

# LS-18-P/LS-18-R1

## Multi-Mode Multi-Band RF Test Modulator

### User's Manual



**Lumistar Inc.**

**3186 Lionshead Ave.  
Suite 100  
Carlsbad, California 92010  
(760) 431-2181**

[www.lumistar.net](http://www.lumistar.net)

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Lumistar Inc.  
3186 Lionshead Ave., Suite 100  
Carlsbad, CA 92010  
(760) 431-2181  
(760) 431-2665 Fax  
[www.lumistar.net](http://www.lumistar.net)

## Table of Contents

.....	1
<b>1 INTRODUCTION .....</b>	<b>10</b>
1.1 GENERAL.....	10
1.2 DOCUMENT OUTLINE .....	10
1.3 DEVICE BRIEF .....	11
<b>2 HARDWARE INTERFACE.....</b>	<b>14</b>
2.1 MECHANICAL OUTLINE: BASIC RF MODULATOR .....	14
2.2 INTERFACE SIGNALS: MICRO-D SUB PIN-OUTS .....	16
2.3 INTERFACE SIGNALS: ELECTRICAL DEFINITIONS/CHARACTERISTICS .....	17
2.4 DESKTOP CHASSIS CABLING INTERFACES.....	18
2.5 CHASSIS/CASE OPTIONS .....	21
2.5.1 DESKTOP CHASSIS.....	21
2.5.2 1U 12" LS-18-R1 CHASSIS .....	24
2.5.3 PORTABLE RUGGEDIZED CASE (PELICAN 1450 CASE) .....	25
2.6 COOLING AND THERMAL CONDITIONING.....	27
<b>3 COMMUNICATIONS INTERFACE.....</b>	<b>29</b>
3.1 TCP/IP CONNECTIVITY.....	29
3.1.1 INITIAL SETUP OF A HOST WINDOWS PC WITH A STATIC IP ADDRESS.....	31
3.1.1.1 Modification of a Windows Host controller to Static IP mode.....	31
3.1.1.2 Modification of a Windows Host controller to DHCP Mode .....	34
<b>4 SOFTWARE APPLICATION: LS18_APP .....</b>	<b>36</b>
4.1 APPLICATION OPERATION .....	36
4.1.1 WINDOWS FIREWALL HOLE FOR THE LS18_APP.....	36
4.1.2 COMMUNICATIONS SETUP LAUNCH WINDOWS .....	38
4.1.3 APPLICATION LAYOUT.....	39
4.1.4 FUNCTION SELECT TAB – HOME.....	51
4.1.5 FUNCTION SELECT TAB – TEST .....	59
4.1.5.1 Function Select Test - BERT .....	59
4.1.5.2 Function Select Test – PCM ENC.....	63
4.1.5.3 Function Select Test – SIM: Standard Mode .....	66
4.1.5.4 Function Select Test – SIM: Playback Mode .....	69

---

4.1.5.5	Function Select Test – WdAttr .....	71
4.1.5.6	Function Select Test – FrmAttr .....	73
4.1.5.7	Function Select Test – Dyn .....	76
4.1.5.8	Function Select Test – REC UL (Recording Upload) .....	78
4.1.6	FUNCTION SELECT TAB – INFO .....	80
4.1.6.1	Info Sub-function Select Tab - ENV .....	80
4.1.6.2	Info Sub-function Select Tab - Configuration .....	81
<b>5</b>	<b><u>OPERATIONAL EXAMPLES:</u></b> .....	<b>83</b>
<b>5.1</b>	<b>STANDARD MODE OF OPERATION</b> .....	<b>83</b>
<b>5.2</b>	<b>STREAMING DATA MODE OF OPERATION</b> .....	<b>88</b>
<b>5.3</b>	<b>INTERNAL RECORDING PLAYBACK MODE OF OPERATION</b> .....	<b>96</b>
5.3.1	PLAYBACK DATA FILE SOURCES .....	96
5.3.2	UPLOADING PLAYBACK FILES .....	96
5.3.3	SELECTING AND PLAYING RECORDED FILES .....	97



## List of Figures

Figure 1-1 Document Flag Formats .....	10
Figure 1-2 General Block Diagram of the LS-18 Configurations (Revision 2 HW) .....	12
Figure 2-1 Representative Top View of the LS-18-M brick assembly .....	14
Figure 2-2 Front-View of the LS-18-M brick assembly .....	15
Figure 2-3 LS-18-M J11 and J12 Connector Pin-out Details (Revision 1 and Revision 2) .....	16
Figure 2-4 P11 User Interface Cable (Rev 2 HW) .....	19
Figure 2-5 P12 User Interface Cable (Rev 2 HW) .....	20
Figure 2-6 LS-18-M Desktop chassis – ISO view .....	21
Figure 2-7 LS-18-M Desktop chassis – Overall Dimensions .....	22
Figure 2-8 LS-18-M Desktop chassis – Lower Housing Mounting Points .....	23
Figure 2-9 LS-18-R1 12" Chassis Front and Rear Panels .....	24
Figure 2-10 LS-18-R1 AUX Connector Pinouts .....	25
Figure 2-11 LS-18-P "Pelican" Portable System .....	26
Figure 2-12 LS-18 Pelican AUX Connector Pinouts .....	27
Figure 3-1 LumistarDevice.exe SYSTEM Tab for LS18 network configuration values .....	30
Figure 3-2 Web Browser INFORMATION tab for DPE unit .....	30
Figure 3-3 Web Browser NETWORK tab for DPE unit .....	31
Figure 3-4 Windows Network and Sharing Page .....	32
Figure 3-5 Windows Network Connections Page .....	32
Figure 3-6 Windows Network Connections properties page .....	33
Figure 3-7 Windows Network Connections IPv4 properties page –Static IP .....	33
Figure 3-8 Windows Network Connections IPv4 properties page - DHCP .....	34
Figure 4-1 Network User Application – Supported Operating Systems .....	36
Figure 4-2 Windows Defender Control Window (Win10 Pro) .....	37
Figure 4-3 Windows Defender Select Application Window (Win10 Pro) .....	37
Figure 4-4 Communications Setup Windows .....	38
Figure 4-5 Network User Application – General Screen Layout .....	40
Figure 4-6 Menu Bar – File Drop-Down List .....	42
Figure 4-7 System – Networking Tab .....	44
Figure 4-8 System – ACI Log .....	45
Figure 4-9 Conversion Utility - Converting Lumistar Recording files to Binary Playback Files .....	46
Figure 4-10 Conversion Utility - Converting CH10 files to Binary Playback Files .....	48
Figure 4-11 Status Window Contents .....	49
Figure 4-12 LS18_App – Home Tab for Configuration 2B .....	51
Figure 4-13 LS18_App – Home Tab for Configuration 2A .....	52
Figure 4-14 LS18_App – Test BERT Function Select Tab .....	59
Figure 4-15 RX BERT Input PCM Decoder Selections .....	61
Figure 4-16 LS18_App – Test PCM Encoding Function Select Tab .....	63
Figure 4-17 PCM Output Encoder Selections .....	64
Figure 4-18 LS18_App – Test SIM-Standard Simulation Mode Function Select Tab .....	66

---

Figure 4-19 LS18_App – Test SIM NAND Playback Function Select Tab .....	69
Figure 4-20 LS18_App – Test Word Attribute Function Select Tab .....	71
Figure 4-21 LS18_App – Test Frame Attribute Function Select Tab .....	73
Figure 4-22 FrmAttr Array - Controls .....	74
Figure 4-23 LS18_App – Dynamic Word Function Select Tab .....	76
Figure 4-24 LS18_App – Test NAND Function Select Tab .....	78
Figure 4-25 LS18_App – Info Sub-function Select: ENV .....	80
Figure 4-26 LS18_App – Info Sub-function Select: Configuration .....	81
Figure 5-1 Test – SIM tab for Standard Telemetry Frame Setup .....	84
Figure 5-2 Test – WdAttr tab for Standard Telemetry Frame Setup .....	85
Figure 5-3 HOME tab for Standard Telemetry Frame Setup .....	86
Figure 5-4 BER tab operations for Standard Telemetry Frame Setup .....	87
Figure 5-5 Point and Click Streaming Mode – SIM Controls .....	89
Figure 5-6 TDynaSim ACI Network Configuration Tab .....	<b>Error! Bookmark not defined.</b>
Figure 5-7 TDynaSim Initial Setup Steps .....	<b>Error! Bookmark not defined.</b>
Figure 5-5 TDynaSim Initiation – Hardware selections .....	91
Figure 5-6 TDynaSim ACI Network Configuration Tab .....	92
Figure 5-7 TDynaSim Initial Setup Steps .....	93
Figure 5-8 TDynaSim FrameWdAlgo Editor Steps .....	94
Figure 5-9 TDynaSim Final Streaming Data Steps .....	95
Figure 5-10 Playback Upload Controls .....	97
Figure 5-11 File Playback Controls .....	98

---

List of Tables

Table 1-1 General LS-18-M Device Specifications Table..... 13

Table 2-1 Primary IO Signal Electrical Definitions..... 17

Table 4-1 PCM Encoding Methods ..... 55

Table 5-1 Example PCM Frame Setup – Standard Mode ..... 83

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## Acronyms

<b>AM</b>	- Amplitude Modulation
<b>ACI</b>	- Alternate Control Interface
<b>BER</b>	- Bit Error Rate
<b>BERT</b>	- Bit Error Rate Test
<b>BNC</b>	- Bayonet Neill–Concelman (connector)
<b>BPSK</b>	- Binary Phase Shift Keying
<b>BW</b>	- Bandwidth
<b>dB</b>	- Decibel
<b>dBm</b>	- Decibel milliwatts
<b>CH10</b>	- Chapter 10 (Streaming and recording IRIG format)
<b>CLK</b>	- Clock
<b>DAT</b>	- Data
<b>DPE</b>	- Real-time Data Processing Engine
<b>DHCP</b>	- Dynamic Host Configuration Protocol
<b>DSP</b>	- Digital Signal Processor or Digital Signal Processing
<b>Eb/No</b>	- Energy per bit/Noise Energy
<b>EOF</b>	- End-of-File
<b>FEC</b>	- Forward Error Correction
<b>FM</b>	- Frequency Modulation
<b>GHz</b>	- Giga Hertz
<b>GUI</b>	- Graphical User Interface
<b>Hz</b>	- Hertz
<b>INV</b>	- Invert
<b>IP</b>	- Internet Protocol
<b>IRIG</b>	- Inter-Range Instrumentation Group
<b>KB</b>	- Kilobyte
<b>kHz</b>	- KiloHertz
<b>LBW</b>	- Loop Bandwidth
<b>LDPC</b>	- Low Density Parity Coding
<b>LED</b>	- Light Emitting Diode
<b>LSB</b>	- Least Significant Bit
<b>Mbps</b>	- Mega Bits Per Second
<b>MH-CPM</b>	- Multi-H Constant Phase Modulation
<b>MHz</b>	- Mega Hertz
<b>MSB</b>	- Most Significant Bit
<b>NAND</b>	- Not-AND (serial Non-volatile Flash Memory Style)
<b>NIC</b>	- Network Interface Card
<b>PCMFM</b>	- Pulse Code Modulation Frequency Modulation
<b>OQPSK</b>	- Offset Quadrature Phase Shift Keying
<b>OS</b>	- Operating System

---

## Acronyms (continued)

**PCM** - Pulse Code Modulation

**PLL** - Phase Lock Loop

**PM** - Phase Modulation

**PSK** – Phase Shift Keying

**QPSK** - Quadrature Phase Shift Keying

**RF** - Radio Frequency

**SE** - Single-Ended

**SMA** - Subminiature Version A

**SOQPSK-TG** - Shapped Offset Quadrature Shift Keying - Task Group

**TCP** - Transmisson Control Protocol

**USB** - Universal Serial Bus

# 1 Introduction

## 1.1 General

The following document contains information on the Lumistar LS-18-R1 and LS-18-P multi-mode, multi-band RF Test modulator product designed and manufactured by Lumistar Inc. The intent is to familiarize the user with the device's mechanical, electrical, and interconnection aspects as well as introduce and train the user in the operations of the supplied software control applications provided as part of the device delivery.

This document is not intended to define and illustrate the detailed communications protocol of the LS-18 necessary for independent software development. This information has not been released to date but will be released in the device **Interface Control Document** (ICD). When published, the document number will be DOC-18P-R1-ICD-xx where the -xx is the documentation revision number.

Consult the web site for the most recent release of all related product documentation.

## 1.2 Document Outline

This document contains the following sections:

- Section 1 provides a document overview as well as a brief on the LS-18 design
- Section 2 provides information on the hardware interfaces of the device
- Section 3 provides information related to the device communications interface setup
- Section 4 provides documentation of the LS18\_App User Application

The document will occasionally utilize document flags to highlight important factors. These flags can appear in any location and relate to any topic. A document flag will always be placed near pertinent information. Document flag examples appear in Figure 1-1.

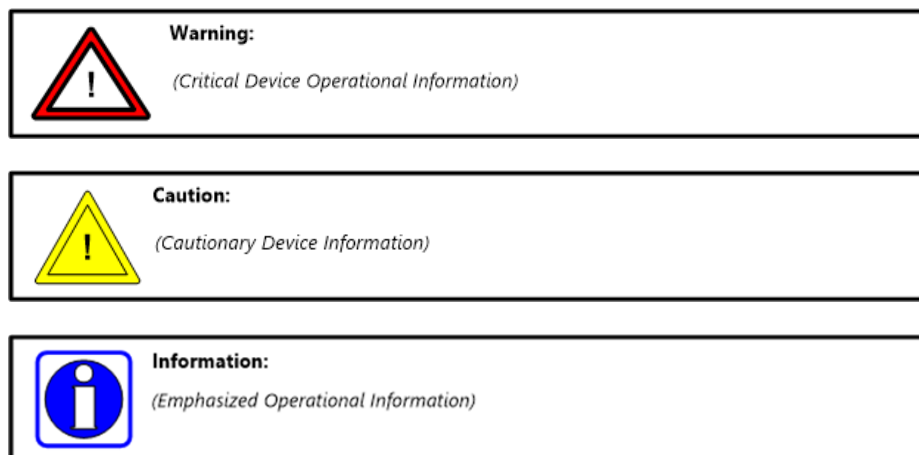


Figure 1-1 Document Flag Formats

## 1.3 Device Brief

The LS-18 is a sophisticated RF data modulator capable of modulating a single test data source in up to five different RF band frequency ranges. Modulation data sources include internal PRN sources, PCM Frame data generated by an on-board simulator, as well as up to two single-ended external clock and data sources and two external RS422 clock and data sources to provide a means on ingesting external user sources. Based on available options, data may be able to be streamed via UDP packets for retransmission or stored on the unit in recording directories for playback. The provided user software interface allows the user to tune the RF output frequency, select between the various modulation sources, select the RF modulation format, set the output levels of the unit, select from various encoding techniques, setup on-board simulation sources, and manage network assets. The LS-18 will output one (or optionally two) RF outputs at various user selected output levels.

The general LS-18 block diagrams are shown in Figure 1-2. All block diagrams are related to the capabilities of Revision 2, or later, hardware. There are two distinct configurations that the system can be deliver in: an autonomous RF test modulator version referred to as configuration 2A system and an autonomous RF test modulator system with super-simulation and playback capabilities designated the 2B configuration.

The 2A configuration only contains a single network device and network connection. Its main processing engine controls all of the RF modulation and level control as well as provides a convenient source of PCM data and PRN data.

The 2B configuration contains a single network connection but communicates to two individual processing engines in the system each at individual IP addresses. The 2B configuration contains an unmanaged 1Gbps Ethernet swtch. One of the processing engines is dedicated to the RF modulation and RF level controls of the output while the other engine is associated with providing PCM simulation data as both frame data and PRN sources, gathering and serializing real-time data from UDP packets for transmission, as well as retrieving stored playback data sets from on-board memory storage.

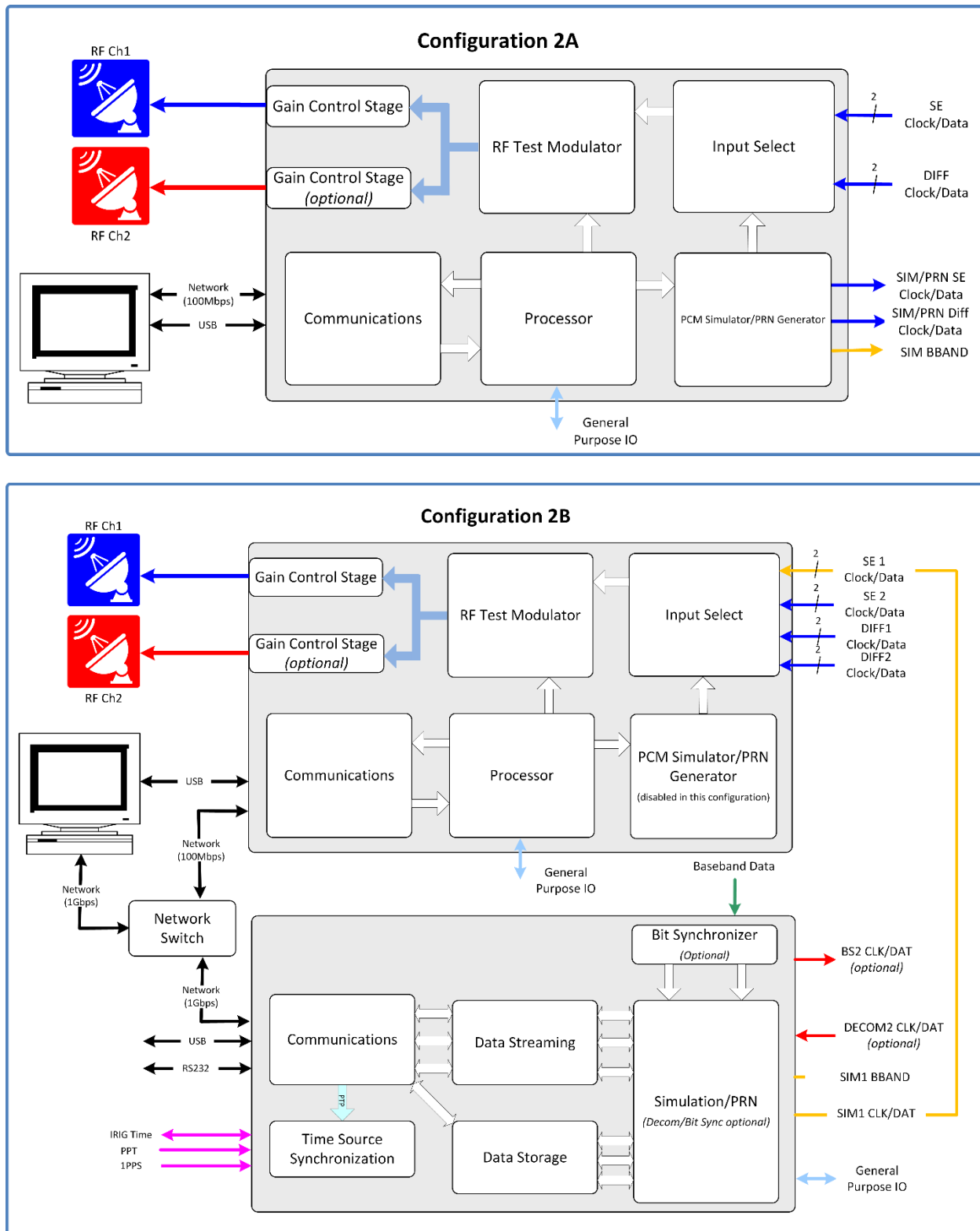


Figure 1-2 General Block Diagram of the LS-18 Configurations (Revision 2 HW)



Some of the primary design objectives of the LS-18 product line were to reduce the platform size, to provide an "OS-less" environment by eliminating product use of commercial software operating systems for functional processing, to provide easy and flexible field upgrade/enhancements capabilities, and to provide a network appliance for device control and data transport. The unit is controlled and monitored using a 100/10Mbps Ethernet interface with alternate controls being provided by USB.

