offset
#define PARAM_STEP_AT              17  step attenuation
#define PARAM_RF_IN                26
#define PARAM_RF_OUT               27
#define PARAM_AWGN_NO              35
#define PARAM_AWGN_ENABLE          36
#define PARAM_AWGN_MODE            38
#define PARAM_AWGN_BR              39
#define PARAM_AWGN_RATIO           40

```

SLEmultipath() function arguments - "ParamCode" argument

```

#define PARAM_MP_TYPE              44
#define PARAM_MP_DOPPLER          45
#define PARAM_MP_DELAY            46
#define PARAM_MP_LOSS             47
#define PARAM_MP_KFACTOR          48
#define PARAM_MP_CORRPATH         49
#define PARAM_MP_CORRVALUE        50
#define PARAM_MP_AOA              51

```

DLL Structure Definitions:

SLE Setup Data

```

default setup values
#define SERVER_IP_ADDR             "192.168.1.106"
#define SERVER_TCP_PORT           5555 (limit range 1025-
                                     32767)
#define SERVER_RESP_TIMEOUT       5

```

This setup information is required by the open command to establish connection to the SLE device.

```

typedef struct
{

```

```

CHAR   SleIpAddr[32];      SLE Server IP Address
USHORT SleTcpPort;         SLE Server Socket Port
USHORT SleTimeout;        SLE Response Timeout in Secs

```

```
} SLE_SETUP;
```

SLE Channel Status Data

This status information may be returned by SLE after connection. All parameters are specified in their base units.

```
typedef struct
```

```

{
    LONG DelayTime;         nsecs
    LONG FreqOffset;        hz
    LONG Attenuation;       db (0-160 represents 0-40 in 1/4 increments)
    LONG PhaseOffset;      degrees (0 to 180)
    LONG CenterFreq;       unused in version 6.0 or higher

```

```
} SLE_CHAN_STATUS;
```

SLE Status Info

This status information may be returned by SLE after connection.

```
typedef struct
```

```

{
    CHAR   SleVersion[8];   Current SLE App software version
    UCHAR  Channel;         Current active channel
    UCHAR  Clock;           UpdateSelect button setting
    UCHAR  Trigger;        TriggerSelect button setting
    UCHAR  Loop;           LoopSelect button setting
    UCHAR  TimeRef;        Time Reference button setting

    UCHAR  Mode;           Current operating mode (see enum
                           MODE_STATUS)
    USHORT DnldFileCnt;    Number of files downloaded in flash
    UCHAR  ActiveChans;    Chans Detected (bit0=ch1, bit1=ch2,
                           bit2=ch3, bit3=ch4)
    UCHAR  Spare;          unused
    SLE_CHAN_STATUS ChParams[4]; Channel parameter values
    LONG   UpdateInterval; 1-1000ms
    LONG   MinFrequencyRange; configuration min base frequency
                           (Mhz)
    LONG   MaxFrequencyRange; configuration max base frequency
                           (Mhz)

```

```
} SLE_STATUS;
```

SLE Global Channel Status Data

This status information may be returned by SLE after connection. All parameters are specified in their base units.

```
typedef struct
```

```

{
    unsigned long RfIn;      Hz
    unsigned long RfOut;     Hz

```

```

short      AwgnNo;           0.01 dBm/Hz increments
long       AwgnBitRate;     Hz
short      AwgnRatio;       0.01 dB increments
short      SigPower;        0.01 dB increments
unsigned char AwgnEnable;   0=off, 1=on
unsigned char AwgnMode;     0=No, 1=EbNo
unsigned char RfOutSlave;   0=not slaved, 1 = slaved
unsigned char RatioCalculated; 0=not calculated, 1=calculated
unsigned char AwgnInRange; 0=not in range,1= in range
unsigned char AwgnLicenseValid; 0=not valid,1= valid
unsigned char FadingLicenseValid; 0=not valid,1= valid
unsigned char Spare[3];

```

```

} SLE_GLOBAL_CHAN_STATUS;

```

SLE Global Status Info

This status information may be returned by SLE after connection.

```

typedef struct
{
    SLE_GLOBAL_CHAN_STATUS ChGlobalParams[4];
    //Channel global parameters values
} SLE_GLOBAL_STATUS;

```

SLE Limits Info

This status information may be returned by SLE after connection.

```

typedef struct
{
    long      MinDelay;           nsec
    long      MaxDelay[4];       nsec
    long      MinFreqOffset;     0.01 Hz increments
    long      MaxFreqOffset;     0.01 Hz increments
    long      MinAtten;          0.25 dB increments
    long      MaxAtten;          0.25 dB increments
    long      MinBitRate;        Hz
    long      MaxBitRate;        Hz
    short     MinRatio;          0.01 dB increments
    short     MaxRatio;          0.01 dB increments
    short     MinDensity[4];     0.01 dBm/Hz
    short     MaxDensity[4];     0.01 dBm/Hz
    unsigned short MinDopp;      0.1 Hz (fading option)
    unsigned short MaxDopp;      0.1 Hz (fading option)
    unsigned short MinDly;       nsec (fading option)
    unsigned short MaxDly;       nsec (fading option)
    unsigned short MinLoss;      0.1 dB increments (fading option)
    unsigned short MaxLoss;      0.1 dB increments (fading option)
    unsigned short RfInHigh[4];  MHz
    unsigned short RfInLow[4];   MHz
    unsigned short RfOutLow[4];  MHz
    unsigned short RfOutHigh[4]; MHz
} SLE_LIMITS;

```

SLE Fading Path Status Data

This status information may be returned by SLE after connection. All parameters are specified in their base units.

```
typedef struct
{
    unsigned long    MPDopp;           // 0-10kHz, 1 Hz increments
    unsigned short  MPDelay;          // 0-20 usec, 1 nsec increments
    unsigned short  MPLoss;           // 0-30 dB, 0.1 dB increments
    unsigned char   MPType;           // 0=off,1=CW,2=RICE,3=RAY
    char            MPKfact;          // 20 to -10 dB, 1 dB increments,
                                        // valid for Ricean only
    unsigned char   MPCorrval;        // 0-100%, 1% increments
    unsigned char   MPCorrpath;      // 1-6
    unsigned char   MPAoa;           // 0-90 degrees,
                                        // valid for Ricean only

    unsigned char   spare[7];
} SLE_FADING;
```

SLE Fading Channel Status Data

This status information may be returned by SLE after connection. All parameters are specified in their base units.

```
typedef struct
{
    SLE_FADING Fading[6];           // 6 paths per channel
} SLE_FADING_CHAN_STATUS;
```

SLE DLL Status Info

This status information is returned by the DLL, connection to SLE is not required.

Note: Once DLL status is read, all three error fields are reset to zero to avoid reading errors multiple times. Also, when StaticModeState reaches DONE, DLL resets it to IDLE.

```
typedef struct
{
    CHAR    DllVersion[8];           Current DLL software version
    UCHAR   LastError;                Last command error
    UCHAR   TimerThreadError;        Error results from DLL timer task
    UCHAR   StaticModeState;         Static Delay command operating
                                        state (0=IDLE, 1=BUSY,
                                        2=DONE)
    UCHAR   StaticModeError;         Error results from DLL Static
                                        Delay task
} SLE_DLL_STATUS;
```

SLE Download Status Data

This status information is returned by the SLE during a download operation.

typedef struct

```
{
    UCHAR DownloadState;          0=IDLE, 1=BUSY, 2=DONE
    UCHAR PercentComplete;      Download Percent Complete
    UCHAR LastError;            Download Error (0=no error)
    UCHAR Spare;                keep word aligned
} SLE_DOWNLOAD_STATUS;
```

SLE Position Status Data

This status information is returned by the SLE during a SLEposition poll.

typedef struct

```
{
    ULONG PointCnt;              HW position of point in file
    USHORT Mode;                 mode to detect PAUSE or DONE
    USHORT ElapsedTime;         elapsed time
} SLE_POSITION;
```

SLE Position32 Status Data

This status information is returned by the SLE during a SLEposition32 poll.
(elapsed time has been lengthened from SLE_POSITION)

typedef struct

```
{
    ULONG PointCnt;              HW position of point in file
    USHORT Mode;                 mode to detect PAUSE or DONE
    ULONG ElapsedTime;          elapsed time
} SLE_POSITION_32;
```

SLE File Preamble**typedef struct**