At the heart of the modular design is a flexible and extensible DSP Engine. The device construction is via two hardware sections, referred to as "slices": RF and Control Processing Engine. New firmware personalities and/or control processing revisions are easily updated in the field. No need to return the unit for most modifications and updates.

The LS-18 is capable of handling up to five frequency bands as defined in the IRIG-106 specification. The modulator can be configured to support PCM/FM (Tier 0), SOQPSK-TG (Tier 1), BPSK, QPSK, OQPSK, and Multi-H CPM (Tier 2). Data rate support is up to 40 Mbps. Consult licensing information for final data rates.

Future versions of the LS-18 will be capable of accepting unencoded data and providing LDPC encoding (per the IRIG-106 specification) prior to transmission. Present shipping versions of the LS-18 system can produce LDPC encoded simulation. However, there is a limitation on this capability. Only internally generated data, or data that is streamed to the unit that contains LDPC encoding within the data packets, can be encode the transmission with LDPC codes. External clock and data can not be internally encoded with LDPC at this point in time. Table 1-1 provides specifications for the LS-18M.

<b>Category:</b>	<b>Specifications:</b>	<b>Details:</b>
<b>Mechanical</b>	Envelope Dimensions ins. (mm.)	6.00 (152.4) L x 4.00 (101.6) W x 1.350 (34.29) H
	Form Factor	Modular Brick
	Weight oz. (kgs)	~ 28oz. (~0.79kgs.)
<b>Electrical</b>	Individual power requirements	9-42VDC
		Nom. +24VDC @ 1.0A max.
	Total Power (both during transmission)	~ 24 Watts (mode and data rate dependent)
<b>Performance</b>		
<i>RF</i>	RF Output Bands (Up to 5 Optional)	1435.5-1534.5, 1750.5-1855.0, 2200.5-2299.5, 2200.5-2394.5, 4400.0-4950.0, 5090.0-5150.0, 5090.0-5250.0 MHz
	Channel Spacing	0.25 MHz
	Frequency Accuracy	0.002% (typ.)
	VSWR:	1.5:1 Maximum
	Variable Output Level Maximum (ea. Channel)	+20dBm/-90dBm (typ. Varies by Band); 100mW version
<i>Modulation</i>	Step Variable Output	4 Steps; consult factory
	Types (optional)	PCMFM (Tier 0), BPSK, QPSK, OQPSK, SOQPSK-TG (Tier 1), MH-CPM (Tier 2)
<i>FEC</i>	LDPC (optional)	1024 and 4096 Block Sizes; Rates: 4/5, 2/3, 1/2
<i>Connectors</i>	RF Signal Output	(2) SMA Jack Receptacle
	Digital I/O Connector	(1) MicroDSUB-25 Plug
	Power/Digital I/O Connector	(1) MicroDSUB-25 Receptacle
<i>Environmental</i>	Temperature, Operational	-40° to 85° Celsius (Industrial)
	Temperature, Storage	-40° to 125° Celsius
	Humidity, non-condensing	<40° C 0-90%, >40° C 0-75%

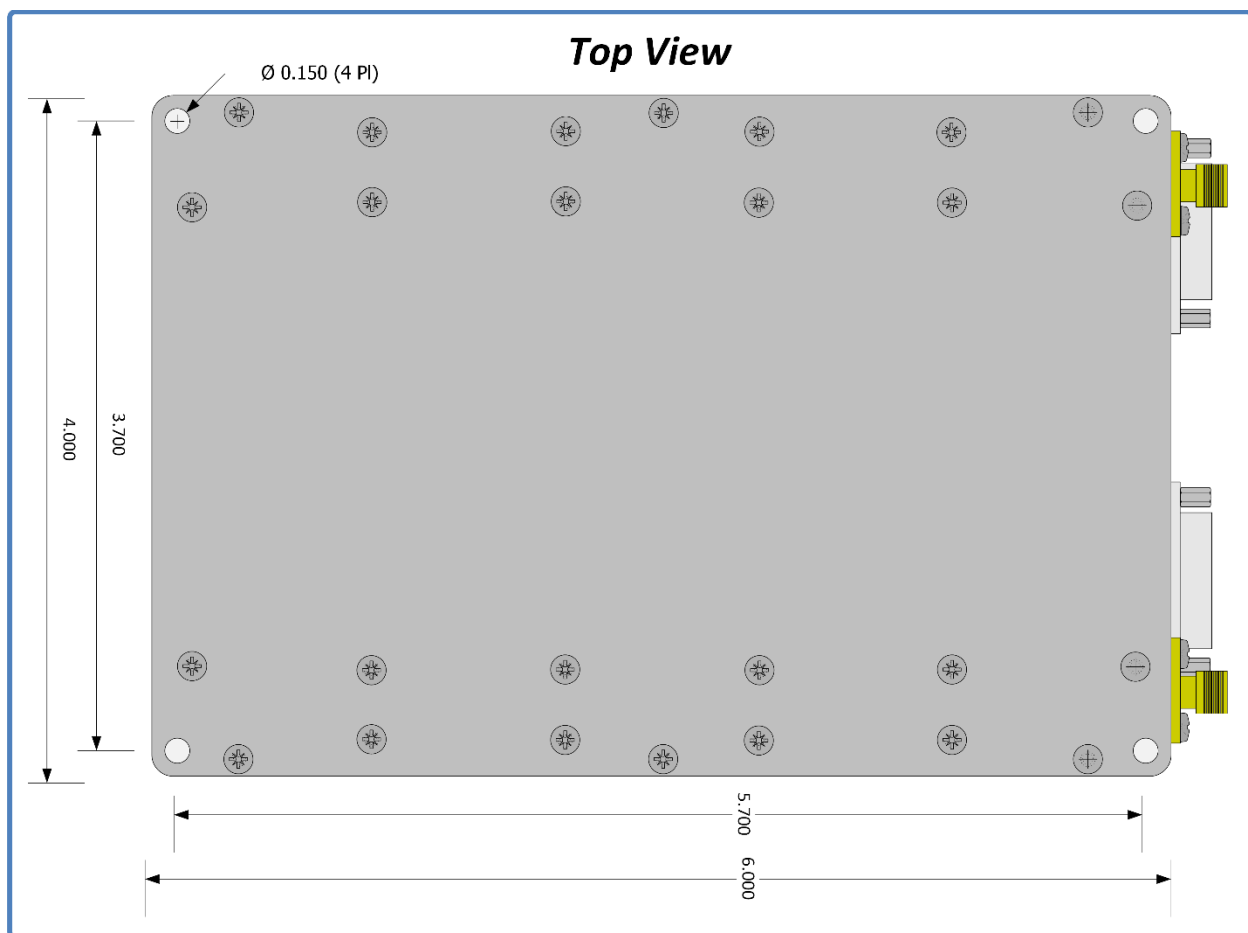
**Table 1-1** General LS-18-M Device Specifications Table

## 2 Hardware Interface

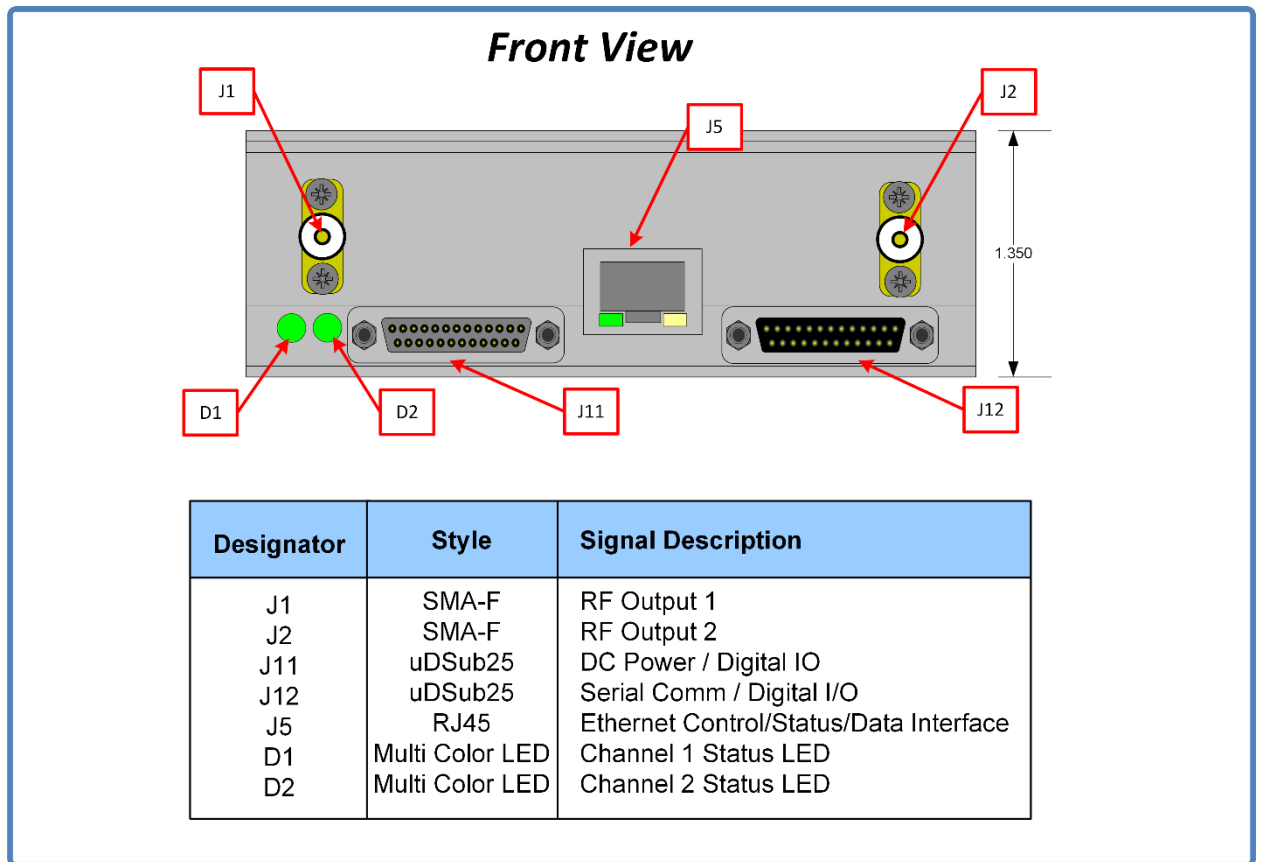
This document section will examine hardware design aspects including physical mounting of the device, electrical interface standards involved with the user connections, power and cooling of the device, and cabling options. This section will also provide specifications for various mechanical enclosures in which the LS-18 system is delivered.

### 2.1 Mechanical Outline: Basic RF Modulator

The LS-18-M is described as a “brick” configuration having the same traditional footprint as a standard 3.5” host computer hard disk drive. Figure 2-1 provides a diagram of the top view of the device. Figure 2-2 illustrates the various front-view configurations available.



**Figure 2-1** Representative Top View of the LS-18-M brick assembly



**Figure 2-2** Front-View of the LS-18-M brick assembly

The device can be mounted using four UNC6-32 or Metric 3 or 3.5mm machine screws. Total device height does not exceed 1.350 inches so the length of the mounting screw will only depend on the desired number of mounting threads.

The LS-18-M contains two multi-color status LEDs on the front of the device. These are shown in figure 2-2 and referenced as D1 and D2. The LEDs provide high-level functional status to the user and can be used in physical location of a particular device in the case that multiple devices have been deployed.

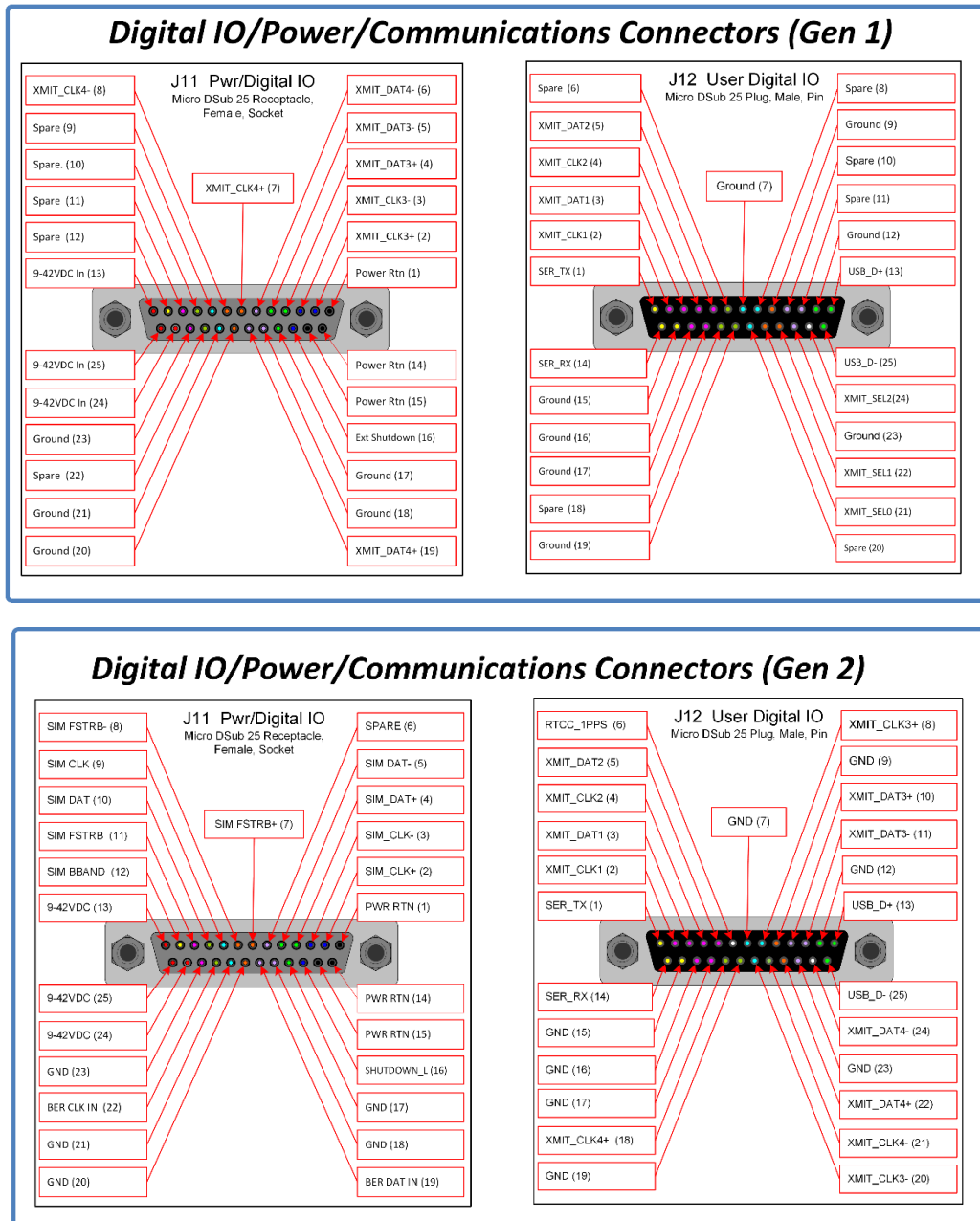
The LEDs are tri-color: **RED**, **GREEN**, **BLUE**. During normal operations, the front LEDs will blink **BLUE** at a very rapid pace directly after application of power. The LED will then proceed to blink on and off individually **BLUE** for an additional period. During this period of **BLUE** LED activity which last less than 10 seconds, no communications with the unit is possible. Once both LEDs start alternating between **GREEN** and off with each state being active for a 1 second period, the unit has full communications ability.

There is a FLASH LED function call that is available that will toggle the LEDs between a **RED** and **BLUE** state for an approximate 8-second period via the application software. This is useful in verifying communications with the device and locating a specific unit.

If the unit D1/D2 LEDs are stuck at **BLUE** after boot, the user should power the unit down for 120-seconds and then re-apply unit power. If after this power cycle the LEDs do not proceed to toggling **GREEN**, contact customer service for *additional support*.

## 2.2 Interface Signals: Micro-D Sub Pin-outs

Figure 2-2 presents a front-view of the LS-18-M. This figure contains a reference table of LS-18-M interface connectors. Figure 2-3 provides detailed interface pinouts of the Micro-D connections of the LS-18-M.



**Figure 2-3** LS-18-M J11 and J12 Connector Pin-out Details (Revision 1 and Revision 2)

## 2.3 Interface Signals: Electrical Definitions/Characteristics

The interface signals of the LS-18-M vary in type and electrical complexity. There are several different types of signals deployed as detailed in Table 2-1.

Signal Name	Interface Direction	Interface Type	Input Voltage Range	Input $\Omega$	Output Voltage	Output $\Omega$	See Note
CLK Input	I	Digital			5V		1
DAT Input	I	Digital			5V		1
CLK +/- Input	I	RS422			3.4V Diff	100 $\Omega$	2
DAT +/- Input	I	RS422			3.4V Diff	100 $\Omega$	2
9-42VDC In	PWR	Power	9-42VDC				3
Pwr Rtn	PWR	Power	GND				3
Ext Shut Down	I	Digital	GND				4
SER TX/RX	I/O	RS232					5
USB_D+/-	I/O	USB 2.0					6

Notes:

- 1.) Transceiver: SN74LVC2T45. 5V inputs switch logic state at >3.5V logic switching levels. Output voltage can be 3.3V. Consult factory for availability.
- 2.) Transceiver: ISL3259E prior to HW Rev 10, MAX22501 in HW Rev 10+; 100-120 ohm differential termination
- 3.) DC input voltage can vary from 9V-42V. Per pin current limit is 3A.
- 4.) Pull below 2.2V for shutdown. Leave unconnected or pull-up for normal operation. Ground or pull low for shutdown. Input tolerance: -40V to 100V.
- 5.) RS232 transceiver: SN75C3221E. This device is capable of 1Mbps transactions. Firmware limits the BAUD rate to 250kbps. RS232 interface is active simultaneously with USB2.0 and Ethernet interfaces.
- 6.) USB2.0 operation only. USB interface is active simultaneously with RS232 and Ethernet interfaces.