```
{
    unsigned char Type;          0=FADE_TYPE_OFF,
                                   1=FADE_TYPE_CW,
                                   2=FADE_TYPE_RICE,
                                   3=FADE_TYPE_RAY
    unsigned char Corrpath;      correlation path (1 to 6)
    unsigned char Corrval;      correlation value (0 to 100%)
    char Kfactor;               Ricean K-factor (-10 to 20)
} ONE_TIME_INIT;
```

ONE_TIME_INIT Type values

```
#define FADE_TYPE_OFF          0
#define FADE_TYPE_CW          1
#define FADE_TYPE_RICE       2
```

```
#define FADE_TYPE_RAY          3
```

```
typedef struct
{
    unsigned short Doppler;
    unsigned short Delay;
    unsigned short Loss;
    unsigned short Aoa;
} TIME_INCREMENT;
```

File header information returned by the SLE due to a SLEpreamble command

```
typedef struct
{
    CHAR          FileName[16];  file name (DLYxxxxxxx.dat)
                                (not case sensitive)
    LONG          InitValue;     init value in ns
                                (for Fading, # of paths on)
    ULONG         NumSamples;    number of sample points
                                (up to 1.8 million)
    UCHAR         Continuous;    Continuous File
    UCHAR         Type;          0=TYPE_DLY,
                                1=TYPE_FREQ,
                                2=TYPE_ATTEN,
                                3=TYPE_WGN,
                                4=TYPE_RFIN,
                                7=TYPE_MULTIPATH
    USHORT        Cksum;         Checksum of data part of file
    UCHAR         SpareChar[2];
    ONE_TIME_INIT OneTime[6];   Valid for fading file only
    TIME_INCREMENT InitValues[6]; Valid for fading file only
    CHAR          Spare[26];     pad out structure to 128 bytes
} SLE_PREAMBLE;
```

SLE Upload Status Data

This status information is returned by the SLE during a SLEupload.

```
typedef struct
{
    UCHAR UploadState;          0=IDLE, 1=BUSY, 2=DONE
    UCHAR PercentComplete;     Download Percent Complete
    UCHAR LastError;           Download Error (0=no error)
    UCHAR Spare;
} SLE_UPLOAD_STATUS;
```

SLE Upload

This structure contains upload file information returned by the SLE during an SLE upload.

```
typedef struct
{
    LONG          NumberOfPoints; # of points: continue with last data if needed
    DOUBLE        MinX;
    DOUBLE        MaxX;
    DOUBLE        MinY;
    DOUBLE        MaxY;
    DOUBLE*       PointBuffer;   Pointer to allocated point buffer
}
```

```

    SHORT    Continuous;    Continuous File
} SLE_UPLOAD;

```

DLL Build and Export Definitions:

Below are definitions required for building the DLL and to be able to link DLL with a client application.

```

#ifdef __cplusplus
#define SLEDLL_FUNC_TYPE "C"    built in C++, force to reference
                                as C
#else
#define SLEDLL_FUNC_TYPE        built in C, leave reference as C
#endif

#ifdef SLEDLL_EXPORTS           Set by developer only when
                                Creating DLL library
#define SLEDLL_API extern SLEDLL_FUNC_TYPE
__declspec(dllexport)
#else
#define SLEDLL_API extern SLEDLL_FUNC_TYPE
__declspec(dllimport)
#endif

```

DLL Variables:

The following variables are exported by the DLL to be accessible by a client application.

```

DLL version may also be obtained from DLL status structure.
SLEDLL_API CHAR SleDLLversion[8];
Table of text strings associated with error codes.
SLEDLL_API CHAR *SleErrMsg[];

```

DLL Functions:

The following functions are exported by the DLL to be accessible by a client application.

```

SLEDLL_API SHORT SLEopen( SLE_SETUP *Setup );
SLEDLL_API SHORT SLEclose( VOID );
SLEDLL_API SHORT SLEconnect( VOID );
SLEDLL_API SHORT SLEdisconnect( VOID );
SLEDLL_API SHORT SLEstatus( SLE_STATUS *Status );
SLEDLL_API SHORT SLEdllstatus( SLE_DLL_STATUS *DllStatus );
SLEDLL_API SHORT SLEtestpattern( USHORT Action );
SLEDLL_API SHORT SLEcnvtSATGENfile( USHORT FileType, CHAR
    *InFileName, CHAR *OutFileName );
SLEDLL_API SHORT SLEdownload( CHAR *FileName, USHORT Action);
SLEDLL_API SHORT SLEdnldstatus( SLE_DOWNLOAD_STATUS
    *DnldStatus );
SLEDLL_API SHORT SLEdeletefile( CHAR AllFiles, CHAR *FileName );

```

```

SLEDLL_API SHORT SLElistfile( USHORT FileIndex, CHAR *FileBuf );
SLEDLL_API SHORT SLEgetchans( USHORT FileIndex, USHORT
                                *FileChans );
SLEDLL_API SHORT SLEsetchans( USHORT FileIndex, USHORT
                                FileChans );
SLEDLL_API SHORT SLEkeypad( USHORT NumKeys, UCHAR
                                *KeyCodes );
SLEDLL_API SHORT SLEparam( UCHAR ParamCode, UCHAR Chan,
                                LONG Value );
SLEDLL_API SHORT SLEtoggle ( UCHAR Key, UCHAR Value );
SLEDLL_API SHORT SLEposition(UCHAR Timer, SLE_POSITION
                                *SlePosition );
SLEDLL_API SHORT SLEupload( USHORT FileIndex, SLE_UPLOAD
                                *SleUpload );
SLEDLL_API SHORT SLEupldpreamble( USHORT FileIndex,
                                SLE_PREAMBLE *SlePreamble );
SLEDLL_API SHORT SLEupldstatus( SLE_UPLOAD_STATUS
                                *UpldStatus );
SLEDLL_API SHORT SLEGlobalstatus( SLE_GLOBAL_STATUS
                                *Status );
SLEDLL_API SHORT SLEMinMaxLimits( SLE_LIMITS *Limits );
SLEDLL_API SHORT SLESetratio( void );
SLEDLL_API SHORT SLEmpfstatus( SLE_FADING_CHAN_STATUS
                                *Status, UCHAR Channel );

```

All DLL functions return an error code. As a general note: Errors identified below are for the most part considered fatal errors. These errors are a result of a lost network connection and require the host program to reconnect. It is suggested to call SLEdisconnect() ignoring errors and then call SLEconnect() to re-establish connection. There should not be a need to close and reopen the interface but it would do no harm.