**Table 2-1** Primary IO Signal Electrical Definitions

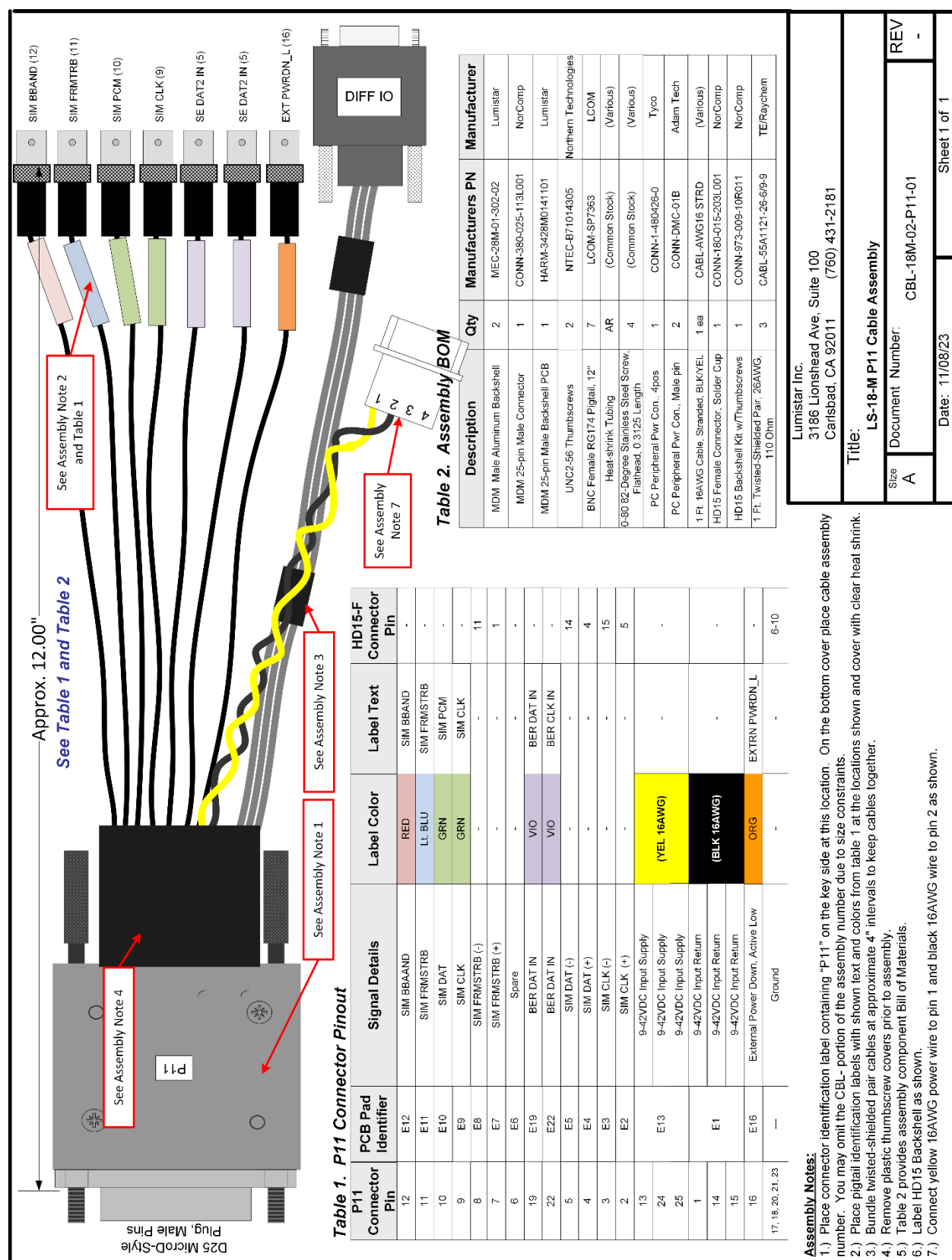
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## 2.4 Desktop chassis Cabling Interfaces

The LS-18-M in the Desktop chassis assembly is typically delivered with a set of two interface cables. These cables interface connections on the Micro D-Sub connections to more commonly available interface connections such as BNC, USB-B, DSub9 and HD15 connections.

Cables are not typically provided for the Ethernet interface or the SMA RF connections. Consult the Lumistar Factory if you are interested in the purchase of any of these cables.

Cables are defined in detail in Figure 2-4 and Figure 2-5 that follow. Revision information is clearly marked on the cable assemblies. There are cabling options that are available. Consult your Lumistar sales representative for available options.



**Figure 2-4** P11 User Interface Cable (Rev 2 HW)

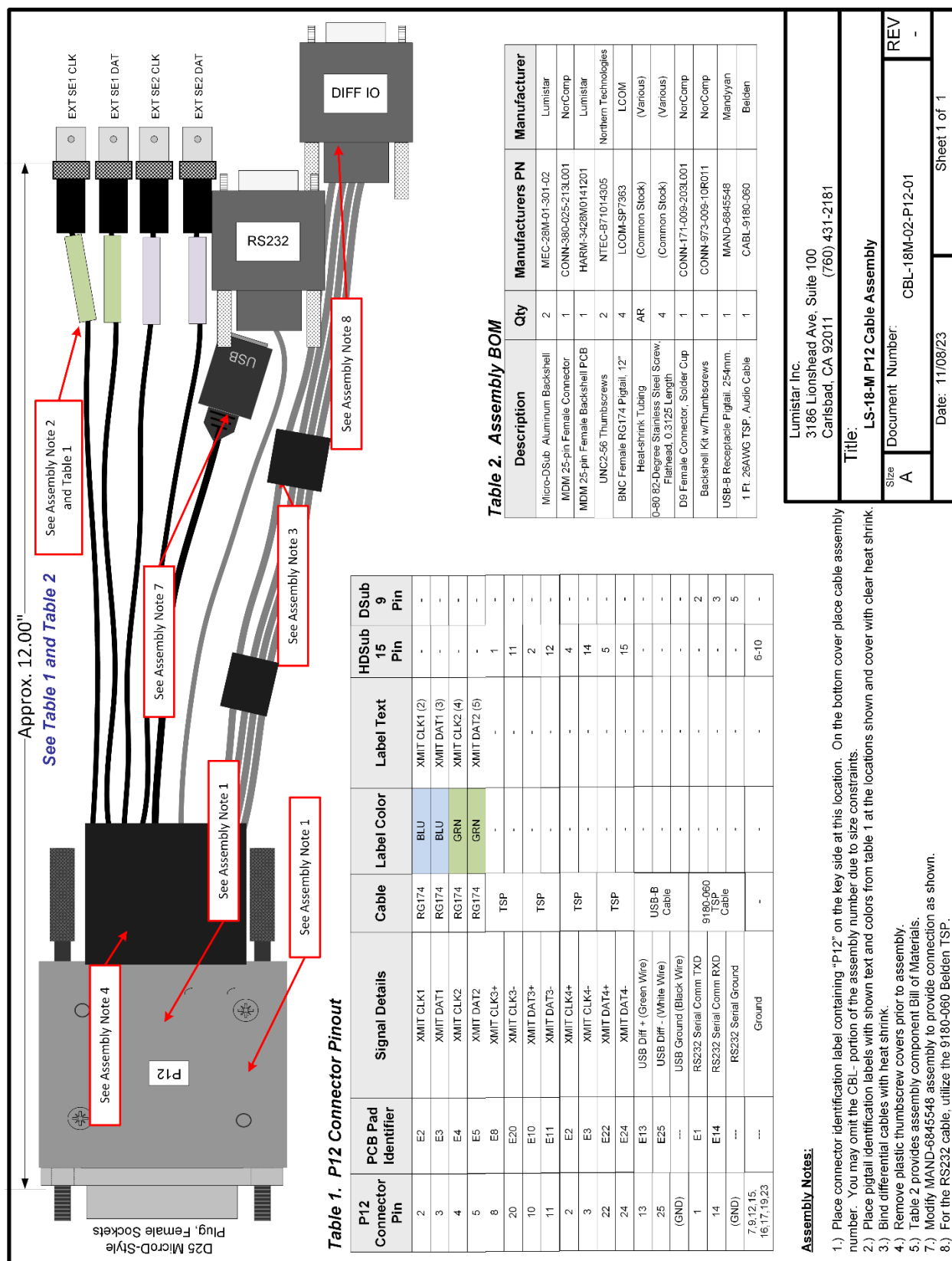


Figure 2-5 P12 User Interface Cable (Rev 2 HW)



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## 2.5 Chassis/Case Options

Lumistar offers an array of delivery options for the LS-18 System. These include:

- Desktop Chassis – Compact desktop arrangement with force air cooling. Includes desktop power supply.
- 1U 19" Rackmount Chassis (Short) – 12" depth solution for rack mounting.
- Portable Ruggedized Case – Pelican 1450 series case with cooling and dual power capabilities.

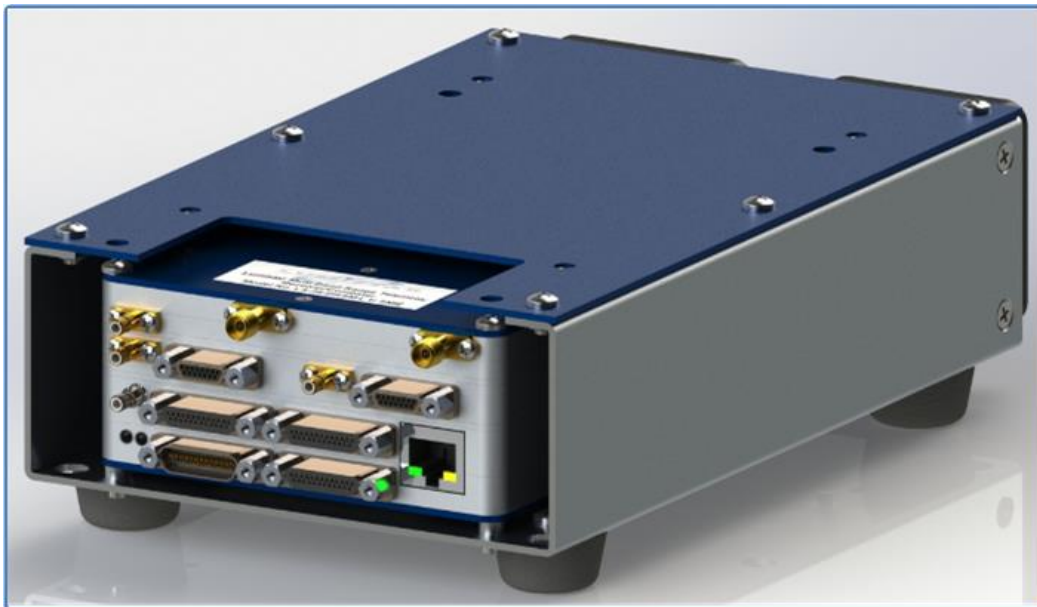
### 2.5.1 Desktop Chassis

Lumistar offers an optional LS-18-M desktop chassis that provides mounting, power cabling provisions, and cooling functions for the LS-18-M. The fixture comes with a desktop AC to DC power converter.

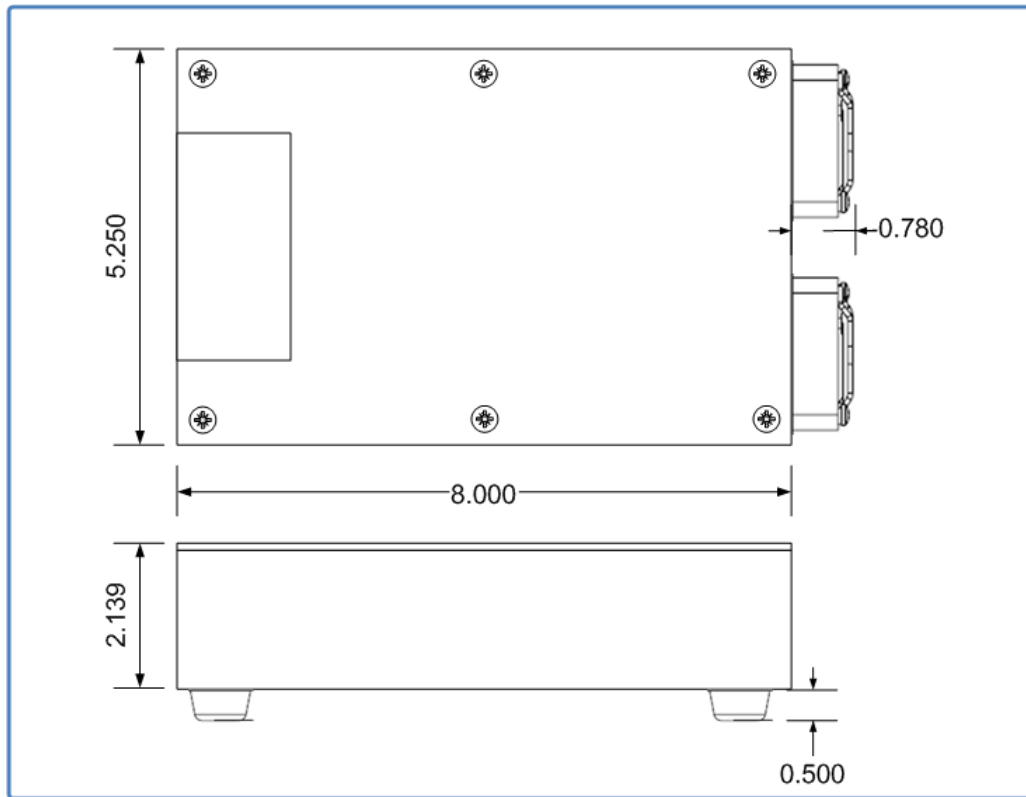
The desktop chassis presently being shipped is shown in Figure 2-6. The fixture can be operated on input voltages between 9 and 36VDC. The overall mechanical dimensions of the desktop chassis are shown in Figure 2-7. Mounting dimensions for the lower section of the housing are provided in Figure 2-8.

Two options for power connections are available for the desktop chassis. The unit is typically delivered with an 8-pin DIN connector which offer keying and better power transfer. Additionally, there is an option to have a MIL-DTL-26482 Series bayonet connector option. Consult Lumistar sales for ordering options.

Configuration 2A from Figure 1-2 can be offered in a single height desktop chassis as shown in Figure 2-6. Configuration 2B from Figure 1-2 requires the use of a stacked desktop fixture. Consult Lumistar for further details.



**Figure 2-6** LS-18-M Desktop chassis – ISO view



**Figure 2-7** LS-18-M Desktop chassis – Overall Dimensions

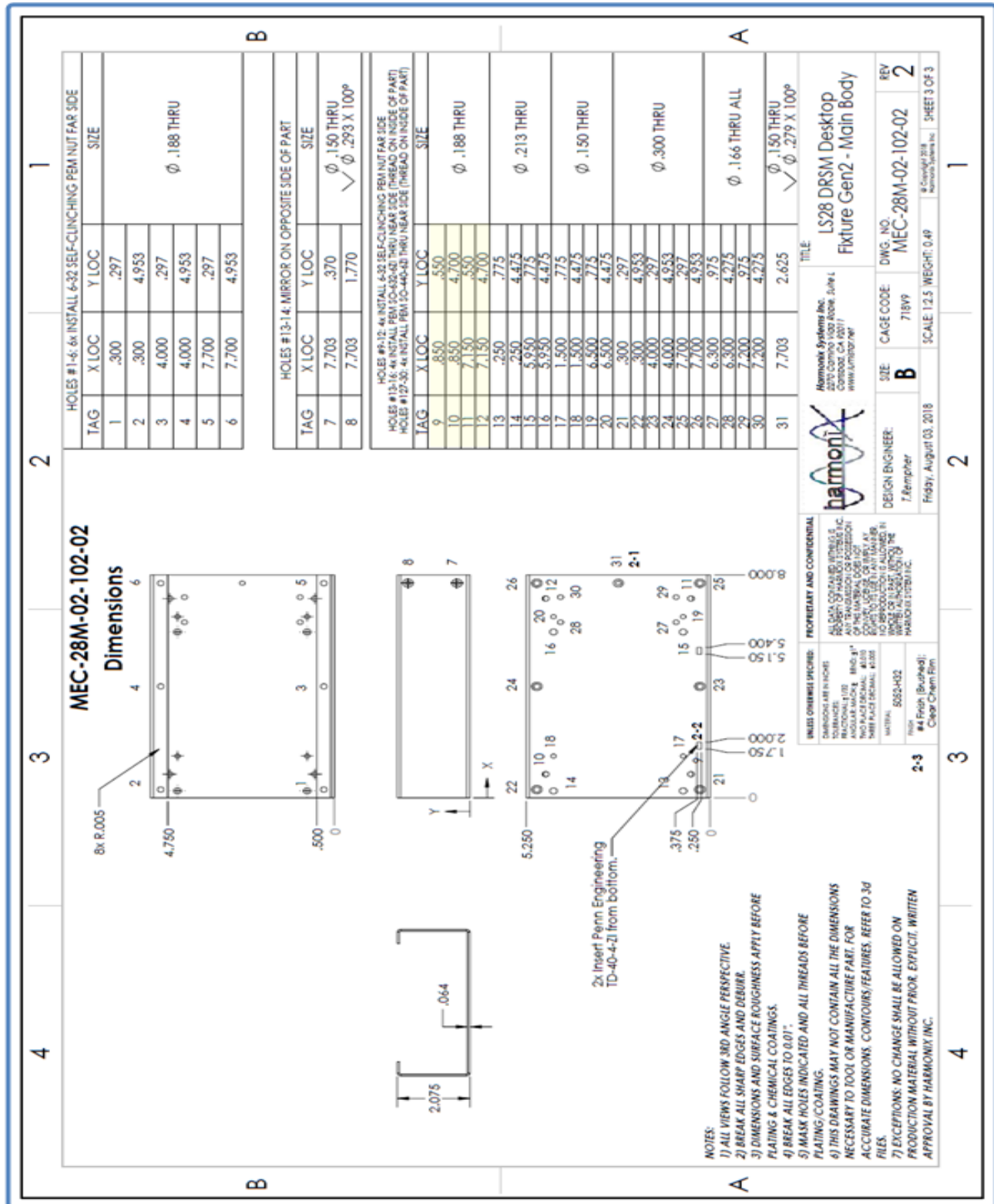
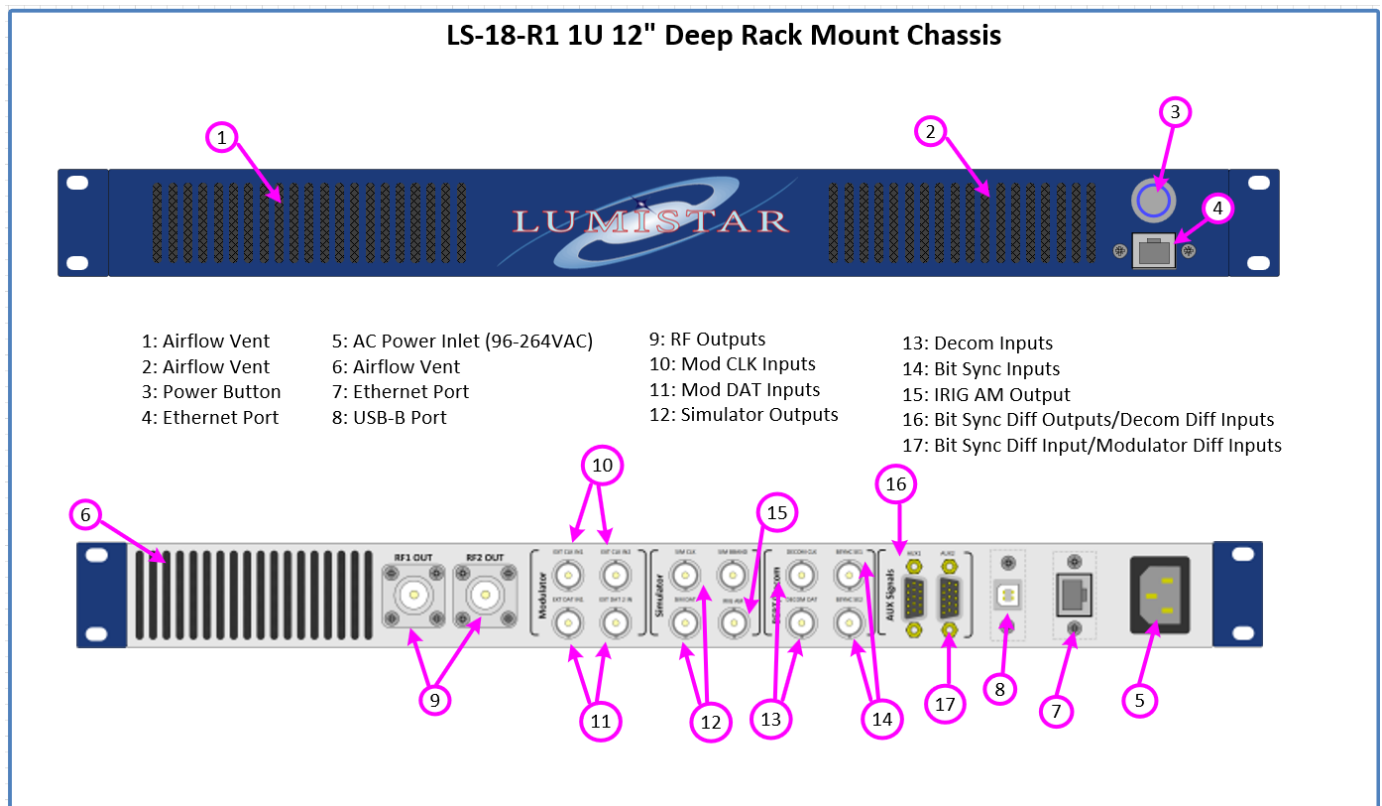


Figure 2-8 LS-18-M Desktop chassis – Lower Housing Mounting Points

## 2.5.2 1U 12" LS-18-R1 Chassis

Lumistar offers LS-18-R1 in 19" wide by 12" deep 1U rackmount configuration. This form can house either configuration 2A and 2B from the Figure 1-2. In the configuration 2B format, the data source for the modulation is the real-time Digital Processing Engine (DPE) and this interface utilizes the EXT SE1 input source to the RF modulation section. In configuration 2A, all four external inputs (two Single-ended, two RS422 differential) are available.

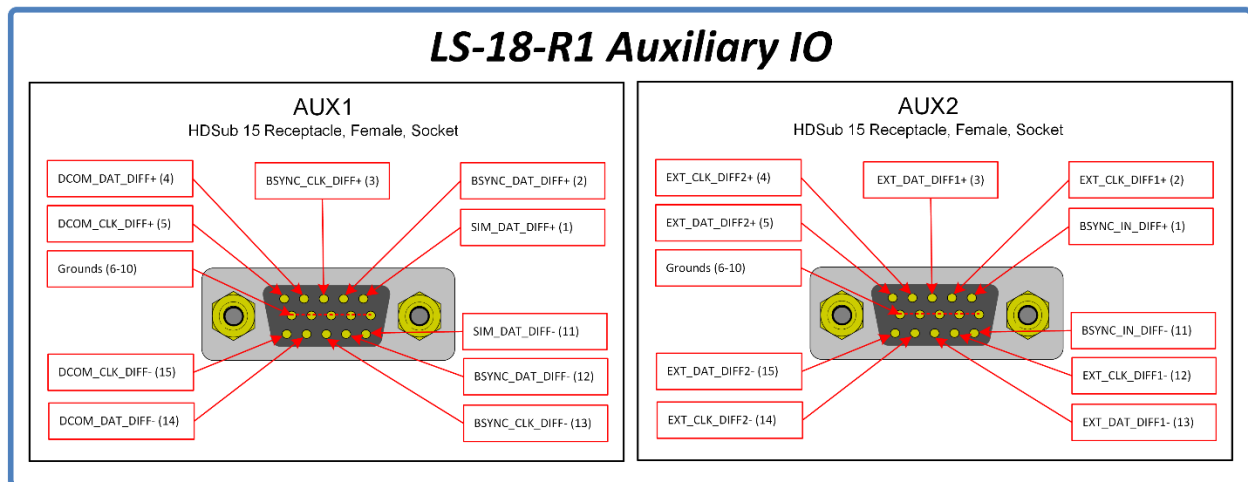


**Figure 2-9** LS-18-R1 12" Chassis Front and Rear Panels

The 12" deep 1U LS-18-M chassis requires an external host PC to run the LS-18-M application software to control and status the LS-18-M. The chassis contains the receiver and all power and cooling provisions. The chassis also contains an unmanaged 1Gbps Ethernet 5-Port Switch (model: Netgear GS305-100PAS) for network connections between the internal receiver and the front and rear panel mounted Ethernet connectors.

In the LS-18-R1 configuration 2B, the data to the RF modulation stages are connected to the SE EXT1 Input selections by default. This input must be selected in the application GUI to use the internal modulation sources, the streaming modulation data, or the NAND playback functions.

The AUX connector pinouts appear in Figure 2-10.



**Figure 2-10** LS-18-R1 AUX Connector Pinouts

### 2.5.3 Portable Ruggedized Case (Pelican 1450 Case)

Lumistar offers an LS-18 system mounted inside of a portable case for ultra-portable and rugged field applications. This form includes an LS68 (Data Processing Engine) to make use of the Stream 1 Simulator to provide Clock and Data signals to the LS18M Modulator+Transmitter. All power and cooling provisions are included.

An external host PC, such as a laptop computer (not included but can be ordered as an option) must be provided if active control interactions and status are required with the unit. Figure 2-11 contains the top view, ISO closed case view of the unit. This figure also contains a picture of the optional Battery Bag with shoulder harness for cases where a LiFePO<sup>4</sup> battery for field DC operations.

This unit is delivered with no cables other than an AC power cord. Pin connections for all Auxiliary connectors and the external DC power connector are listed in Figure 2-12. All D-Sub connectors are High-Density 15-pin receptacles. Mating connectors are available from a multitude of suppliers. Figure 2-12

**LS-18 Pelican AUX Connector Pinouts**





Figure 2-11 LS-18-P "Pelican" Portable System

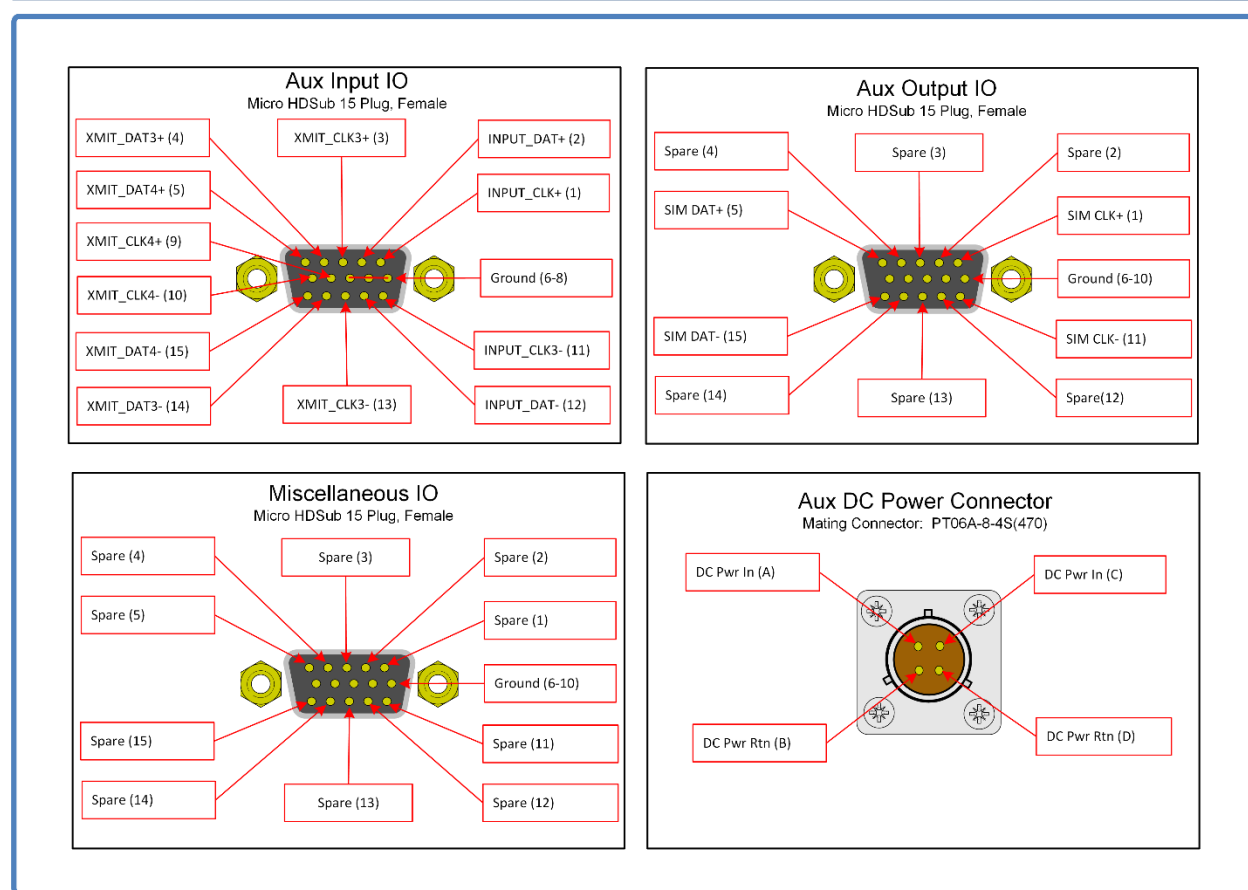


Figure 2-12 LS-18 Pelican AUX Connector Pinouts

## 2.6 Cooling and Thermal Conditioning

The LS-18 must maintain a satisfactory operating temperature range to ensure sustainable functionality. It is **highly recommended** that provisions for cooled air are used during operation. The unit itself provides a heat load during typical operations which typically reaches 20 to 30 Watts, depending on operational configuration and state. This load can and will vary based on operating mode. The actual calculation of the total heat load of the system is quite complex due to many factors involved which include:

- Operational mode
- Modulated data rate
- Operational configuration

The design utilizes CMOS logic. The higher the processing rate, the more power the device will consume.

The design is constructed from aluminum which is where all generated heat is directed. The sides of the unit are the primary heat sinking area. Although the top and bottom surfaces of the device will dissipate heat, they act in a secondary role to the sides of the device. This fact is what drives the design of our

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desktop chassis. In this fixture, we provide approximately 40.6 Cubic Feet per Minute (CFM) of airflow which is directed around the sides of the chassis.

Of course, ambient temperature of the applied forced air is also a factor. In general, the maximum operating temperature of **the unit should not exceed 70 degrees C for extended periods**. Its optimal operational temperature should be maintained in the 40-60 degree C range.

The user must maintain awareness of the ambient ingested air. Conditions such as barometric pressure, the amount of moisture in the air, and air temperature will affect the cooling capacity of inlet air. If the ambient air temperature is already 40 degrees Celsius, the cooling efficiency of this input air is very limited.



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## 3 Communications Interface

The LS-18-M communicates through a 10/100 Mbps Ethernet serial interface directly. A USB and RS232 interface are provided for maintenance and debugging activities only. Contact Lumistar customer service for details of these interfaces.

For the LS-18-P and LS-18-R1 configurations that include streaming and/or playback NAND flash, these units communicate through 1Gbps Ethernet. Inside each of these units resides an unmanaged multi-port switch. All user ethernet connections are connected to this internal switch. Do not connect all available external RJ45 connections to the same user network switch. Doing so will cause network looping which results in network crashes and other anomalies.

### 3.1 TCP/IP Connectivity

The TCP/IP IPv4 protocol suite requires five values to establish a connection or reply to a message from a remote host.

- Transport Layer Protocol (UDP or TCP, typically).
- Local IP Address.
- Local Port Number
- Remote IP Address
- Remote Port Number

The Ethernet enabled Lumistar LS-18 device, in standalone mode, will all have a single IP Address and port value assigned prior to shipment. This will also be the case for Pelican and 1U Rack Mount implementations. The assigned factory IP address will be **192.168.1.18** and the subnet mask will be set to **255.255.255.0**. These settings can be changed using the *LumistarDevice* application that is provided in the **Utilities** folder of the supplied software/support DVD which was supplied with the shipment. To change the default IP address, open the *LumistarDevice* or *IPAddressChanger* utilities with the unit connected to a network that allows for address set to 192.168.1.xxx, using Windows administrative mode, and select the SYSTEM tab. In the lower left corner of the application resides a section entitled TOE Network Configuration. Changes to the device IP address, Subnet mask, Gateway Address, and DNS server settings can be changed via controls in this section. Once modifications are complete, select the UPDATE button and then power cycle the device to make the changes active. Refer to Figure 3-1.

Units which contain the Configuration 2B arrangement of Figure 1-2 will contain a second IP network address for the real-time Data Processing Engine (DPE). This interface's default location is **192.168.1.68**. To change the network settings for this device, open any web browser and enter the address of 192.168.1.68. A window similar to the shown in Figure 3-2 should appear. Select the NETWORK tab from the browser window which will change the windows to that shown in Figure 3-3. Network values can be changed in this window and then applied by using the UPDATE button.

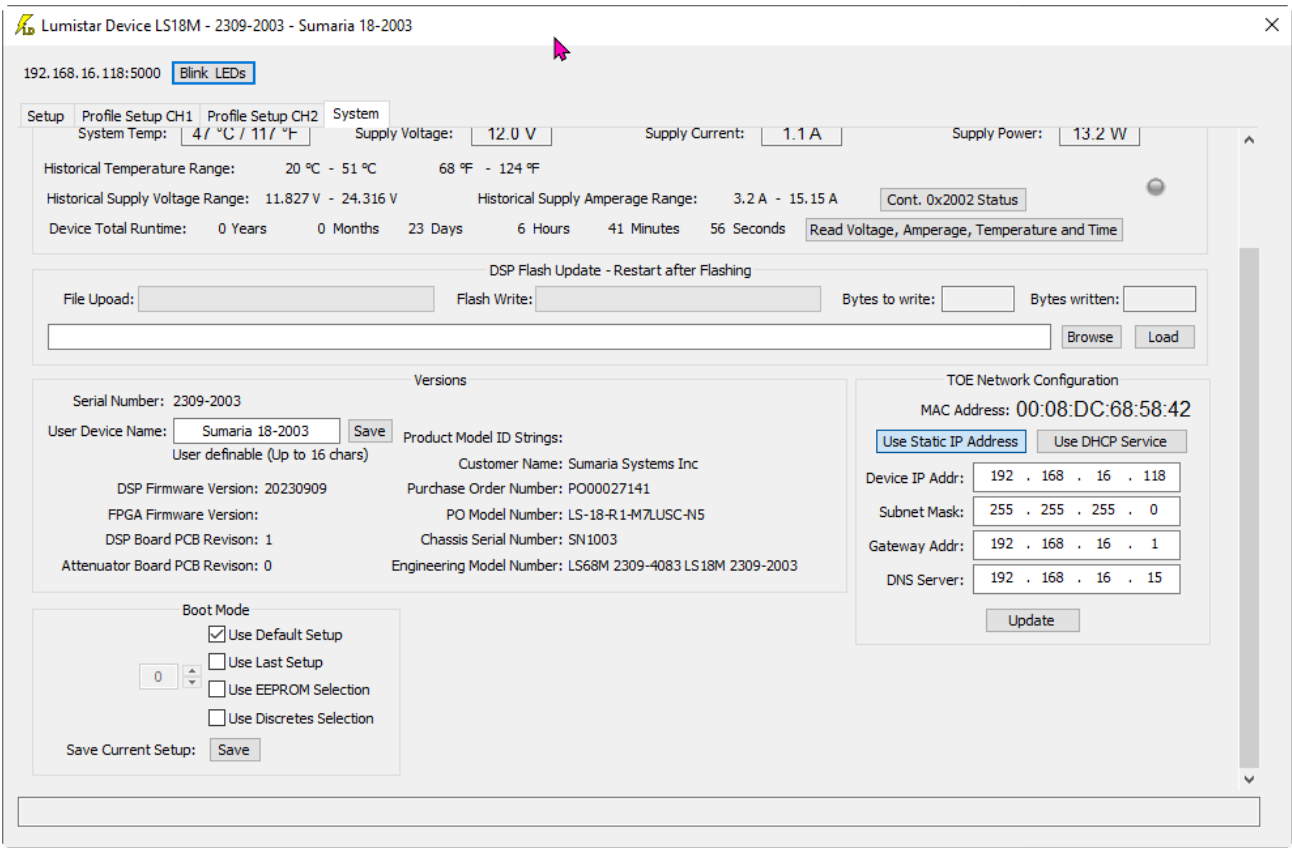


Figure 3-1 LumistarDevice.exe SYSTEM Tab for LS18 network configuration values.



Figure 3-2 Web Browser INFORMATION tab for DPE unit.

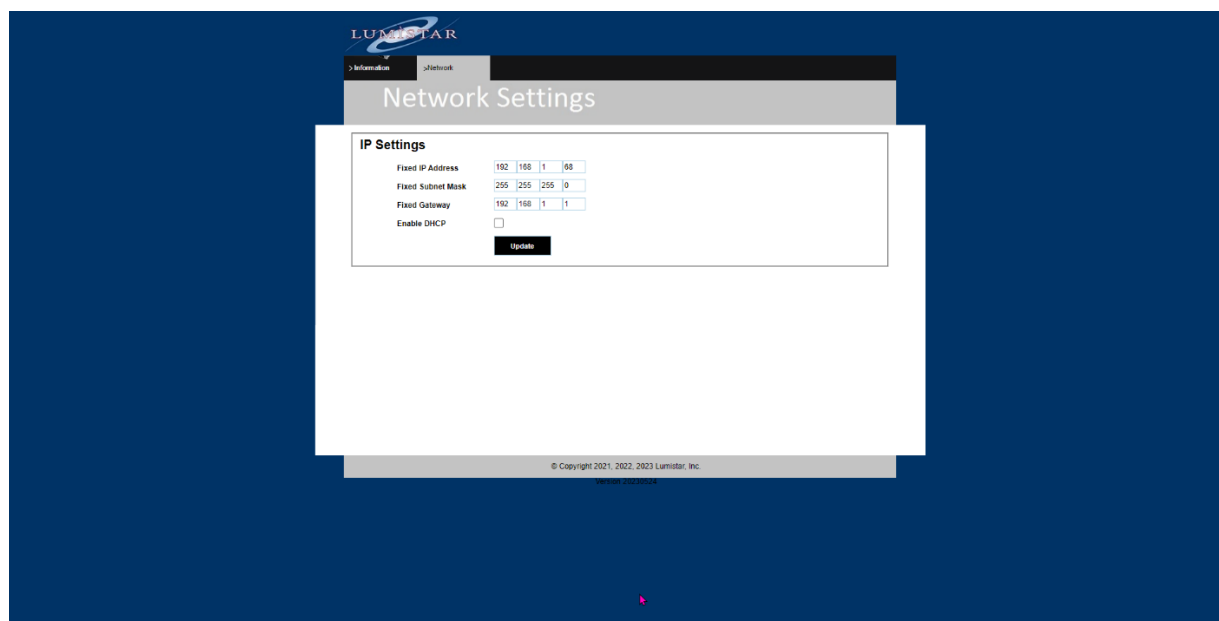


Figure 3-3 Web Browser NETWORK tab for DPE unit.