```

SLE_CONNECT_ERR
SLE_SWRITE_ERR
SLE_SREAD_ERR
SLE_SYSTEM_ERR
SLE_OP_ERR
SLE_TIMEOUT_ERR

```

Detailed Function Descriptions:

DLL function SLEopen:

SHORT SLEopen(SLE_SETUP ***Setup**) – This function opens the interface to the SLE application program and enables the DLL to configure for SLE operations. This must be the first function called. SLE application program sets up to communicate with a host device via Ethernet connection. A timer thread is created by the DLL to monitor the SLE and maintain connected status.

Input Arguments: **Setup** - Address to structure containing setup parameters (See structure definition **SLE_SETUP** for detailed setup parameters required) It is recommended to use the default values for timeout and socket port. IP address must be set to the IP address of the SLE.

Output Argument: Returns Error code.

- **SLE_NO_ERR** – No error. Function completed normally.
- **SLE_OPEN_ERR** – SLE already open
(Remedy- Issue a SLEclose() before attempting to open)
- **SLE_SOCKET_ERR** – Unable to find usable WinSock DLL.
(Remedy- WS2_32.DLL may not exist on the client PC)
- **SLE_THREAD_ERR** – Not able to create application timer thread.
(Remedy- PC lacks available resources, contact dBm service.)
- **SLE_SYSTEM_ERR** – General programming error, in this case, failed to create mutex operating system objects.
(Remedy- PC lacks available resources, contact dBm service.)

DLL function SLEclose:

SHORT **SLEclose(VOID)** – This function closes the interface to the SLE application program. This must always be the last function called. SLE application program will disconnect and disassociate itself with the host application. The timer thread is terminated.

Input Arguments: none

Output Argument: Returns Error code.

- **SLE_NO_ERR** – No error. Function completed normally.
- **SLE_CLOSE_ERR** – SLE already closed
(Remedy- Ignore error.)

DLL function SLEconnect:

SHORT **SLEconnect(VOID)** – This function is called to establish a network connection between the host and SLE. The host must have a valid open interface before connecting to the SLE. If the connection has been broken, new connections may be established without closing and reopening the interface. A successful connection will result in activity on the network. When system is idle, data packets are sent between the SLE and host every two seconds. Network activity may be determined by viewing the LED's on the network card.

Input Arguments: None

Output Argument: Returns Error code.

- **SLE_NO_ERR** – No error. Function completed normally.
- **SLE_SOCKET_ERR** – Unable to create communication socket
(Remedy- PC lacks available resources, contact dBm service.)
- **SLE_CONNECT_ERR** – Unable to connect to SLE
(Remedy- Assure SLE and client specify the same IP address)
- **SLE_ALREADY_CON_ERR** – SLE already connected
(Remedy- Issue a SLEdisconnect() before attempting to connect)
- **SLE_SWRITE_ERR** – Write on network socket operation to SLE failed
(Remedy- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SREAD_ERR** – Read of network socket operation from SLE failed

- (**Remedy-** Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_TIMEOUT_ERR** – DLL timed out waiting for acknowledgement from SLE
(**Remedy-** Assure SLE is in Remote mode, not Local. Assure network connection. Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SYSTEM_ERR** – General programming error, in this case, system network select function failed.
(**Remedy-** Error should not occur. Contact dBm service.)

DLL function SLEdisconnect:

SHORT **SLEdisconnect**(VOID) – This function terminates the network connection between the host and SLE.

Input Arguments: None

Output Argument: Returns Error code.

- **SLE_NO_ERR** – No error. Function completed normally.
- **SLE_ALREADY_DISC_ERR** – SLE is already disconnected.
(**Remedy-** Ignore error.)

DLL function SLEstatus:

SHORT **SLEstatus**(SLE_STATUS ***Status**) – This function request status information from the SLE. See structure definition **SLE_STATUS** for supported status information. SLE must be connected to the client. On return, **Status** structure is updated with the latest status.

Input Arguments: **Status** - Address of **SLE_STATUS** structure

Output Argument: Returns Error code.

- **SLE_NO_ERR** – No error. Function completed normally.
- **SLE_CONNECT_ERR** – Lost connection between client and SLE
(**Remedy-** Try reconnecting and re-issue command)
- **SLE_WRITE_ERR** – Write on network socket operation to SLE failed
(**Remedy-** Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_READ_ERR** – Read of network socket operation from SLE failed
(**Remedy-** Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SYSTEM_ERR** – General programming error, in this case, system network select function failed.
(**Remedy-** Error should not occur. Contact dBm service.)
- **SLE_OP_ERR** – DLL sent command properly however, SLE failed to perform operation. SLE could not return status.
(**Remedy-** SLE returned a NAK. Contact dBm service.)
- **SLE_TIMEOUT_ERR** – DLL timed out waiting for acknowledgement from SLE
(**Remedy-** Assure SLE is in Remote mode, not Local. Assure network connection. Lost connection, try to reconnect, if problem persists, contact dBm service.)

DLL function SLEGlobalstatus:

SHORT **SLEGlobalstatus**(SLE_GLOBAL_STATUS ***Status**) - This function requests global status information from the SLE. See structure definition **SLE_GLOBAL_STATUS** for supported global status information. SLE must be connected to the client. On return, **Status** structure is updated with the latest global status.

Input Arguments: **Status** - Address of **SLE_GLOBAL_STATUS** structure

Output Argument: Returns Error code.

- **SLE_NO_ERR** – No error. Function completed normally.
- **SLE_CONNECT_ERR** – Lost connection between client and SLE
(**Remedy**- Try reconnecting and re-issue command)
- **SLE_SWRITE_ERR** – Write on network socket operation to SLE failed
(**Remedy**- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SREAD_ERR** – Read of network socket operation from SLE failed
(**Remedy**- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SYSTEM_ERR** – General programming error, in this case, system network select function failed.
(**Remedy**- Error should not occur. Contact dBm service.)
- **SLE_OP_ERR** – DLL sent command properly however, SLE failed to perform operation. SLE could not return status.
(**Remedy**- SLE returned a NAK. Contact dBm service.)
- **SLE_TIMEOUT_ERR** – DLL timed out waiting for acknowledgement from SLE
(**Remedy**- Assure SLE is in Remote mode, not Local. Assure network connection. Lost connection, try to reconnect, if problem persists, contact dBm service.)

DLL function SLEMinMaxLimits:

SHORT **SLEMinMaxLimits**(SLE_LIMITS ***Limits**); - This function requests parameter limits (minimum and maximum) information from the SLE. See structure definition **SLE_LIMITS** for supported limits information. SLE must be connected to the client. On return, **Limits** structure is updated with the latest limits. Limits are factory set, therefore **SLEMinMaxLimits** need only be called once upon connection.

Input Arguments: **Limits** - Address of **SLEMinMaxLimits** structure

Output Argument: Returns Error code.

- **SLE_NO_ERR** – No error. Function completed normally.
- **SLE_CONNECT_ERR** – Lost connection between client and SLE
(**Remedy**- Try reconnecting and re-issue command)
- **SLE_SWRITE_ERR** – Write on network socket operation to SLE failed

- (**Remedy-** Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SREAD_ERR** – Read of network socket operation from SLE failed
(**Remedy-** Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SYSTEM_ERR** – General programming error, in this case, system network select function failed.
(**Remedy-** Error should not occur. Contact dBm service.)
- **SLE_OP_ERR** – DLL sent command properly however, SLE failed to perform operation. SLE could not return status.
(**Remedy-** SLE returned a NAK. Contact dBm service.)
- **SLE_TIMEOUT_ERR** – DLL timed out waiting for acknowledgement from SLE
(**Remedy-** Assure SLE is in Remote mode, not Local. Assure network connection. Lost connection, try to reconnect, if problem persists, contact dBm service.)

DLL function SLEmpfstatus:

SHORT **SLEmpfstatus**(**SLE_FADING_CHAN_STATUS** ***Status**, **UCHAR Channel**); - This function requests fading status information from the SLE. See structure definition **SLE_FADING_CHAN_STATUS** for supported global status information. SLE must be connected to the client. On return, **Status** structure is updated with the latest fading status.

Input Argument: **Status** - Address of **SLE_FADING_CHAN_STATUS** structure

Input Argument: **Channel** – Channel of fading status being requested

Output Argument: Returns Error code.

- **SLE_NO_ERR** – No error. Function completed normally.
- **SLE_CONNECT_ERR** – Lost connection between client and SLE
(**Remedy-** Try reconnecting and re-issue command)
- **SLE_SWRITE_ERR** – Write on network socket operation to SLE failed
(**Remedy-** Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SREAD_ERR** – Read of network socket operation from SLE failed
(**Remedy-** Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SYSTEM_ERR** – General programming error, in this case, system network select function failed.
(**Remedy-** Error should not occur. Contact dBm service.)
- **SLE_OP_ERR** – DLL sent command properly however, SLE failed to perform operation. SLE could not return status.
(**Remedy-** SLE returned a NAK. Contact dBm service.)
- **SLE_TIMEOUT_ERR** – DLL timed out waiting for acknowledgement from SLE
(**Remedy-** Assure SLE is in Remote mode, not Local. Assure network connection. Lost connection, try to reconnect, if problem persists, contact dBm service.)

DLL function SLESetratio:

SHORT SLESetratio(VOID) – This function is equivalent to pressing the “Set Ratio” button on the SLE. Valid only when the noise mode is set to EbNo.

Input Arguments: none

Output Argument: Returns Error code.

- **SLE_NO_ERR** – No error. Function completed normally.
- **SLE_CONNECT_ERR** – Lost connection between client and SLE
(Remedy- Try reconnecting and re-issue command)
- **SLE_SWRITE_ERR** – Write on network socket operation to SLE failed
(Remedy- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SREAD_ERR** – Read of network socket operation from SLE failed
(Remedy- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SYSTEM_ERR** – General programming error, in this case, system network select function failed.
(Remedy- Error should not occur. Contact dBm service.)
- **SLE_OP_ERR** – DLL sent command properly however, SLE failed to perform operation. SLE could not return status.
(Remedy- SLE returned a NAK. Contact dBm service.)
- **SLE_TIMEOUT_ERR** – DLL timed out waiting for acknowledgement from SLE
(Remedy- Assure SLE is in Remote mode, not Local. Assure network connection. Lost connection, try to reconnect, if problem persists, contact dBm service.)

DLL function SLEdllstatus:

SHORT SLEdllstatus(SLE_DLL_STATUS *DllStatus) – This function request status information from the DLL. See structure definition **SLE_DLL_STATUS** for supported status information. Unknown to the client application, the DLL is managing its own group of tasks. The DLL occasionally spawns tasks to perform SLE operations so that it may maintain the interface with the client. The DLL status contains the status of the spawned tasks when they exist. For example, if a Delay parameter setting is changed in static mode the DLL starts a static delay task. Since this particular command causes the SLE hardware to run exclusively for as much as 35 seconds, the task is required to maintain the network connection and to monitor for the error response from the hardware when it completes. The client may request the DLL status and monitor the **StaticModeState** and **StaticModeError** fields for completion. Another example is the timer task. When the SLE is idle (not receiving commands), the timer task is sending an “I’m Alive” message to the SLE every 2 seconds. The client program may monitor the **TimerThreadError** field to know the state of the network connection. On return, **DllStatus** structure is updated with the latest DLL status.

Input Arguments: **DllStatus** - Address of **SLE_DLL_STATUS** structure

Output Argument: Returns Error code.

- **SLE_NO_ERR** – No error. Function completed normally.

DLL function SLEtestpattern:

SHORT **SLEtestpattern**(USHORT **Action**) – This function downloads an ASCII test pattern to the SLE. This function was created strictly for testing the Ethernet interface during program development. SLE does not do anything with the data except output it through its debug serial port if the serial port is enabled. This function is not recommended to exist in a client application.

DLL function SLEcvtSATGENfile:

SHORT **SLEcvtSATGENfile**(USHORT **FileType**, CHAR ***InFileName**, CHAR ***OutFileName**)

This function converts a SATGEN “.DAT” data file to a “.SLE” formatted file. The conversion process creates a preamble structure in the beginning of the file followed by an end of file marker, the point data and another end of file marker. The first end of file marker is used when the file is played back in the reverse direction. The point data is converted from absolute coordinates to relative offsets to the next point. This conversion reduces the format size, thus allowing for more files to fit in the SLE flash memory. Relative points are verified to not exceed file limits. The preamble structure contains 128 reserved bytes of the following format:

typedef struct