### 3.1.1 Initial setup of a host Windows PC with a static IP address.

Configuring hosts communication between various network configurations is operating system dependent and will be generally outlined below. Slight operating system variations in functional screens may exist and will be up to the user to interpret. An example of how to configure a common Windows network Host Controller to operate in either Static mode which is necessary to change the delivered mode of operation is described in section 3.1.1.1. An example of how to set a Windows network host to DHCP mode follows in section 3.1.1.2.



**Information:**

Network configuration, connection and security typically require consent and access privileges from a network system administrator. The sections that follow attempt to describe the necessary steps that need to be taken in a rather "Open" network environment. Specific requirements in terms of network security and connection routing are the user's responsibility. Please contact your system administrator before going further.

#### 3.1.1.1 Modification of a Windows Host controller to Static IP mode

To modify the controlling host's network configuration to static IP mode, perform the following steps:

Step 1: Connect the LS-18-M to the target host machine either directly with an Ethernet crossover cable or by connecting both the device and the host to an Ethernet switch using standard Ethernet cables.

Step 2: On the target host application machine, access the Windows Control Panel.

Step 3: From Windows Control Panel, select the Network and Sharing Center.

Step 4: From Network and Sharing Center, select the "Change adapter settings" option from the left-hand menu. See Figure 3-4.

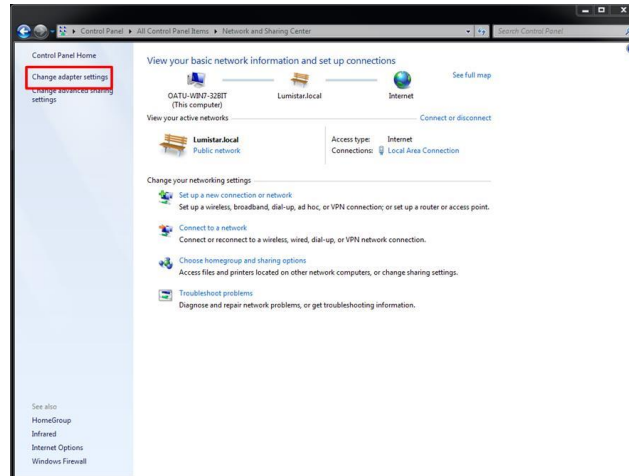


Figure 3-4 Windows Network and Sharing Page

Step 5: The Network Connections window shows the available connections the target host can use. Right-click on the local area connection attached to the LS-18-M and select "Properties". See Figure 3-5

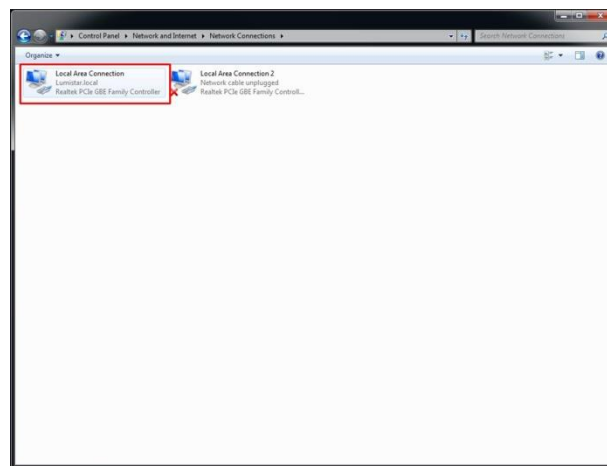


Figure 3-5 Windows Network Connections Page

Step 6: From the Local Area connection Properties window, double-click on "Internet Protocol Version 4 (TCP/IPv4)". See Figure 3-6.

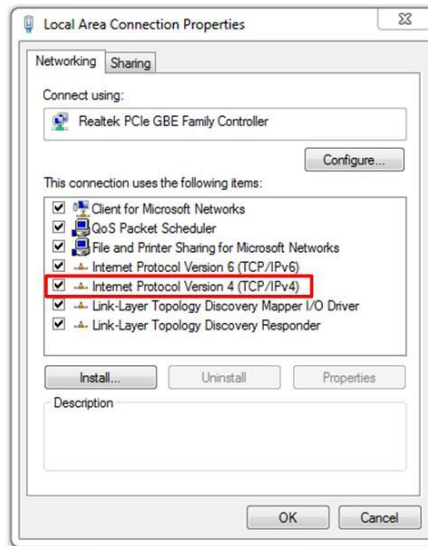


Figure 3-6 Windows Network Connections properties page

Step 7: To set the unit to a static IP address, select the "Use the following IP address:" option. Then enter the desired IP address in the designated field. A suggestion is to use the IP address 192.168.16.200 as shown below. Once the IP address is filled, the Subnet mask field will automatically populate. See Figure 3-7.



**Warning:**

The static IP address of the host machine cannot be set identically to any device on the connected network.

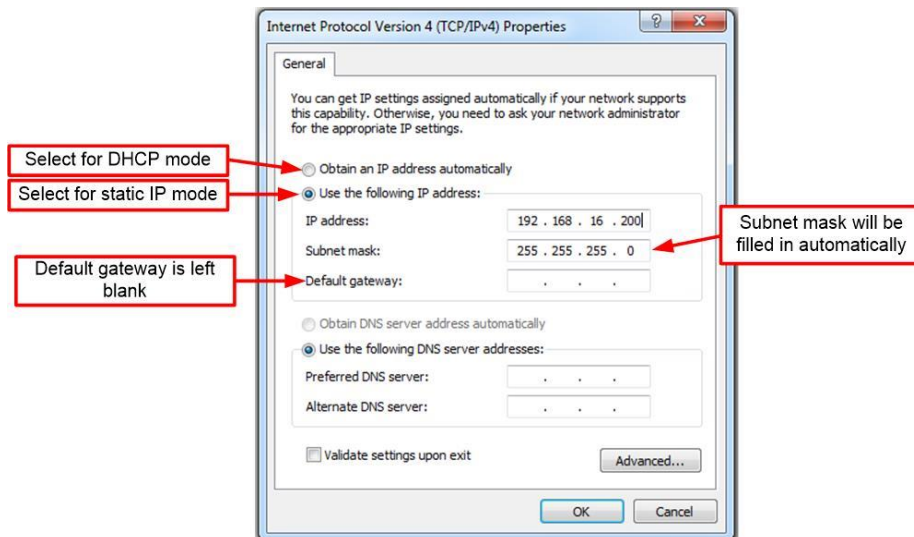


Figure 3-7 Windows Network Connections IPv4 properties page –Static IP

Step 8: From the Internet Protocol Version 4 (TCP/IPv4) Properties window, click "OK".

Step 9: From the Local Area Connection Properties window, click "OK".

### 3.1.1.2 Modification of a Windows Host controller to DHCP Mode

To modify the controlling hosts to the DHCP network configuration, perform the following steps:

Step 1: Connect the target host to a DHCP enabled network.

Step 2: On the target host application machine, access the Windows Control Panel.

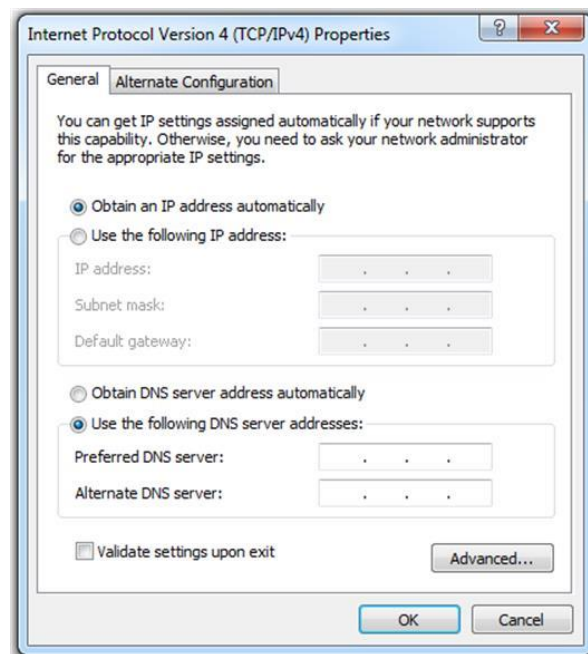
Step 3: From Windows Control Panel, select the Network and Sharing Center.

Step 4: From Network and Sharing Center, select the "Change adapter settings" option from the left-hand menu. See Figure 3-4.

Step 5: The Network Connections window shows the available connections the target host can use. Right-click on the local area connection connected to the DHCP enabled network and select "Properties". See figure 3-3.

Step 6: From the Local Area connection Properties window, double-click on "Internet Protocol Version 4 (TCP/IPv4)". See Figure 3-6.

Step 7: To set the unit to DHCP mode, select the "Obtain an IP address automatically" option. See Figure 3-8.



**Figure 3-8** Windows Network Connections IPv4 properties page - DHCP

Step 8: From the Internet Protocol Version 4 (TCP/IPv4) Properties window, click "OK".

Step 9: From the Local Area Connection Properties window, click "OK".

Settings can be entered in the provided spaces and then updated by clicking the UPDATE button.

---

The DHCP check-box allows the DHCP mode to be enabled and disabled. If the DHCP mode is enabled, the fixed IP address fields will be ignored and addressing will be assigned by another controlling network source. **If no such host is available to assign the unit an address, all network communications will cease.**

Deselecting the DHCP box will place the device in static IP mode using the address field setting set on this tab. Be sure to press the UPDATE button prior to closing this page to make the settings active. Settings will be retained between power cycles.

**Warning:**

If the DHCP mode is selected, the unit will not contain an IP address, subnet or gateway setting. If set to this mode, a DHCP network controller **MUST** be present to assign network interface settings. If the unit is set to DHCP mode, the **ONLY** means to change network control settings is to attach the unit to a network which contains a DHCP controller.

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## 4 Software Application: LS18\_App

The LS-18 Network Application (LS18\_APP) is the primary software deliverable for the LS-18-M. This application provides a user interface to all functions of the device that can be run on most Windows platforms. A list of supported Windows platforms is shown in Figure 4-1.

<b>Supported Operating Systems:</b>	
Windows 7 x86/x64	Windows Server 2008
Windows 8 x86/x64	Windows Server 2008 R2
Windows 8.1 x86/x64	Windows Server 2012
Windows 10 x86/x64	Windows Server 2012 R2
	Windows Server 2016

**Figure 4-1** Network User Application – Supported Operating Systems

Lumistar suggests that the user install the application on modern processor platforms with a minimum of 4GB (16GB for Windows 10 Pro) of high-speed RAM, 100GB of free disk space, hardware graphics acceleration, and a minimum of a 4<sup>th</sup> generation Intel i7 processor.

### 4.1 Application Operation

Install the LS18\_App on the target host PC that resides on the supplied software/support DVD. Use administrator privileges if possible.

The following paragraphs will illustrate the operation of the LS18\_App.

#### 4.1.1 Windows Firewall Hole for the LS18\_App

To grant the software application privileges that it will need for operations, a network Firewall hole should be created. To create a Windows firewall hole in Windows 10 Pro, follow the steps provided below.

- 1.) In the Windows search bar, type in "Windows Defender". This will result in a Window similar to the one shown in Figure 4-2.



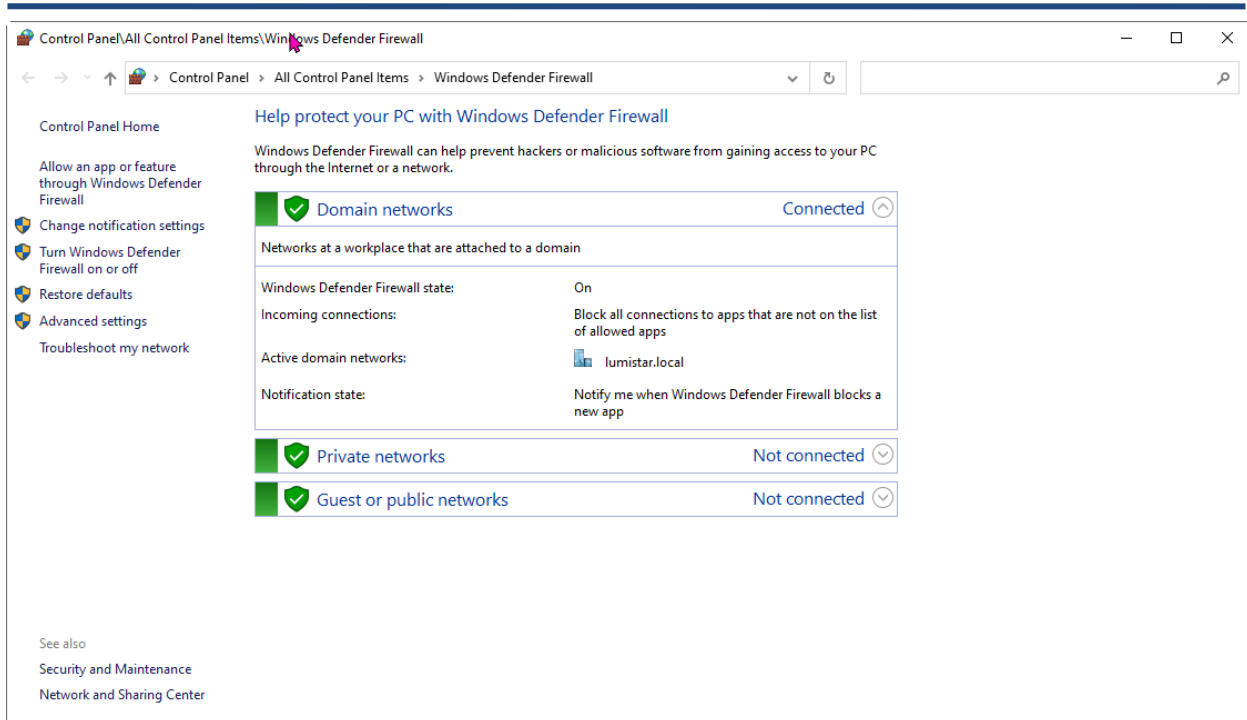


Figure 4-2 Windows Defender Control Window (Win10 Pro)

- 2.) From the menu items on the left of the window, select the option to “Allow an app or feature through Windows Defender Firewall”. This will result in a window as shown in Figure 4-3.

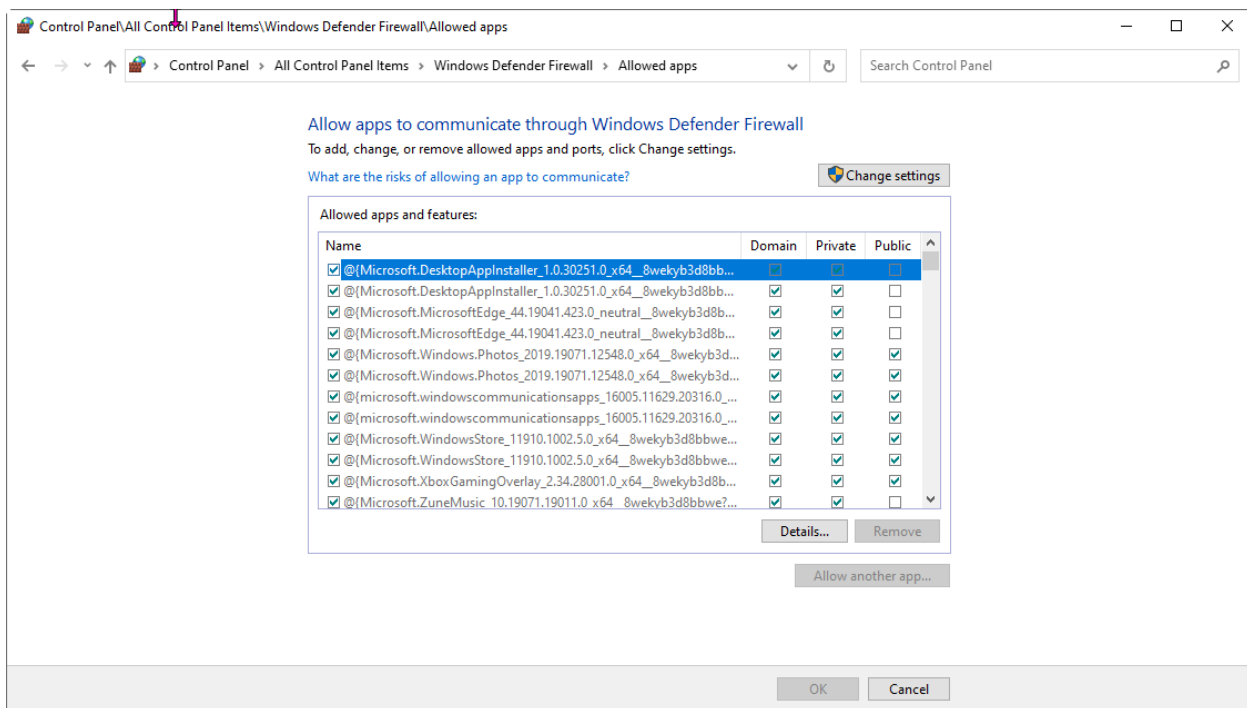
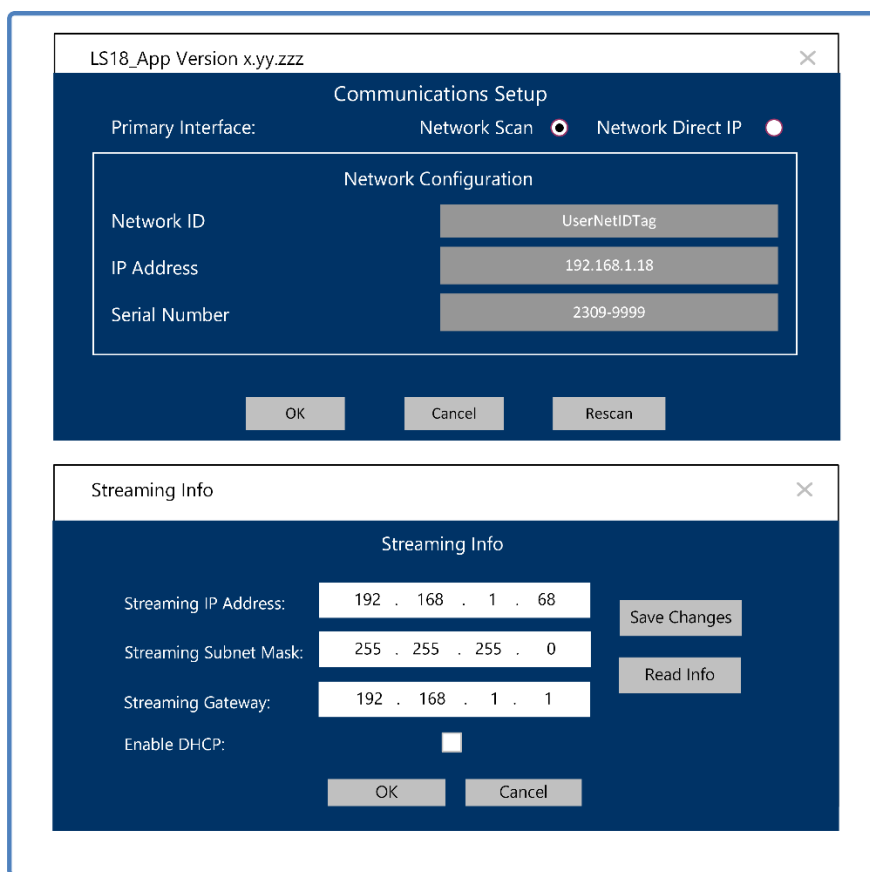


Figure 4-3 Windows Defender Select Application Window (Win10 Pro)

- 3.) Select the **Change Settings** button followed by the **"Allow another app"**. Browse to the installation of the LS18\_App location (c:\Lumistar\LS18M\LS18\_App.exe is the default install location) and select the application. Select to add the application and elect all network types for access.

#### 4.1.2 Communications Setup Launch Windows

When the application is launched, the Communications Setup window shown in Figure 4-4 will be displayed.



**Figure 4-4** Communications Setup Windows

The upper window of Figure 4-4 will appear at the initiation of the LS18\_App after a network scan looking for devices that meet the criteria for LS-18 connections. If units are discovered, they will appear in the list below. Direct IP addressing mode can also be used by selecting the "Network Direct IP" button.

In either case, the user should enter the assigned IP address or select the IP address of the network unit desired and select the OK button. If configuration 2B is available that contains a real-time Data Processing Engine (DPE) is discovered, this is automatically discovered and the window shown in the lower half of Figure 4-4 will be displayed. The customer will be provided with the Device ID reported by the device and the serial number of the device at the accepted IP address. If the device is not discovered at the IP address entered, a message will be returned indicating that the device does not exist at this address. If this occurs, repeat the steps of section 3.1.1 to discover the address of the devices on the network.

---

### 4.1.3 Application Layout

After successfully attaching via the network connection, the network application will open and to the home tab. The general layout of the applications is defined in Figure 4-5. The network application employs extensive use of **tool-tips** to assist the user with quick references related to system controls and status as well as context sensitive help.

For the context sensitive help to work properly, Adobe Acrobat reader needs to be installed. Not all versions of Adobe Acrobat reader allow for remote addressing. Thus, Lumistar has provided a qualified version which can be found in the Utilities Directory on the Software/Support DVD supplied with the delivery of the equipment. An additional copy is available in the install directory of the LS18\_App (in the c:\lumistar\ls18M\UserTools directory).

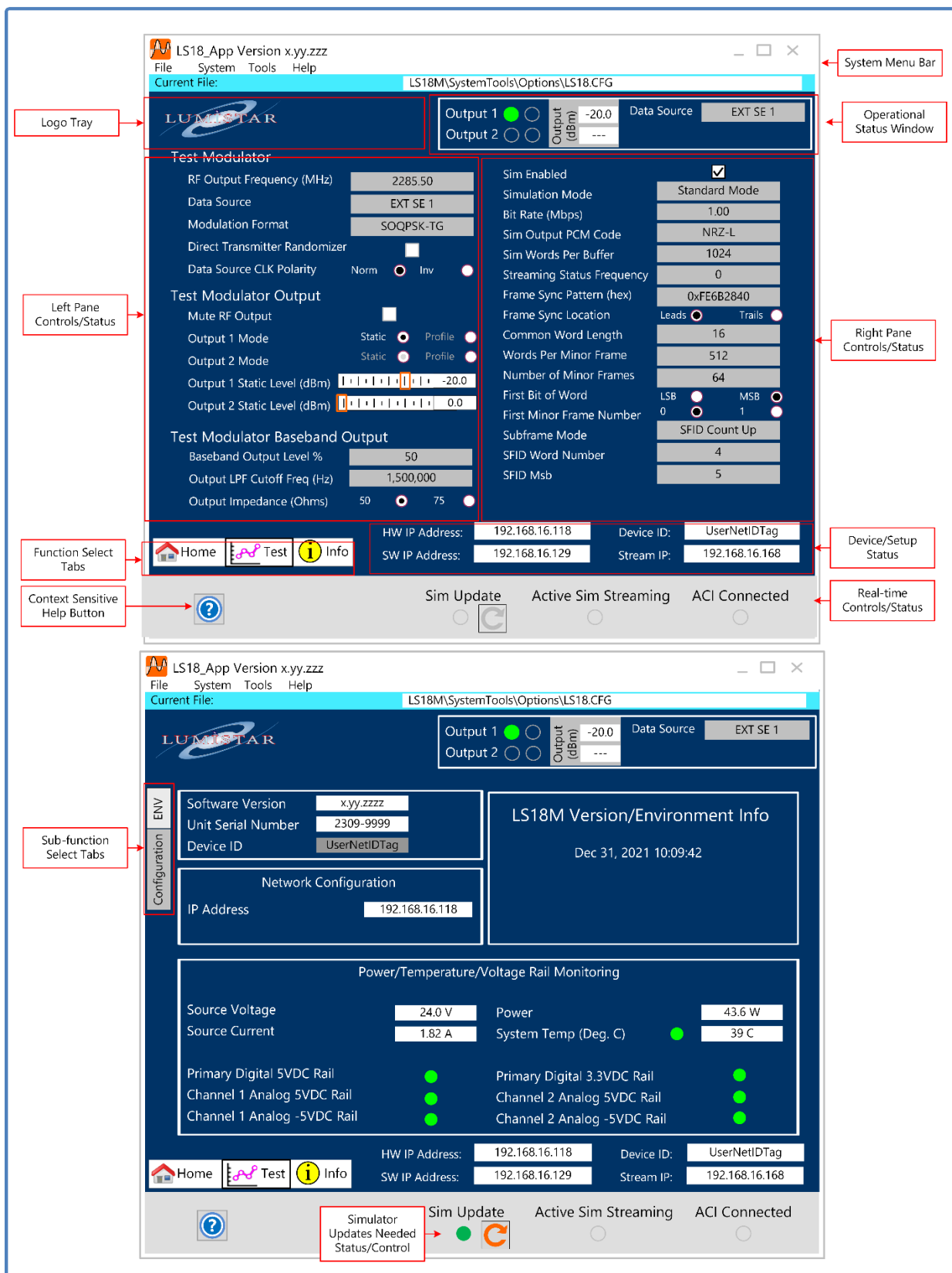


Figure 4-5 Network User Application – General Screen Layout

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The application layout sections are defined as follows:

**Function Select Tabs:** Towards the lower left corner of the application, a series of horizontal selection tabs breaks the command and status functions for the LS-18-M application into signal path components. These tabs are what the user will select to move to various functions within the user application. All function select tabs are visible regardless of the active function select tab selected.

**Logo Tray:** This area of the application provides a company logo display area. The application provides the user the ability to add custom logos in this area. To do so, follow the procedure outlined below:

- 1.) Custom logos can be any pixel density but must be in JPG format.
- 2.) The custom logo must be named "StartupLogo.jpg" to be incorporated into the application at startup.
- 3.) The custom logo must reside in the \Lumistar\LS18\System\Images directory.
- 4.) The custom logo should be presented in a 3.275:1 (L:H) aspect ratio. If the logo is not in the aspect ratio, it will be stretched to this aspect ratio.
- 5.) To prevent a custom logo from being stretched, place the logo in a 1:1 aspect ratio on a box filled with the RGB color of (1, 51, 102).

The logo tray is visible regardless of the active function select tab selected.

**Left Pane Controls/Status:** The left half of the screen below the logo tray contains an area for functional setup entry. The pane contains controls associated with the function or sub-function tab that is selected. The pane is used primarily for command control entry but may secondarily contain status.

**System Menu Bar:** This bar contains typical Windows application menu functions and controls. The upper right corner of this area contains typical windows minimize, maximize, and exit buttons. The minimize button will shrink the application to the toolbar. The maximize button does nothing because the actual size of the application on the host desktop is scaled by a different process which will be described in future paragraphs. The exit button operates in standard windows fashion.

The upper left-hand side displays the application name and version information. Version information has taken two formats since the applications inception. Early versions of the application were in the format of X.YYY where X was always "1" and the YYY function was either two numbers indicating the release or two numbers and a release subversion letter. Present and future version numbers follow the format XX.YY.ZZZ. In this configuration, the XX field represents the generational release number of the application. The YY field represents a major release of the software. Changes in this field often indicate the need for updated DLLs and may indicate that firmware updates are also required. The ZZZ field represents a minor release of the software. Most changes in this field do not require any firmware updates and are indications of application enhancements and/or repairs of discovered issues.

The main menu item bars are detailed in Figure 4-6.

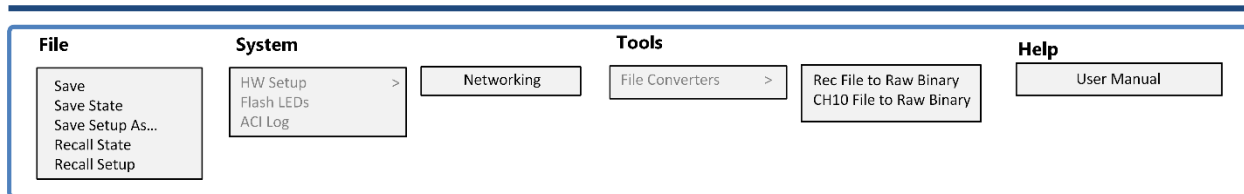


Figure 4-6 Menu Bar – File Drop-Down List

1.) **File:**

- a. Save – This menu option allows the user to save the present setups directly, overwriting the present saved values with the same given name. Be cautious when using this command. Once overwritten, the saved file prior to saving cannot be recovered.
- b. Save State - This menu option allows the user to select and save the present setup as a state file which will be recalled automatically at the next boot.
- c. Save Setup As - This menu option allows the user to select and save a setup under a user defined name.
- d. Recall State – This menu option allows the user to select the last LS-18-M operational state. Each time the application is run, at the time the application is exited, a “state” file is saved. This state file represents the very last setup regardless of whether the user has saved the last operational setup or not.
- e. Recall Setup - This menu option allows the user to recover and load a previously stored setup.

2.) **System:**

- a. HW Setup -> Networking - If the configuration contains a real-time streaming engine (configuration 2B), the SYSTEM menu tab will contain a HW Setup -> Networking tab. This tab allows for the selection of many network attributes. This window appears in Figure 4-7.
  - i. Streaming Status Socket: When streaming data between a network server application and the LS18\_App, handshaking is required to control buffering resources. This status stream requires that a destination IP address and port number be set. This field allows the user to program these values. The values are only activated once the ENABLE checkbox is selected and the “Enable Network Settings” check box is enabled. Multicast addresses can be used. There is no checking of the IP addresses for validity. Many addresses are reserved for special purposes. The Internet Assigned Numbers Authority (IANA) is responsible for maintaining the official assignments of IP addresses for specific uses. IANA provides a list of registered IP address ranges which can be found at the following link: <https://www.iana.org/assignments/ipv4-address-space/ipv4-address-space.xhtml>

The use of the provided Lumistar UDP agent application **TDynaSim** operating in ACI mode will automatically control and coordinate these settings.

- 
- ii. Streaming Data Socket: When streaming data between a network software server and the LS18\_App, an input socket address needs to be provided to the LS18\_App to instruct it where the data stream will be sent from. This socket requires that a destination IP address and port number be set. This field allows the user to program these values. The values are only activated once the ENABLE checkbox is selected and the "Enable Network Settings" check box is enabled. Multicast addresses can be used. There is no checking of port assignment validity other than a range check for values between 0 and 65,535. Many of these are reserved for privileged services.

The use of the provided Lumistar UDP agent application **TDynaSim** operating in ACI mode will automatically control and coordinate these settings.

- iii. Streaming Ack Socket: When streaming data between a network software server and the LS18\_App, a socket for acknowledgments must be established. This socket requires that a destination IP address and port number be set. This field allows the user to program these values. The values are only activated once the ENABLE checkbox is selected and the "Enable Network Settings" check box is enabled. Multicast addresses can be used. There is no checking of port assignment validity other than a range check for values between 0 and 65,535. Many of these are reserved for privileged services.

The use of the provided Lumistar UDP agent application **TDynaSim** operating in ACI mode will automatically control and coordinate these settings.

- iv. Close UDP Streams on Exit: This control allows the user to select the behavior of the UDP streaming data upon the close of the control application. If it is desired that the UDP streaming data sources automatically be halted at the close of the application, then select this option. If selected, during the normal closing of the application, all open streaming sources will be properly closed upon exit. If something unexpected happens in the execution of the controlling application software or to the OS of the hosting platform that interrupts normal software operations, selecting this option will instruct the DPE server to halt these streams on its own within 90 seconds of the application or OS anomaly even in cases where the software is no longer in control.
  - v. Enable Network Settings: This is a master control for all individual UDP stream control definitions. The intended implementation is to have the user set controls for all desired UDP streams via the other tab controls. Once all controls are set, enabling this selection will make the control settings active. Conversely, deselecting this control will revert to direct internal application control of all UDP streams.
  - vi. Enable Alternate Control Interface (Streaming ACI): This selection enables and disables the Alternate Control Interface of the streaming application. This
-

interface allows for an external client to control and status all aspects of the LS18 through a private TCP connection. A shared port number must be set for this interface. It is beyond the scope of this documentation to describe the details of this interface. Once enabled, the *ACI Connected* LED on the Real-time Launch Controls/Status section of the application window will be green. When disabled, the *ACI Connected* LED will be shown as transparent.

The use of the provided Lumistar UDP agent application *TDynaSim* operating in ACI mode will automatically control and coordinate these settings.

- vii. *Network Adapter Name*: In modern target host platforms, it is not uncommon to have multiple, independent network interfaces. This sometimes causes confusion as to which NIC adapter is associated with the application. This control allows the user to select the NIC adapter a target host by OS name identification.
- viii. *Network Adapter IP Address*: This control allows the user to identify the associated IP address of a given NIC adapter by IP address.
- b. *FLASH LEDs* – This button initiates a toggling red-blue LED cadence that lasts for approximately 8 seconds on the unit being commanded. This is useful for identification scenarios where more than one device is on the network.
- c. *ACI Log* – This is a debug window of Alternate Control Interface (ACI) commands used during setup and network control. This window will be activated via this menu. The ACI interface will be described further later in this document. The window is shown in Figure 4-8.

The screenshot shows the 'Networking Setup' dialog box. It has a title bar 'Networking Setup' and a close button. The main content area is titled 'Networking'. It contains several sections:

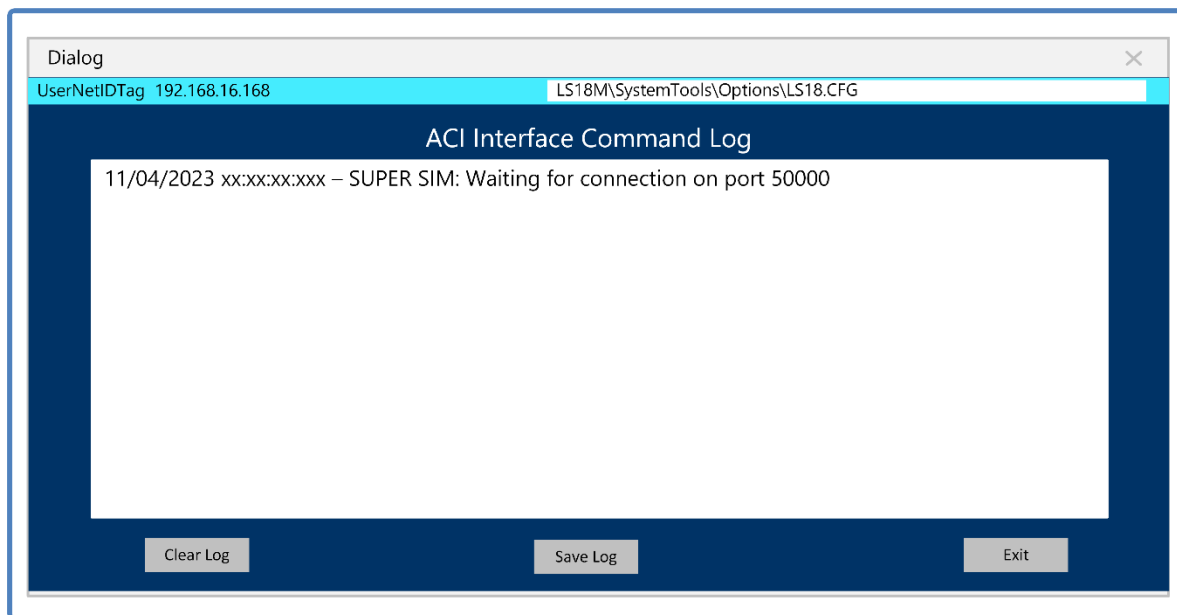
- UDP Stream Table:**

UDP Stream	IP Address	Destination Port No	Multi Cast	Enable
Streaming Status Socket	230 . 10 . 10 . 10	56000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Streaming Data Socket	192 . 168 . 16 . 129	55000	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Streaming Ack Socket	192 . 168 . 16 . 129	56000	<input type="checkbox"/>	<input checked="" type="checkbox"/>
- Close UDP Streams on Exit (90 sec Max.):** ☒ (Annotated: UDP Stream Time-out Enable/Disable)
- Enable Network Settings:** ☒ (Annotated: Master Network Enable/Disable)
- Enable Alternate Control Interface (Streaming ACI):** ☒ (Annotated: ACI Interface Controls)
- ACI Server Port Number:** 55000 (Annotated: ACI Interface Controls)
- Network Adapter Name:** Intel Ethernet Connection 1219-LM
- Network Adapter IP:** 192 . 168 . 16 . 129

At the bottom are 'OK' and 'Cancel' buttons. Annotations with pink boxes and arrows point to specific controls: 'Multicast Connection' points to the 'Multi Cast' column header; 'Source Enable/Disable' points to the 'Enable' column header; 'UDP Stream Time-out Enable/Disable' points to the 'Close UDP Streams on Exit' checkbox; 'Master Network Enable/Disable' points to the 'Enable Network Settings' checkbox; and 'ACI Interface Controls' points to the 'Enable Alternate Control Interface' checkbox and the 'ACI Server Port Number' field.