```

{
    CHAR                FileName[16];  file name
                                (ex. DLYxxxxxxx.dat,
                                (not case sensitive)
    LONG                InitValue;    init value in ns
                                (for Fading, # of paths on)
    ULONG               NumSamples;   number of sample points
                                (up to 1.8 million)
    UCHAR               Continuous;   Continuous File
    UCHAR               Type;         0=TYPE_DLY,
                                1=TYPE_FREQ,
                                2=TYPE_ATTN,
                                3=TYPE_WGN,
                                4=TYPE_RFIN,
                                7=TYPE_MULTIPATH
    USHORT              Cksum;        Checksum of data
                                part of file
    UCHAR               SpareChar[2];
    ONE_TIME_INIT      OneTime[6];    Valid for fading file only
    TIME_INCREMENT   InitValues[6]; Valid for fading file only
    CHAR               Spare[26];    pad out structure to 128 bytes
} SLE_PREAMBLE;

```

The Preamble is created and inserted by the DLL. All unused bytes are set to zero. Application programs work strictly with raw SATGEN data files, not “.SLE” files.

Units for the point data varies depending on the file type:

TYPE_DLY- Delay files contain 16 bit data points with range +- 32767 ns

End of File value is 8000hex;

TYPE_FRQ- Frequency files contain 16 bit data points with range +- 32767 hz

End of File value is 8000hex;
 TYPE_ATN-Attenuation files contain 8 bit data points with range 0-160(.25 db)
 End of File value is FFhex;
 TYPE_WGN- Noise files contain 16 bit data points with range -150 to -80 dBm/Hz
 End of File value is 8000hex;
 TYPE_RFIN- RF In/Out files contain 16 bit data points with range +- 32767 ns
 End of File value is 8000hex;
 TYPE_MULTIPATH- Fading files contain 16 bit data points (parameter dependent)
 End of File value is FFFFhex;

SLEcvtSATGENfile Function Arguments:

Input Argument: **FileType** – TYPE_DLY, TYPE_FREQ, TYPE_ATTEN,
 TYPE_WGN, TYPE_RFIN, or
 TYPE_MULTIPATH

Input Argument: **InFileName** – Pointer to ASCII string containing full path of
 input .dat file.

Input Argument: **OutFileName** – Pointer to ASCII string containing full path of
 output .sle file.

Output Argument: Returns Error code.

- **SLE_NO_ERR** – No error. Function completed normally.
- **SLE_FILE_ERR** – DLL not able to open input or output file
(Remedy- Verify file name and path. Check file permissions.)
- **SLE_FREAD_ERR** – Input file read operation failed
(Remedy- Check file permissions and file format.)
- **SLE_FWRITE_ERR** – Output file write operation failed
(Remedy- Check file permissions and file format.)
- **SLE_SYSTEM_ERR** – General programming error, in this case, system
 file function failed.
(Remedy- Error should not occur. Contact dBm service.)
- **SLE_FRANGE_ERR** – Point data exceeds the expected value. Original
 data has not been created properly.
(Remedy- Fix the data in the original .DAT file.)

DLL function SLEdownload:

SHORT SLEdownload(CHAR *FileName, USHORT Action) – This function
 downloads a SATGEN (.DAT) file that has been converted to SLE format
 (.SLE) into the flash memory of the SLE. “.SLE” files are SATGEN files that
 have been converted from fixed point to relative offsets to the next point.
 “.SLE” files also contain a definition preamble structure in a format known by
 the SLE. The DLL first sends the file preamble packet to SLE. SLE determines
 if room exists to accept the download and responds with an ACK or NAK. If the
 DLL receives an ACK response, the download continues by sending fixed
 length packets 8KBytes in length to the SLE until complete. The SLE restrains
 the DLL from sending data while writing packets to flash on 64 Kbyte
 boundaries. A NAK response from the SLE at any time causes the DLL to

terminate the download. Also, the download can be aborted by sending the download command with the argument **DNLD_STOP**.

Input Arguments: **Filename** – Pointer to ASCII string containing download file name. Valid file names must start with “DLY”, “FRQ”, “ATN”, “WGN”, “RFF”, or “MPF” and end with “.SLE” extension. Valid file names must not exceed 14 characters in length. File names are not case sensitive. Filename argument contains the complete path followed by the 14 character file name. The DLL does not error check file names before downloading. The application must assure correct file format.

Input Arguments: **Action** - **DNLD_START** to start download. **DNLD_STOP** to abort download.

Output Argument: Returns Error code.

- **SLE_NO_ERR** – No error. Function completed normally.
- **SLE_CONNECT_ERR** – Lost connection between client and SLE
(Remedy- Try reconnecting and re-issue command)
- **SLE_THREAD_ERR** – Not able to create DLL download thread
(Remedy- PC lacks available resources, contact dBm service.)
- **SLE_FILE_ERR** – DLL not able to open specified file
(Remedy- Verify file name and path. Check file permissions.)
- **SLE_FREAD_ERR** – File read operation failed
(Remedy- Check file permissions and file format.)
- **SLE_SWRITE_ERR** – Write on network socket operation to SLE failed
(Remedy- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SREAD_ERR** – Read of network socket operation from SLE failed
(Remedy- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SYSTEM_ERR** – General programming error, in this case, system network select function failed.
(Remedy- Error should not occur. Contact dBm service.)
- **SLE_OP_ERR** – DLL sent file properly however, SLE failed to complete operation. SLE could not accept download.
(Remedy- SLE returned a NAK. Try download again, if error does not clear, contact dBm service. Assure SLE flash is not full.)
- **SLE_TIMEOUT_ERR** – DLL timed out waiting for acknowledgement from SLE
(Remedy- System select function timed out waiting for ACK/NAK response. Try reconnecting and execute download again, if error does not clear, contact dBm service.)

DLL function SLEdnldstatus:

SHORT SLEdnldstatus(SLE_DOWNLOAD_STATUS *DnldStatus) – This function request status information for a download in progress. See structure definition **SLE_DOWNLOAD_STATUS** for supported status information. SLE must be connected to the client. On return, **DnldStatus** structure is updated with the latest status.

Input Arguments: **DnldStatus** - Address of **SLE_DOWNLOAD_STATUS** structure

Output Argument: Returns Error code.

- **SLE_NO_ERR** – No error. Function completed normally.
- **SLE_CONNECT_ERR** – Lost connection between client and SLE
(Remedy- Try reconnecting and re-issue command)
- **SLE_SWRITE_ERR** – Write on network socket operation to SLE failed
(Remedy- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SREAD_ERR** – Read of network socket operation from SLE failed
(Remedy- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SYSTEM_ERR** – General programming error, in this case, system network select function failed.
(Remedy- Error should not occur. Contact dBm service.)
- **SLE_OP_ERR** – DLL sent command properly however, SLE failed to perform operation. SLE could not return status.
(Remedy- SLE returned a NAK. Contact dBm service.)
- **SLE_TIMEOUT_ERR** – DLL timed out waiting for acknowledgement from SLE
(Remedy- Assure SLE is in Remote mode, not Local. Assure network connection. Lost connection, try to reconnect, if problem persists, contact dBm service.)

DLL function SLEdeletefile:

SHORT **SLEdeletefile**(CHAR **AllFiles**, CHAR ***FileName**) – This function causes the SLE to remove files from its flash memory. This is the mechanism to make room for more file downloads.

Input Arguments: **AllFiles** – 1 = delete all files in flash, 0=delete file specified by second argument.