Figure 4-7 System – Networking Tab



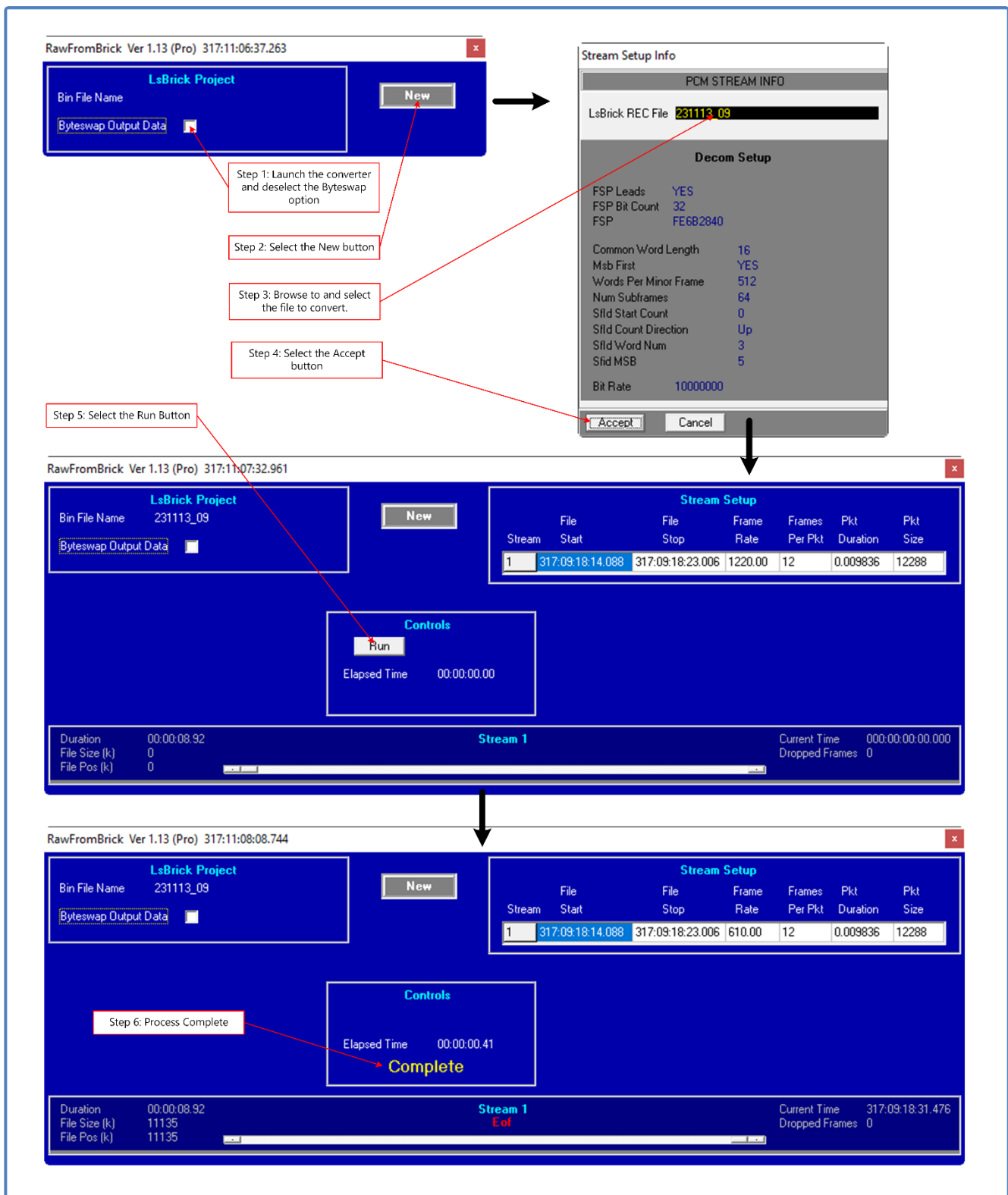


**Figure 4-8** System – ACI Log

**3.) Tools:**

- a. File Converters – This menu selection will launch one of two different file converter utilities to produce binary playback files for upload.
  - i. Rec File to Raw Binary – This utility allows the user to convert recorded files from the Lumistar equipment capable of recording real-time data to binary playback files for the LS-18 system. Equipment capable of recording data files include the LS-28M, the LS-48M and the LS-68M (DPE).

Once this utility is launched, Figure 4-9 shows the steps to properly utilize this utility.



**Figure 4-9** Conversion Utility - Converting Lumistar Recording files to Binary Playback Files

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- ii. CH10 Filer to Raw Binary - This utility allows the user to convert CH10 recorded files from the Lumistar equipment, or other sources, to binary playback files for the LS-18 system. Since CH10 files can contain multiple PCM streams, each stream will need to be extracted. Ensure that the desired stream of data has been selected during conversion.

Once this utility is launched, Figure 4-10 shows the steps to properly utilize this utility.

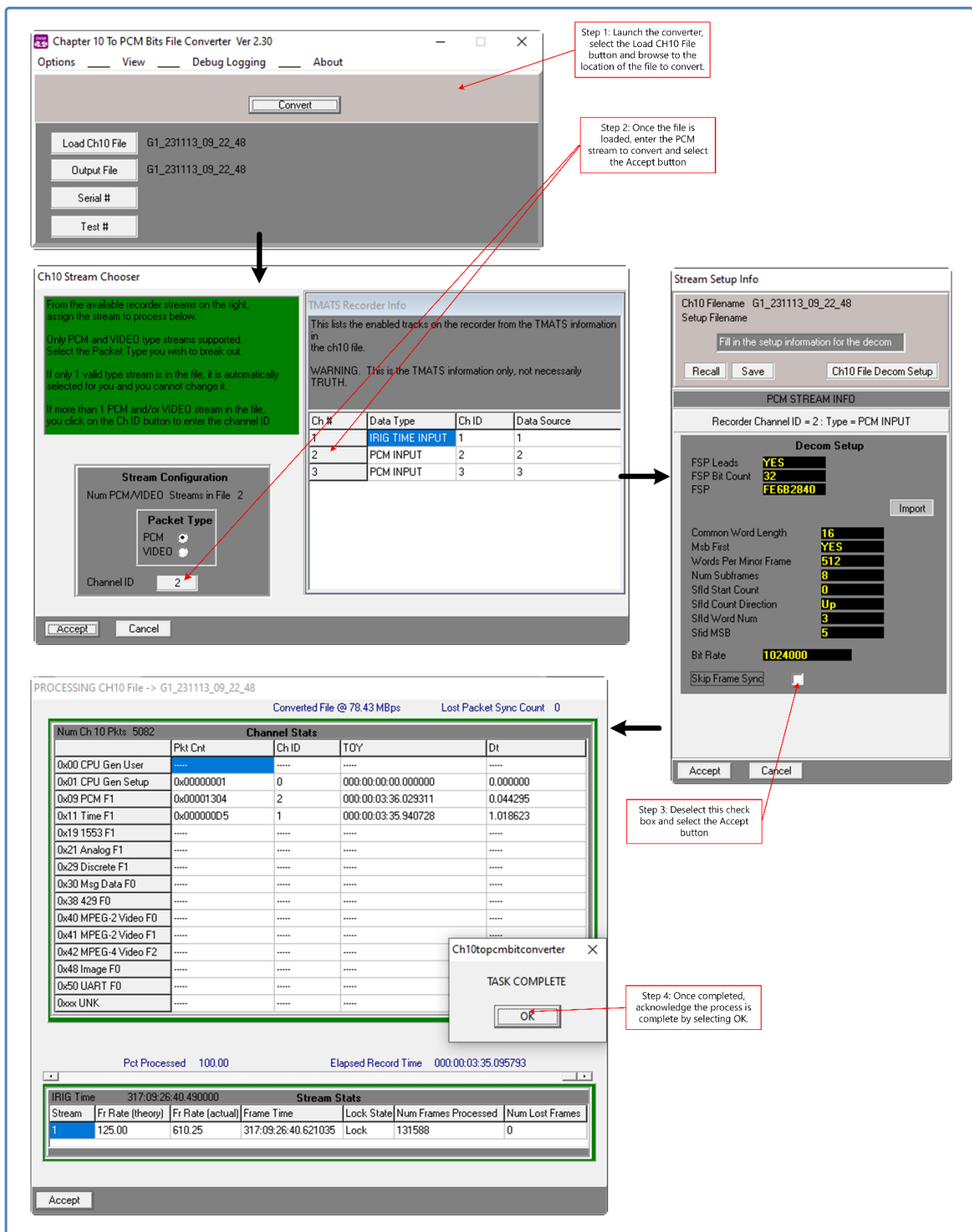


Figure 4-10 Conversion Utility - Converting CH10 files to Binary Playback Files

4.) **Help:**

- b. User's Manual – This menu selection will launch a host PC's PDF viewer and display a full copy of any available associated manuals.

The System menu bar is visible in all function select tabs.

**Operational Status Window:** In the upper right-hand corner of the active application window is the operational status window. This area contains status related to the RF channel operations within the LS-18 system. The meanings of the LEDs and window contents is shown in Figure 4-11.

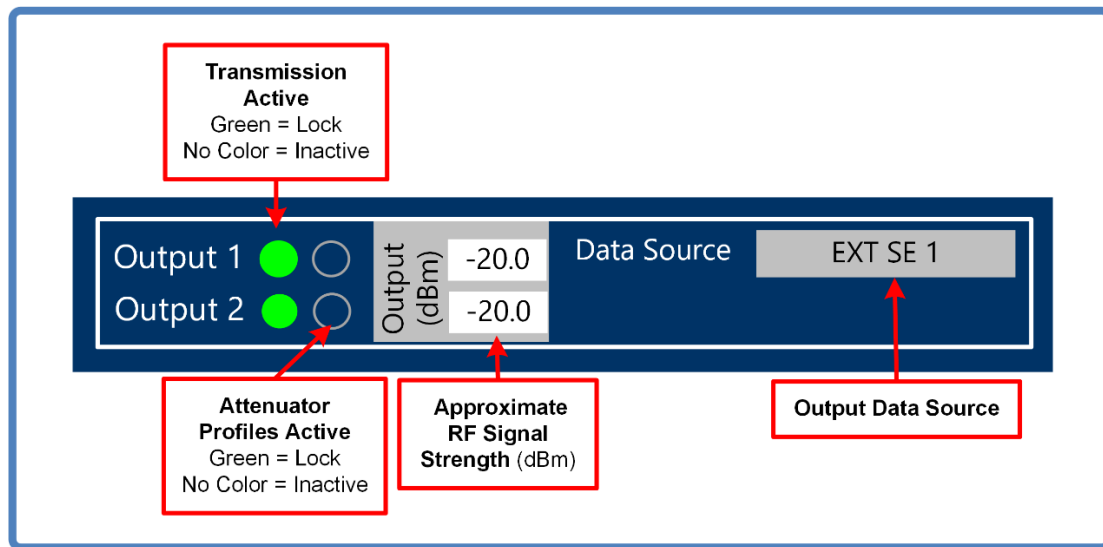


Figure 4-11 Status Window Contents

**Device/Setup Status:** In the lower right-hand half of the screen is an area which indicates that device IP Addresses of the target host and the address of the LS-18 RF engine, the user selected device network ID tag, and the real-time DPE streaming IP address, if applicable. This data is visible in all function select tabs.

**Sub-function Select Tabs:** On several of the function select tabs, a series of vertical sub-selection tabs provide the operator the ability to address specific functions within the primary tab function. These vertical tabs redefine the page layouts to detail controls and status for the requested specialized tab sub-function. Only sub-function tabs associated with the operational mode that is active are enabled.

**Right Pane Controls/Status:** The right half of the screen below the logo tray contains an area reserved primarily for status updates but can facilitate additional functional setup entry.

**Real-time Controls/Status:** At the bottom of the application GUI, real-time controls and status are displayed. This area is available in all tab views. Status on whether the ACI interface is active and whether the simulator data has been updated and not downloaded. If simulation data settings have been changed

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but not downloaded to the hardware, the simulator update button will turn orange. If the update button is gray, simulator settings are reflected by the values displayed in the operator GUI.

**Context Sensitive Help:** Context sensitive help is available for the operational software. Depressing the blue question mark on any operational software tab will bring up the user's manual page directly related to the tab being displayed. This assists the user in finding information related to operations of the tab being displayed.

In order for this feature to work, a copy of Adobe Reader must be installed on the target host. Lumistar has signed agreements to distribute a copy of Adobe Reader for installation. This installation can be found in the c:\lumistar\LS28M\UserTools directory. Once installed, this application will automatically be opened to the correct User's Manual page of the associated tab being viewed.

#### 4.1.4 Function Select Tab – Home

The Home tab is one of the three function select tabs and likely the most utilized. From this tab, most users can setup 90% plus of all the primary functions of the RF Modulator as well as view status on the operations of all aspects of the system. The Home tab for Configuration 2B is shown in Figure 4-12. The Home tab for configuration 2A is shown in Figure 4-13.

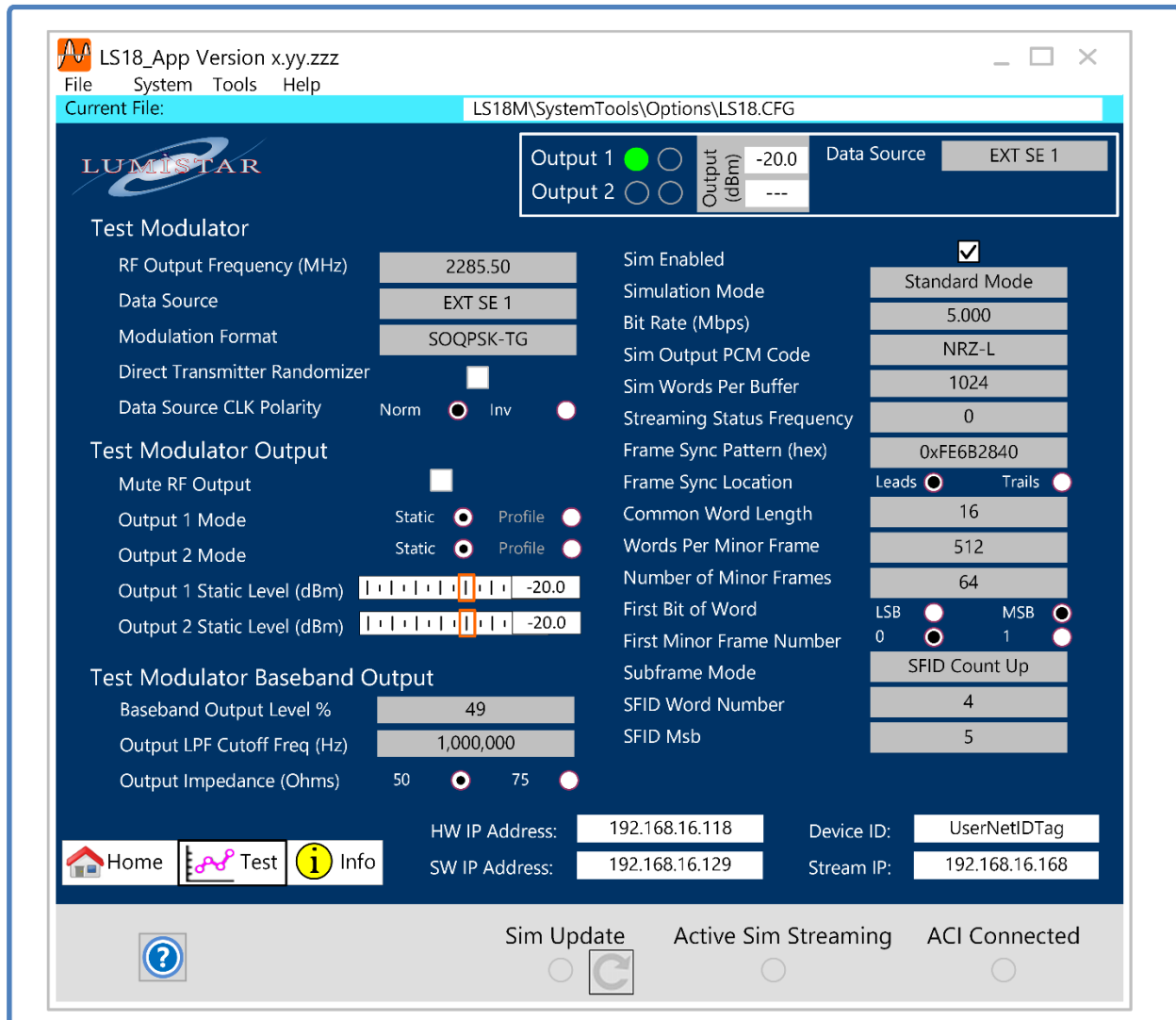
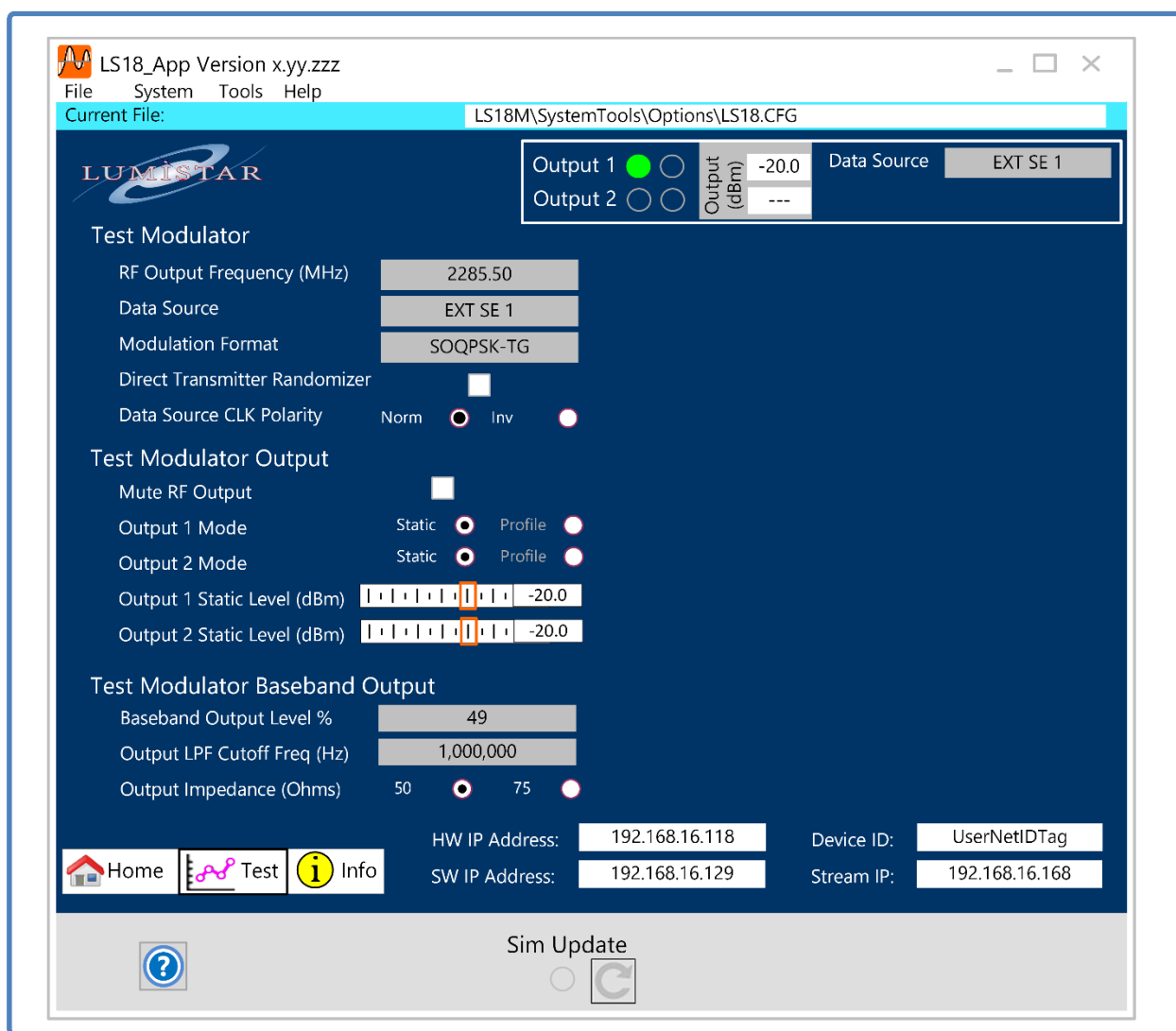


Figure 4-12 LS18\_App – Home Tab for Configuration 2B



**Figure 4-13** LS18\_App – Home Tab for Configuration 2A

**RF Output Frequency:** This application control allows the user to program the RF modulation frequency center frequency in megahertz. Minimum frequency step is 250kHz. RF frequency bands are defined on the INFO-CONFIGURATION tab and are automatically displayed by selecting this input tab. Setting frequencies outside the allowed ranges or for bands that have not been enabled will be ignored and the present tune frequency will be unchanged.