Input Arguments: **FileName** – Pointer to ASCII string containing file name to delete. Valid file names must start with “DLY”, “FRQ”, “ATN, or “WGN” and end with “.DAT” extension. Valid file names must not exceed 14 characters in length. File names are not case sensitive. This argument contains just the file name, no path.

Output Argument: Returns Error code.

- **SLE_NO_ERR** – No error. Function completed normally.
- **SLE_CONNECT_ERR** – Lost connection between client and SLE
(Remedy- Try reconnecting and re-issue command)
- **SLE_SWRITE_ERR** – Write on network socket operation to SLE failed
(Remedy- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SREAD_ERR** – Read of network socket operation from SLE failed
(Remedy- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SYSTEM_ERR** – General programming error, in this case, system network select function failed.
(Remedy- Error should not occur. Contact dBm service.)
- **SLE_OP_ERR** – DLL sent command properly however, SLE failed to perform operation. SLE could not perform file delete.

- (Remedy- SLE returned a NAK. Verify file exists in SLE flash memory.)
- **SLE_TIMEOUT_ERR** – DLL timed out waiting for acknowledgement from SLE
(Remedy- System select function timed out waiting for ACK/NAK response. Try reconnecting and execute file delete command again, if error does not clear, contact dBm service.)

DLL function SLElistfile:

SHORT **SLElistfile**(USHORT **FileIndex**, CHAR ***FileBuf**) – This function causes the SLE to return the name of the file loaded in flash memory associated with a file index.

The SLE maintains a count and order of files downloaded. Client may read the “**DnldFileCnt**” variable of **SLE_STATUS** to know how many filenames to request.

Any time a file is added to SLE flash or deleted from flash the file indexes will change. For any change of files in flash this function must be called to obtain the indexes for all files. The client uses the returned file indexes as arguments to the **SLEsetchans** or **SLEgetchans** functions.

Input Argument: **FileIndex**– File index position, this is a index maintained by the SLE. The SLE will use this value as an index into the SLE directory table.

Input Argument: **FileBuf** - Pointer to buffer for DLL to store found filename. Buffer must be a minimum of 16 characters in length. If no file exists for the specified **FileBuf** , DLL will return a filename string of size 0. The filename returned by this function has no path or extension associated with it. A downloaded file of “c:\filedir\DLYfile1.sle” will be return by this function as “DLYfile1”.

Output Argument: Returns Error code.

- **SLE_NO_ERR** – No error. Function completed normally.
- **SLE_CONNECT_ERR** – Lost connection between client and SLE
(Remedy- Try reconnecting and re-issue command)
- **SLE_SWRITE_ERR** – Write on network socket operation to SLE failed
(Remedy- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SREAD_ERR** – Read of network socket operation from SLE failed
(Remedy- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SYSTEM_ERR** – General programming error, in this case, system network select function failed.
(Remedy- Error should not occur. Contact dBm service.)
- **SLE_OP_ERR** – DLL sent command properly however, SLE failed to perform operation. SLE could not obtain filename.
(Remedy- SLE returned a NAK. **FileIndex** is not a valid value, should never exceed “**DnldFileCnt**” -1.)
- **SLE_TIMEOUT_ERR** – DLL timed out waiting for acknowledgement from SLE
(Remedy- System select function timed out waiting for ACK/NAK response. Try reconnecting and execute listfile command again, if error does not clear, contact dBm service.)

DLL function SLEgetchans:

SHORT **SLEgetchans**(USHORT **FileIndex**, USHORT ***FileChans**) – This function returns a bitmask (lower 4 bits) of enabled/disabled channels associated with a downloaded file. An enabled channel indicates that the file has been selected to execute when running in dynamic mode. A disabled channel is an unselected file.

Input Argument: **FileIndex**– File index position, this is a sequential index count maintained by the SLE. The SLE will use this value to reference the correct file channel status table.

Input Argument: **FileChans** - Pointer to variable to store found file channel status. Bit0=ch1, Bit1=ch2, Bit2=ch3, Bit3=ch4, all other bits are not used.

Output Argument: Returns Error code.

- **SLE_NO_ERR** – No error. Function completed normally.
- **SLE_CONNECT_ERR** – Lost connection between client and SLE
(Remedy- Try reconnecting and re-issue command)
- **SLE_SWRITE_ERR** – Write on network socket operation to SLE failed
(Remedy- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SREAD_ERR** – Read of network socket operation from SLE failed
(Remedy- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SYSTEM_ERR** – General programming error, in this case, system network select function failed.
(Remedy- Error should not occur. Contact dBm service.)
- **SLE_OP_ERR** – DLL sent command properly however, SLE failed to perform operation. SLE could not obtain **FileChans**.
(Remedy- SLE returned a NAK. **FileIndex** is not a valid value, should never exceed “**DnldFileCnt**” -1. Also an error may occur if the SLE found no file associated with the **FileIndex**. Verify command arguments.)
- **SLE_TIMEOUT_ERR** – DLL timed out waiting for acknowledgement from SLE
(Remedy- System select function timed out waiting for ACK/NAK response. Try reconnecting and execute getchans command again, if error does not clear, contact dBm service.)

DLL function SLEsetchans:

SHORT **SLEsetchans**(USHORT **FileIndex**, USHORT **FileChans**) – This function associated files selected to execute in dynamic mode with all 4 channels. The SLE is set to the values specified by the client. The **FileChans** argument must contain a bitmask to reflect selection values in the following bit order: Bit0=ch1, Bit1=ch2, Bit2=ch3, Bit3=ch4, all other bits are not used. A bit value of 1 indicates file is enabled and 0 indicates file is disabled to run.

Input Argument: **FileIndex**– File index position, this is a sequential index count maintained by the SLE. The SLE will use this value to index the channel status table.

Input Argument: **FileChans** – File channel status to update to.

Output Argument: Returns Error code.

- **SLE_NO_ERR** – No error. Function completed normally.
- **SLE_CONNECT_ERR** – Lost connection between client and SLE
(Remedy- Try reconnecting and re-issue command)
- **SLE_SWRITE_ERR** – Write on network socket operation to SLE failed
(Remedy- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SREAD_ERR** – Read of network socket operation from SLE failed
(Remedy- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SYSTEM_ERR** – General programming error, in this case, system network select function failed.
(Remedy- Error should not occur. Contact dBm service.)
- **SLE_OP_ERR** – DLL sent command properly however, SLE failed to perform operation. SLE could not set SLE to **FileChans**.
(Remedy- SLE returned a NAK. **FileIndex** is not a valid value, should never exceed “**DnldFileCnt**” -1. Also an error may occur if the SLE found no file associated with the **FileIndex**. Verify command arguments.)
- **SLE_TIMEOUT_ERR** – DLL timed out waiting for acknowledgement from SLE
(Remedy- System select function timed out waiting for ACK/NAK response. Try reconnecting and execute setchans command again, if error does not clear, contact dBm service.)

DLL function SLEkeypad:

SHORT **SLEkeypad**(USHORT **NumKeys**, UCHAR ***KeyCodes**) – This function causes the SLE to mimic a front panel key operations. Care must be taken to use the same key sequence that would be entered by the operator at the front panel. For example, some keys require a terminating enter key and some do not:

Example1:

```
Perform a Store to Settings #0
UCHAR keys[] = {KEY_STORE, KEY_ZERO, KEY_ENTER};
SLEkeypad ( 3, keys );
```

Example2:

```
Start Dynamic Mode
UCHAR keys[] = {KEY_START};
SLEkeypad ( 1, keys );
```

It is important to note that there are only certain times that the SLE polls for keys and keys are accepted and processed one at a time. Therefore the keypad command will return not knowing if the key sequence was accepted and processed properly by the SLE. Due to the large number of possible keypad sequences, the SLE does not error check the validity of each command. The return status in this case just implies the SLE received a proper formatted keypad command. The contents of the command will execute after the SLE responds to the network. The programmer must be cautious to debug the use of keypad commands thoroughly one at a time before stringing multiple commands. If commands are complex, it is suggested to use separate keypad commands. If the SLE is busy executing a keypad command and a second one is

sent to early, the SLE will reject the second command. The application may require a delay between multiple keypad commands depending on the complexity of the commands.

Input Argument: **NumKeys**– This argument indicates the number of **KeyCodes** in the character buffer to process. Maximum size is 100. SLE buffer size is 100.

Input Argument: **KeyCodes** – This argument is a pointer to a buffer of key codes to process. The SLE will process the key codes in the same manner as if the user entered them at the front panel.

Output Argument: Returns Error code.

- **SLE_NO_ERR** – No error. Function completed normally.
- **SLE_CONNECT_ERR** – Lost connection between client and SLE
(Remedy- Try reconnecting and re-issue command)
- **SLE_SWRITE_ERR** – Write on network socket operation to SLE failed
(Remedy- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SREAD_ERR** – Read of network socket operation from SLE failed
(Remedy- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SYSTEM_ERR** – General programming error, in this case, system network select function failed.
(Remedy- Error should not occur. Contact dBm service.)
- **SLE_OP_ERR** – DLL sent command properly however, SLE failed to perform operation. SLE could not perform keypad operation.
(Remedy- SLE returned a NAK. Verify function arguments.)
- **SLE_TIMEOUT_ERR** – DLL timed out waiting for acknowledgement from SLE
(Remedy- System select function timed out waiting for ACK/NAK response. Try reconnecting and execute keypad command again, if error does not clear, contact dBm service.)

DLL function SLEparam:

This function is for setting parameter values in static mode.

SHORT SLEparam(UCHAR **ParamCode**, UCHAR **Chan**, LONG **Value**) –
This function sets channel parameters. Allowable parameters for **ParamCode** argument are:

Delay:	(PARAM_DELAY) May take as long as 35 secs
Frequency Offset:	(PARAM_FREQOFFSET)
Attenuation:	(PARAM_ATTEN)
Phase Offset:	(PARAM_PHASEOFFSET)
Center Frequency:	(PARAM_FREQUENCY) Only valid for systems with external frequency converters
Update Interval:	(PARAM_UPDATEINTERVAL)
RF Input Frequency:	(PARAM_RF_IN)
RF Output Frequency:	(PARAM_RF_OUT)

Noise Density:	(PARAM_AWGN_NO)
Noise On/Off:	(PARAM_AWGN_ENABLE)
Noise Mode:	(PARAM_AWGN_MODE)
Bit Rate:	(PARAM_AWGN_BR)
Eb/No Ratio:	(PARAM_AWGN_RATIO)

All parameters will update immediately and return an error code except for Delay. The Delay parameter is treated as an exception by the DLL due to the time it takes to execute. Changing the Delay parameter causes the SLE hardware slew to the new value. During this time, the SLE cannot accept network commands. The DLL is running a separate process solely to monitor for the hardware to complete. The DLL maintains the interface and status to the client to avoid forcing the client into a wait loop. The client may periodically check the DLL status error results **StaticModeState** or **StaticModeError** to know when the hardware has completed. The DLL sets a 60 second timeout error code if processing exceeds this time. The SLE verifies parameters to be within a specified range and will not exceed minimum and maximum limits that have been hard coded. Setting the delay parameter also requires the global variable SleDllSpareByte to be set for extended resolution (tenths of a nanosecond).

Example to set delay to 122.3000001 msec

```
SleDllSpareByte = 1;
SLEparam( PARAM_DELAY, CHAN1, 122300000 );
```

The parameter PARAM_UPDATEINTERVAL is restricted to the following values specified in msec:

1, 2, 5, 10, 20, 50, 100, 200, 500, 1000

If any other value other than these ten are used, the SLE will select the closest allowable value.

Example to set Frequency Offset to 1000 Hz for Channel 1:

```
err = SLEparam( PARAM_FREQOFFSET, CHAN1, 1000 );
```

Replaces:

```
UCHAR keys[] = {KEY_FREQ_OFFSET, KEY_ONE, KEY_ZERO,
KEY_ZERO, KEY_ZERO, KEY_ENTER};
err = SLEtoggle( KEY_CHANNEL, CHAN1 );
err = SLEkeypad ( 6, keys );
```

Units for the SLEparam **Value** argument are as follows:

PARAM_DELAY	1 nsec increments
PARAM_FREQOFFSET	0.01 Hz increments
PARAM_ATTEN	0.25 or 0.10 increments
PARAM_PHASEOFFSET	1 degree increments
PARAM_RF_IN	1 Hz increments
PARAM_RF_OUT	1 Hz increments
PARAM_AWGN_NO	0.01 dB/Hz increments
PARAM_AWGN_BR	1 Hz increments
PARAM_AWGN_RATIO	0.01 dB increments

Input Argument: **ParamCode**– This argument is the parameter code associated with parameter.

Input Argument: **Chan**– This argument specifies associated channel

Input Argument: **Value**– This argument specifies the parameter value in base units.

Output Argument: Returns Error code.

- **SLE_NO_ERR** – No error. Function completed normally.
- **SLE_CONNECT_ERR** – Lost connection between client and SLE
(Remedy- Try reconnecting and re-issue command)
- **SLE_SWRITE_ERR** – Write on network socket operation to SLE failed
(Remedy- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SREAD_ERR** – Read of network socket operation from SLE failed
(Remedy- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SYSTEM_ERR** – General programming error, in this case, system network select function failed.
(Remedy- Error should not occur. Contact dBm service.)
- **SLE_OP_ERR** – DLL sent command properly however, SLE failed to perform operation. SLE could not perform param operation.
(Remedy- SLE returned a NAK. Verify function arguments.)
- **SLE_TIMEOUT_ERR** – DLL timed out waiting for acknowledgement from SLE
(Remedy- System select function timed out waiting for ACK/NAK response. Try reconnecting and execute param command again, if error does not clear, contact dBm service.)

DLL function SLEmultipath:

This function is for setting fading parameter values in static mode.

SHORT **SLEmultipath**(UCHAR **ParamCode**, UCHAR **Chan**, UCHAR **Path**, LONG **Value**); – This function sets fading parameters. Allowable parameters are:

Fading Type	(PARAM_MP_TYPE)
Fading Doppler	(PARAM_MP_DOPPLER)
Fading Delay	(PARAM_MP_DELAY)
Fading Loss	(PARAM_MP_LOSS)
Fading Rician K Factor	(PARAM_MP_KFACTOR)
Fading Rician Aoa	(PARAM_MP_AOA)
Fading Correlation Path	(PARAM_MP_CORRPATH)
Fading Correlation Percent	(PARAM_MP_CORRVALUE)

All parameters will update immediately and return an error.

Input Argument: **ParamCode**– This argument is the parameter code associated with parameter.

Input Argument: **Chan**– This argument specifies associated channel

Input Argument: **Path**– This argument specifies associated path

Input Argument: **Value**– This argument specifies the parameter value in base units.

Output Argument: Returns Error code.

- **SLE_NO_ERR** – No error. Function completed normally.
- **SLE_CONNECT_ERR** – Lost connection between client and SLE
(Remedy- Try reconnecting and re-issue command)
- **SLE_SWRITE_ERR** – Write on network socket operation to SLE failed
(Remedy- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SREAD_ERR** – Read of network socket operation from SLE failed
(Remedy- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SYSTEM_ERR** – General programming error, in this case, system network select function failed.
(Remedy- Error should not occur. Contact dBm service.)
- **SLE_OP_ERR** – DLL sent command properly however, SLE failed to perform operation. SLE could not perform param operation.
(Remedy- SLE returned a NAK. Verify function arguments.)
- **SLE_TIMEOUT_ERR** – DLL timed out waiting for acknowledgement from SLE
(Remedy- System select function timed out waiting for ACK/NAK response. Try reconnecting and execute param command again, if error does not clear, contact dBm service.)

DLL function SLEtoggle:

SHORT **SLEtoggle(UCHAR Key, UCHAR Value)** – This is a macro helper function for accessing the front panel keys immediately below the VFD display. These keys are known as toggle keys. They toggle between a fixed set of values. These keys may also be used with the keypad command however their usage would be slightly more difficult.

Input Argument: **Key**– This argument indicates key code to modify. Allowable toggle keys:

```
KEY_UPDATE
KEY_TIME_REF
KEY_LOOP
KEY_TRIGGER
KEY_CHANNEL
KEY_MODE.
```

Input Argument: **Value** – This argument specifies the value to set the key to. (Reference above section labeled “**Toggle Key Defines**” to obtain allowable values.)

Output Argument: Returns **Error** code.

- **SLE_NO_ERR** – No error. Function completed normally.
- **SLE_CONNECT_ERR** – Lost connection between client and SLE
(Remedy- Try reconnecting and re-issue command)
- **SLE_SWRITE_ERR** – Write on network socket operation to SLE failed

- (Remedy- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SREAD_ERR** – Read of network socket operation from SLE failed
(Remedy- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SYSTEM_ERR** – General programming error, in this case, system network select function failed.
(Remedy- Error should not occur. Contact dBm service.)
- **SLE_OP_ERR** – DLL sent command properly however, SLE failed to perform operation. SLE could not perform toggle operation. Either an invalid toggle key was specified or the value is not within the allowable range.
(Remedy- SLE returned a NAK. Verify command arguments.)
- **SLE_TIMEOUT_ERR** – DLL timed out waiting for acknowledgement from SLE
(Remedy- System select function timed out waiting for ACK/NAK response. Try reconnecting and execute toggle command again, if error does not clear, contact dBm service.)

DLL function SLEposition:

SHORT SLEposition(UCHAR Timer, SLE_POSITION *SlePosition) - This function reads the position of the point being replayed when running in dynamic mode. A client application may periodically read this value to synchronize a point cursor on a graphical display.

The position is a running count from the start of replay. Client must take into account the position of the KEY_LOOP toggle key when calculating position. Must consider direction changes due to fwd/rev, continuous mode and number of points in each direction. On return, **SlePosition** structure is updated with the latest point count, mode and elapsed time information from the SLE.

Input Argument: **Timer** – This is a timer disable argument. 1=disable timer on the SLE, 0=re-enable timer on the SLE. The default at SLE power-up is the timer is on. The SLE uses the timer to detect when it has lost a network connection. Normally when the SLE is not running a dynamic file, the DLL is sending an “I’m Alive” message every two seconds. In the case when using the **SLEposition** command since it is typically sent at a one second rate, a returned failure is enough to indicate a network communication problem. The SLEposition command is sent in place of the “I’m Alive” command. Setting the timer to off during the polling of **SLEposition** simply cuts down overhead at the SLE. Once the dynamic file stops running, as the last step, the timer should then be re-enabled.

Input Argument: **SlePosition** – Address where DLL stores positional status data.

Output Argument: Returns **Error** code.

- **SLE_NO_ERR** – No error. Function completed normally.
- **SLE_CONNECT_ERR** – Lost connection between client and SLE
(Remedy- Try reconnecting and re-issue command)
- **SLE_SWRITE_ERR** – Write on network socket operation to SLE failed

- (**Remedy-** Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SREAD_ERR** – Read of network socket operation from SLE failed
(**Remedy-** Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SYSTEM_ERR** – General programming error, in this case, system network select function failed.
(**Remedy-** Error should not occur. Contact dBm service.)
- **SLE_OP_ERR** – DLL sent command properly however, SLE failed to perform operation. SLE could not obtain position value.
(**Remedy-** SLE returned a NAK. Verify command arguments.)
- **SLE_TIMEOUT_ERR** – DLL timed out waiting for acknowledgement from SLE
(**Remedy-** System select function timed out waiting for ACK/NAK response. Try reconnecting and execute position command again, if error does not clear, contact dBm service.)

DLL function SLEupload:

SHORT SLEupload(USHORT FileIndex, SLE_UPLOAD *SleUpload) – This function uploads the point data of file resident in flash on the SLE into a client allocated buffer. During the upload process the SLE relative file is converted to an absolute file format that is accessible by the client application. (Effectively converting back to the original .DAT file format). File uploads packet sizes are fixed at 1456 bytes. The upload process performs all conversions of the data from the SLE resident interleaved format. A NAK response from the SLE at any time causes the DLL to terminate the upload.

Input Argument: **FileIndex**– File index position, this is a sequential index count maintained by the SLE. The SLE will use this value to index the file table.

Input Arguments: **SleUpload** – Pointer to the structure SLE_UPLOAD. Address where DLL stores uploaded file point data.

Output Argument: Returns **Error** code.

- **SLE_NO_ERR** – No error. Function completed normally.
- **SLE_CONNECT_ERR** – Lost connection between client and SLE
(**Remedy-** Try reconnecting and re-issue command)
- **SLE_THREAD_ERR** – Not able to create DLL upload thread
(**Remedy-** PC lacks available resources, contact dBm service.)
- **SLE_FILE_ERR** – DLL not able to open specified file
(**Remedy-** Verify file name and path. Check file permissions.)
- **SLE_FREAD_ERR** – File read operation failed
(**Remedy-** Check file permissions and file format.)
- **SLE_SWRITE_ERR** – Write on network socket operation to SLE failed
(**Remedy-** Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SREAD_ERR** – Read of network socket operation from SLE failed
(**Remedy-** Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SYSTEM_ERR** – General programming error, in this case, system network select function failed.
(**Remedy-** Error should not occur. Contact dBm service.)

- **SLE_OP_ERR** – DLL sent command properly however, SLE failed to complete upload operation.
(Remedy- SLE returned a NAK. Try upload again, if error does not clear, contact dBm service.)
- **SLE_TIMEOUT_ERR** – DLL timed out waiting for acknowledgement from SLE
(Remedy- System select function timed out waiting for ACK/NAK response. Try reconnecting and execute upload again, if error does not clear, contact dBm service.)

DLL function SLEupldpreamble:

SHORT **SLEupldpreamble**(USHORT **FileIndex**, SLE_PREAMBLE ***SlePreamble**) - This function request the preamble information for a specified file on resident on the SLE. See structure definition **SLE_PREAMBLE** for detailed member definitions. SLE must be connected to the client. On return, **SlePreamble** structure is updated with the latest preamble information. The client program may issue this command before an upload operation to obtain the number of samples in order to calculate the size of the sample buffer to allocate.

Input Argument: **FileIndex**– File index position, this is a sequential index count maintained by the SLE. The SLE will use this value to index the file table.

Input Arguments: **SlePreamble** – Pointer to the structure SLE_SLE_PREAMBLE, address where DLL stores file preamble information.

Output Argument: Returns **Error** code.

- **SLE_NO_ERR** – No error. Function completed normally.
- **SLE_CONNECT_ERR** – Lost connection between client and SLE
(Remedy- Try reconnecting and re-issue command)
- **SLE_SWRITE_ERR** – Write on network socket operation to SLE failed
(Remedy- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SREAD_ERR** – Read of network socket operation from SLE failed
(Remedy- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SYSTEM_ERR** – General programming error, in this case, system network select function failed.
(Remedy- Error should not occur. Contact dBm service.)
- **SLE_OP_ERR** – DLL sent command properly however, SLE failed to return preamble information.
(Remedy- SLE returned a NAK. Try command again, if error does not clear, contact dBm service.)
- **SLE_TIMEOUT_ERR** – DLL timed out waiting for acknowledgement from SLE
(Remedy- System select function timed out waiting for ACK/NAK response. Try reconnecting and execute command again, if error does not clear, contact dBm service.)

DLL function SLEupldstatus:

SHORT **SLEupldstatus**(SLE_UPLOAD_STATUS ***UpldStatus**) – This function request status information for an upload operation that is in progress. See structure definition **SLE_UPLOAD_STATUS** for supported status information. SLE must be connected to the client. On return, **UpldStatus** structure is updated with the latest status. Client program may issue this command to monitor for either completion of the upload or an error condition.

Input Arguments: **UpldStatus** - Address of **SLE_UPLOAD_STATUS** structure

Output Argument: Returns **Error** code.

- **SLE_NO_ERR** – No error. Function completed normally.
- **SLE_CONNECT_ERR** – Lost connection between client and SLE
(**Remedy**- Try reconnecting and re-issue command)
- **SLE_SWRITE_ERR** – Write on network socket operation to SLE failed
(**Remedy**- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SREAD_ERR** – Read of network socket operation from SLE failed
(**Remedy**- Lost connection, try to reconnect, if problem persists, contact dBm service.)
- **SLE_SYSTEM_ERR** – General programming error, in this case, system network select function failed.
(**Remedy**- Error should not occur. Contact dBm service.)
- **SLE_OP_ERR** – DLL sent command properly however, SLE failed to perform operation. SLE could not return status.
(**Remedy**- SLE returned a NAK. Contact dBm service.)
- **SLE_TIMEOUT_ERR** – DLL timed out waiting for acknowledgement from SLE
(**Remedy**- Assure SLE is in Remote mode, not Local. Assure network connection. Lost connection, try to reconnect, if problem persists, contact dBm service.)

C Programming Examples to Access DLL:

Below are typical operating scenarios.

(Note: All DLL commands return an error code that should be checked, however, for the purposes of this sample code most error checking has been omitted to keep the code illustration clear.)

Open Interface, Establish Connection and Read Current Status:

```
#include "SleDLL.h"

SLE_SETUP SleSetup;
SLE_STATUS SleStatus;
SLE_GLOBAL_STATUS GlobalStatus;
SLE_LIMITS Limits;
SLE_DOWNLOAD_STATUS DnldStatus;
SLE_POSITION SlePositionStatus;
SLE_UPLOAD SleUpload;
SLE_PREAMBLE SlePreamble;
SLE_UPLOAD_STATUS UpldStatus;
SLE_UPLOAD_STATUS SleUpldStatus;
SLE_DLL_STATUS SleDllStatus ;
SHORT err;
USHORT index;
USHORT FileIndex;

// Open interface to DLL
strcpy( SleSetup.SleIpAddr, "198.12.1.120" );          // IP address that SLE is set to
SleSetup.SleTcpPort = SERVER_TCP_PORT;
SleSetup.SleTimeout = SERVER_RESP_TIMEOUT;// secs
err = SLEopen( &SleSetup );

if ( err != SLE_NO_ERR)
{
    /* handle error */
}
else
{
    err = SLEconnect();
    if ( err != SLE_NO_ERR)
    {
        /* handle error */
    }
    else
    {
        err = SLEstatus( &SleStatus );
        if ( err != SLE_NO_ERR)
        {
            /* handle error */
        }
        err = SLEGlobalstatus( &GlobalStatus);
    }
}
```

```

        if ( err != SLE_NO_ERR)
        {
            /* handle error */
        }
        err = SLEMinMaxLimits( &Limits);
        if ( err != SLE_NO_ERR)
        {
            /* handle error */
        }
    }
}

```

Setup Static Parameters for Channel 1 if Channel 1 exists and Run Static Mode:

```

// put SLE in default Static Mode
SLEtoggle( (UCHAR)KEY_MODE, (UCHAR)MODE_STATIC );

// Verify SLE has a Channel 1
if ( SleStatus.ActiveChans & 1)
{
    err = 0;
    err |= SLEparam( PARAM_FREQOFFSET, CHAN1, 1000 ); // 1000 hz
    err |= SLEparam( PARAM_ATTEN, CHAN1, 5 ); // 1 db
    SleDllSpareByte = 0;
    err |= SLEparam( PARAM_DELAY, CHAN1, 600000000 ); // 600 msec

    // Static Mode Starts Executing. Wait for Delay command to have completed.
    // (Completion status may be monitored by a timer task however this sample
    // code simply waits in a loop)

    err |= SLEdllstatus( &SleDllStatus );
    while ( ! err )
    {
        if ( SleDllStatus.StaticModeState == 2 || SleDllStatus.StaticModeError )
            break;
        Sleep( 1000 ); // delay 1 sec
        err |= SLEdllstatus( &SleDllStatus );
    }
}
/* Done with commands, handle errors if any occurred */

```

Download a File and Run In Dynamic Mode:

```

// put SLE in Dynamic Mode
SLEtoggle( (UCHAR)KEY_MODE, (UCHAR)MODE_DYNAMIC );

// Setup Update Interval to 50 msec
SLEparam( PARAM_UPDATEINTERVAL, CHAN1, 50 ); // chan field is don't care

// Convert a SATGEN file to SLE format
err = SLEcnvtSATGENfile(TYPE_DLY, "c:\filedir\dlyfile1.dat", "c:\filedir\dlyfile1.sle");
if ( !err )
{
    // Download file and monitor when complete
}

```

```

err = SLEdownload( "c:\filedir\dlyfile1.sle", DNLD_START );

while( ! err )
{
    err = SLEdnldstatus( &DnldStatus );
    if ( ! err )
    {
        err = DnldStatus.LastError;
        if ( err || DnldStatus.DownloadState == 2 )
            break;
        else
            printf( "Progress = %d\n", DnldStatus.PercentComplete );
    }
}

// If file downloaded without error, select file to execute
// Note: The SLE maintains a FileIndex to be able to reference a file.
// Every time a file is added or deleted to/from flash memory the SLE must be
// queried to obtain indexes of all files. Indexes are not sequential, they
// are determined according to how flash is most efficiently used.

if ( ! err )
{
    index = SubGetFileIndex( "DLYFILE1.DAT" );

    // Select (enable) file to execute on channel 1 only
    err = SLEsetchans( index, 0x0001 );          // chan bitfield set to 1
}

// If no error, start Dynamic Mode
if ( ! err )
{
    UCHAR slekeybuf[2] = { KEY_RESET, KEY_START };

    // put SLE in fwd/rev mode
    err |= SLEtoggle( (UCHAR)KEY_LOOP, (UCHAR)LOOP_FWD_REVERSE);

    // Issue Reset and Start key commands to SLE
    SLEposition(1, &SlePositionStatus); // disable timer and Keep Alive
    err |= SLEkeypad( 2, slekeybuf );
    while( 1 )
    {
        SLEposition(1, &SlePositionStatus);
        // Determine if stopped running
        if ( SlePositionStatus.Mode == M_PAUSE // received a PAUSE cmd
            || SlePositionStatus.Mode == M_DONE // job completed normally
            || SlePositionStatus.Mode == M_READY ) // received a RESET cmd
        {
            break; // done running
        }
        else
        {

```

```

        // display elapsed time from SLE
        printf( "time=%d\n", SlePositionStatus.ElapsedTime);

        // use point position to display location or graph cursor
    }
}
// obtain last position
SLEposition(0, &SlePositionStatus); // re-enable timer and Keep Alive
}

```

Subroutines:

```

USHORT SubGetFileIndex( CHAR *file )
{
    SHORT offset;
    CHAR buf[16];

    for ( offset = 0; offset < SleStatus.DnldFileCnt; offset++ )
    {
        err = SLElistfile( offset, buf );
        if ( strcmp( file, buf ) == 0 )
            return( offset );
    }
    return 0xFFFF;
}

```

Example of File Upload from the SLE:

```

FileIndex = 0; // first file

// delete old client buffer if allocated
if ( SleUpload.PointBuffer )
    delete SleUpload.PointBuffer

// init for new file
memset( &SleUpload, 0, sizeof(SLE_UPLOAD) );

// Get Number of Points from Preamble to know size of buffer to allocate
err = SLEupldpreamble( FileIndex, &SlePreamble );
if ( err != SLE_NO_ERR || SlePreamble.NumSamples <= 2 )
{
    /* handle error */
}

// Allocate client buffer for sample points
SleUpload.PointBuffer = new double[SlePreamble.NumSamples];

// Read points from uploaded SLE file
err = SLEupload( FileIndex, &SleUpload );
if ( err != SLE_NO_ERR )
{
    /* handle error */
}

```

```
// Wait for Upload to Complete
while( 1 )
{
    Sleep( 250 );
    err = SLEupldstatus( &SleUpldStatus );
    if ( err == SLE_NO_ERR )
    {
        if ( SleUpldStatus.UploadState == 2 )
        {
            break; // done
        }
        else if ( SleUpldStatus.LastError )
        {
            /* handle error */
            break;
        }
    }
    else
    {
        /* handle error */
        break;
    }
}
```