**Data Source:** There are five allowed data sources for the LS-18 system when operation in configuration 2A. The unit contains an internal PCM/PRN data source, two single-ended 5V TTL clock and data inputs, and two RS422 differential clock and data inputs. This control provides a drop-down menu with these selections. When the unit is operating in the LS-18-R1 or LS-18-P format in configuration 2B, EXT\_SE\_1 input is the default input connected to the real-time DPE source. This will be the selection used most often. Selections of any other input sources will require connections to external sources.



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**Modulation Format:** The unit can provide several different RF modulation techniques for the source data tuned to the output center frequency. These include PCMFm, SOQPSK-TG, MH-CPM, BPSK, QPSK, OQSPK. Future additions to these formats are in development. A drop-down menu is provided to select between these options. Consult the INFO-CONFIGURATION tab for modes enabled.

**Direct Transmitter Randomizer:** This select box enables the randomizing of the source data, regardless of the source providing it, directly at the transmission engine. This may be helpful or necessary for proper transmission and reception of the data source especially when the source data lacks transition density. When the box is checked, this function is enabled.

**WARNING:** On-board data PCM encoding provides randomization functions. Thus, if randomization has been applied to simulated, streamed or playback data sources, this selection box should not be used. Using transmitter randomization in conjunction with already randomized data will likely result in undesirable effects.

**Data Source CLK Polarity:** This radio button selection enables the polarity of the source data clock. This may be helpful in some decoding situations. It is advised to maintain Normal clock polarity during normal operations.

**Mute RF Output:** This select box enables and disables the RF Modulation outputs for all available outputs. When enabled (checked), the Output Mode and Output Static Level controls will be removed from the control window. When enabled (checked), no RF power will be provided at the outputs. When disabled (unchecked), all output controls will be active.

**Output X Mode:** This radio button selection is available when the Mute RF Output is disabled. Each channel, represented by **X**, allows for separate controls, if optional dual channel operational is present. Consult the INFO tab for licensing. The Static adjust mode allows for manual control of the individual output. The Profile mode allows for automated control of the RF output levels based on downloaded profiles. The profile functionality will be provided in future releases.

**Output X Static Level (dBm):** The slide control allows for the adjustments of individual RF modulation outputs. Each channel, represented by **X**, allows for separate controls. At the end of each slide control is a entry box where the desired value can be directly entered.

**Baseband Output Level (%):** This control adjusts the peak-to-peak voltage of the baseband output voltage. Actual voltage levels depend on the impedance of the load so controls are provided in percentage of maximum possible output drive.

**Output LPF Cutoff Frequency (Hz):** This control selects the output low-pass filter cutoff frequency applied to the baseband output. There are fifteen selectable filters between 125kHz and 35MHz. This selection is performed automatically based on PCM code selections and data rate. The user can select to override this selection if desired by using this control.

**Output Impedance (Ohms):** This control selects the output impedance of the baseband port. Selections between 50 ohms and 75 ohms.

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**SIM Enabled [Configuration 2B Only]:** This check box enables the on-board simulator. If this selection is made, then the PRN source is disabled. Only one source can be made between the PCM encoder and the PRN encoder in terms of sourcing data to the outputs and the RF modulation engine.

**Simulation Mode [Configuration 2B Only]:** This control provides a drop-down menu that allows the user to select the simulation operational mode. Items listed in this control are based on licensed functionality but can include the following: Standard Mode, Streaming Mode and Playback Mode.

Standard mode indicates that the source of the data being supplied to the RF modulation, PCM outputs and baseband outputs is coming from the IRIG106 PCM simulator based inside the LS-18 system. When in streaming mode, data for the RF modulation, PCM outputs and baseband outputs are coming from UDP streamed packets to the LS-18 system. In NAND Flash File Mode, data must first be uploaded to the on-board NAND flash and then "playback" is performed via user selection from a list of saved recordings.

**Bit Rate [Configuration 2B Only]:** This control provides the rate at which the simulation data will be provided to the RF modulation, PCM outputs and baseband outputs.

This value will be the same rate as that of the SIM tab settings or PRN source settings when in standard mode. It is important to note that only one of these two sources can be active.

In streaming mode, the rate indicates the clock rate at which data from the UDP packets being streamed to the unit will be serialized and produced as outputs. Handshaking between the UDP source software and the unit will maintain a coordinated flow of data in streaming mode. Lumistar provides a software application **TDynaSim** which is capable of streaming UDP binary files to the LS-18 application. This will be described in greater detail later in this document.

In NAND flash playback mode, the rate indicates the clock rate at which data from the recorded files will be retrieved, serialized and produced as outputs.

**Sim Output PCM Code [Configuration 2B Only]:** This value is intended to be a status to the user but can also be used as a control. The primary control for this setting is located on the TEST-PCM Encoder tab. This control provides the user the ability to set the PCM encoding of the output stream produced as digital signals, baseband signals and RF modulation.

PCM output encoding has a direct effect on modulation bandwidth. Self-clocked modulation formats, those which exclusive OR the clock into the data stream, double the modulation bandwidth of the resulting RF.

This setting controls the same routing as the applicable setting on the TEST-PCM ENCODER page. It is shown on the HOME tab as a means of providing the greatest amount of overall setup detail on a single user tab. The two controls on different tabs will be correlated by the software. Changes at either source will be translated to the other control tab automatically.

A table of the available encoding methods is provided in Table 4-1.

**Sim Words Per Buffer [Configuration 2B Only]:** This control only applies to the streaming mode of operation. It provides the number of bytes in the UDP streaming package. When using the Lumistar

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provided **TDynaSim** application to stream data packets, this value should be set automatically. This is the recommended use of this control. Consult the Lumistar factory for additional details.

**Streaming Status Frequency [Configuration 2B Only]:** This control only applies to the streaming mode of operation. It provides a figure as to the rate of streaming status messages that are being passed between the LS18\_App and the streaming software agent. When using the Lumistar provided **TDynaSim** application to stream data packets, this value should be set automatically. This is the recommended use of this control. Consult the Lumistar factory for additional details. This value will be disregarded when not in streaming mode.

PCM Output Encoder Selections	
NRZ-L	Non Return To Zero - Level
NRZ-M	Non Return To Zero - Mark
NRZ-S	Non Return To Zero - Space
RNRZ11-L	PRN11 Randomized Non Return To Zero - Level
RNRZ11-M	PRN11 Randomized Non Return To Zero - Mark
RNRZ11-S	PRN11 Randomized Non Return To Zero - Space
RNRZ15-L	PRN15 Randomized Non Return To Zero - Level
RNRZ15-M	PRN15 Randomized Non Return To Zero - Mark
RNRZ15-S	PRN15 Randomized Non Return To Zero - Space
RNRZ17-L	PRN17 Randomized Non Return To Zero - Level
RNRZ17-M	PRN17 Randomized Non Return To Zero - Mark
RNRZ17-S	PRN17 Randomized Non Return To Zero - Space
RNRZ23-L	PRN23 Randomized Non Return To Zero - Level
RNRZ23-M	PRN23 Randomized Non Return To Zero - Mark
RNRZ23-S	PRN23 Randomized Non Return To Zero - Space
BIO-L	Bi Phase - Level
BIO-M	Bi Phase - Mark
BIO-S	Bi Phase - Space
RZ	Return To Zero
DM-M	Delay Modulation (Miller Code) - Mark
DM-S	Delay Modulation (Miller Code) - Space
DBIO-M	Differential Bi Phase - Mark
DBIO-S	Differential Bi Phase - Space
MDM-M	Modified Delay Modulation (Miller Code) - Mark
MDM-S	Modified Delay Modulation (Miller Code) - Space

**Table 4-1** PCM Encoding Methods

**Frame Sync Pattern [Configuration 2B Only]:** This value is intended to be a status to the user but can also be used as a control. As a secondary control it allows the user to set the frame sync pattern for the standard mode of operation. This pattern can up to 64 bits in length. When using the primary control on the TEST-SIM tab, selection of the frame sync pattern length will result in the appropriate IRIG106 suggested Barker code being set automatically. It is shown on the HOME tab as a means of providing the greatest amount of overall setup detail on a single user tab. The two controls on different tabs will be correlated by the software. Changes at either source will be translated to the other control tab automatically.

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**Frame Sync Location [Configuration 2B Only]:** This value is intended to be a status to the user but can also be used as a control. As a secondary control, the user can specify the location of the frame sync pattern within the frame by the use of this radio button. If the frame sync pattern is at the front of the frame the user should select LEADS. Conversely, if the frame sync pattern is at the end of the data frame the user should select the TRAILS option. The primary control of this setting is located on the TEST-SIM tab. It is shown on the HOME tab as a means of providing the greatest amount of overall setup detail on a single user tab. The two controls on different tabs will be correlated by the software. Changes at either source will be translated to the other control tab automatically.

**Common Word Length [Configuration 2B Only]:** This value is intended to be a status to the user but can also be used as a control. As a secondary control it allows the user to enter the anticipated common word length of the data in a particular frame. The common word length defines the length in bits of the *majority* of words that make up a minor frame. Note, not all words in a minor frame need be of the same length. For example, the majority of the words in a minor frame could be 8-bits in length, and thus the common word length would be 8. However, several of the words might be 14 or 16 bits in length and would be individually specified using the detailed decommutator word attributes which will be outlined in following section. Values between 3 and 16 are provided in accordance with IRIG standards for framed telemetry.

The primary control of this setting is located on the TEST-SIM tab. It is shown on the HOME tab as a means of providing the greatest amount of overall setup detail on a single user tab. The two controls on different tabs will be correlated by the software. Changes at either source will be translated to the other control tab automatically.

**Words per Minor Frame [Configuration 2B Only]:** This value is intended to be a status to the user but can also be used as a control. As a secondary control, the user can define the minor frame length by invoking the Words Per Minor Frame control. Here, the user enters the number of words (of length specified by common word length) that make up a minor frame. The minor frame length may be between 3 and 65536 words.

The primary control of this setting is located on the TEST-SIM tab. It is shown on the HOME tab as a means of providing the greatest amount of overall setup detail on a single user tab. The two controls on different tabs will be correlated by the software. Changes at either source will be translated to the other control tab automatically.

**Number of Minor Frames [Configuration 2B Only]:** This value is intended to be a status to the user but can also be used as a control. As a secondary control, this control dialog box allows the user to enter the number of minor frames in a major frame. Values can be entered between 1 and 65536.

The primary control of this setting is located on the TEST-SIM tab. It is shown on the HOME tab as a means of providing the greatest amount of overall setup detail on a single user tab. The two controls on different tabs will be correlated by the software. Changes at either source will be translated to the other control tab automatically.

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**First Bit of Word [Configuration 2B Only]:** This value is intended to be a status to the user but can also be used as a control. As a secondary control, this radio button control allows the user to set up the meaning of the first bit in a given word. Selection of Most Significant Bit (MSB) and Least Significant Bit (LSB) are provided.

The primary control of this setting is located on the TEST-SIM tab. It is shown on the HOME tab as a means of providing the greatest amount of overall setup detail on a single user tab. The two controls on different tabs will be correlated by the software. Changes at either source will be translated to the other control tab automatically.

**First Minor Frame Number [Configuration 2B Only]:** This value is intended to be a status to the user but can also be used as a control. As a secondary control, this control allows changes in minor frames numbering. This radio button control allows the user to select the number of the first frame.

The primary control of this setting is located on the TEST-SIM tab. It is shown on the HOME tab as a means of providing the greatest amount of overall setup detail on a single user tab. The two controls on different tabs will be correlated by the software. Changes at either source will be translated to the other control tab automatically.

**Subframe Mode [Configuration 2B Only]:** This value is intended to be a status to the user but can also be used as a control. This also acts as a secondary control to implement a subframe synchronization scheme, telemetry designers often add one or more "special" words to each minor frame. The frame synchronizer then uses the special words to establish the location of the first minor frame in the major frame. The LS-18 supports five options in terms of subframe synchronization modes: None, SFID Counting Up, SFID Counting Down, FCC, and URC.

The primary control of this setting is located on the TEST-SIM tab. It is shown on the HOME tab as a means of providing the greatest amount of overall setup detail on a single user tab. The two controls on different tabs will be correlated by the software. Changes at either source will be translated to the other control tab automatically.

**SFID Word Number [Configuration 2B Only]:** This value is intended to be a status to the user but can also be used as a control. The location of the subframe identification (SFID) word(s) is arbitrary within the minor frame and may be specified by the user. As the LS-18 can support up to 65,536 words per minor frame, the user may thus locate the SFID word anywhere within this range, provided it does not overlap or coincide with the frame synchronization pattern location.

The primary control of this setting is located on the TEST-SIM tab. It is shown on the HOME tab as a means of providing the greatest amount of overall setup detail on a single user tab. The two controls on different tabs will be correlated by the software. Changes at either source will be translated to the other control tab automatically.

**SFID MSB [Configuration 2B Only]:** This value is intended to be a status to the user but can also be used as a control. The SFID acts as a frame counter, but it is not always the case that all of the bits in the SFID word are used for this purpose. For example, the SFID word might be 16-bits in length, but there might only

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be 512 minor frames in the major frame. In this scenario, a 9-bit counter ( $2^9 = 512$ ) would be required. The user would specify the location of the counter within the larger 16-bit word by setting the Sync ID most significant bit (MSB) command and selecting the appropriate bit position for the most significant bit of the SFID counter.

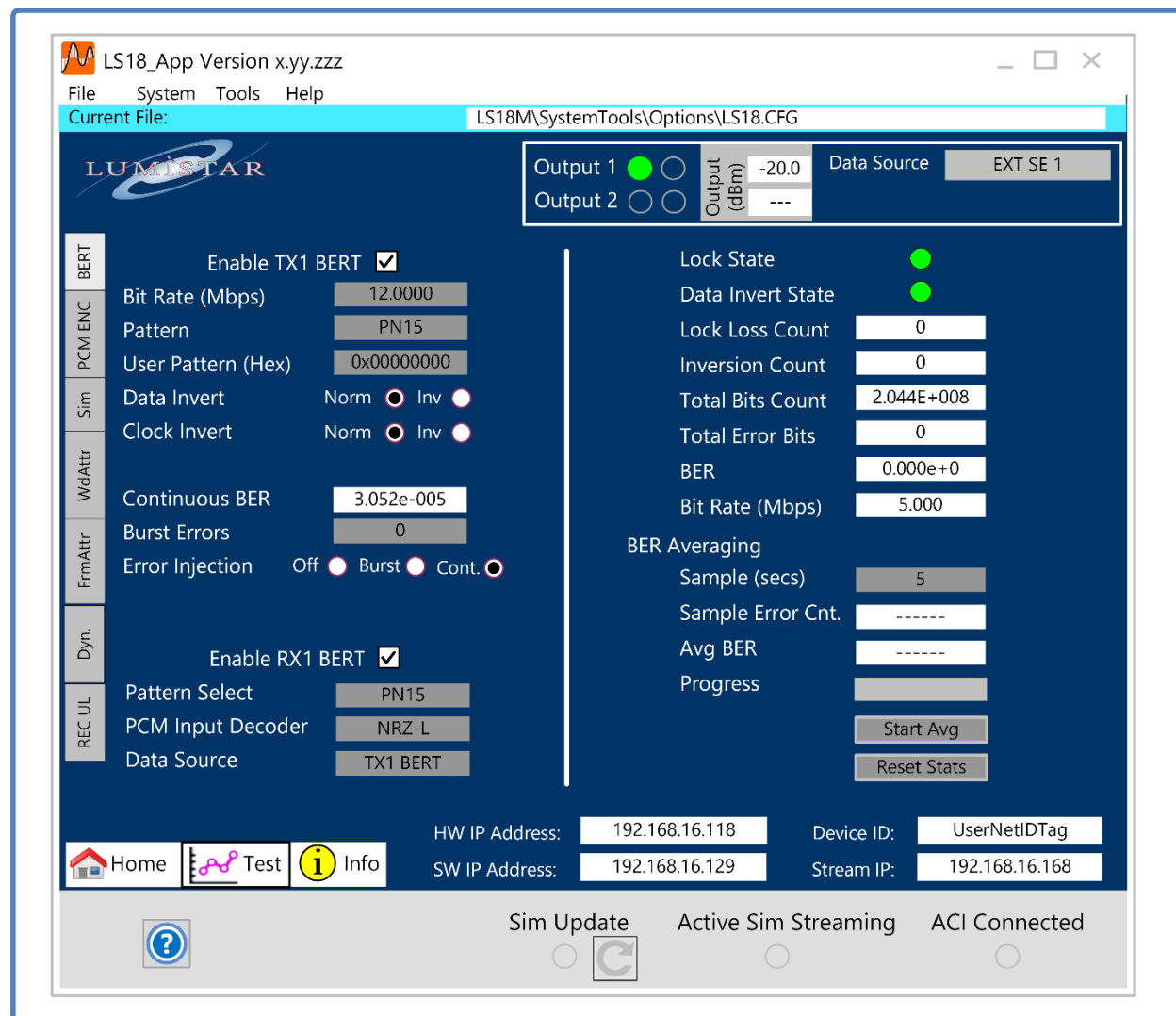
The primary control of this setting is located on the TEST-SIM tab. It is shown on the HOME tab as a means of providing the greatest amount of overall setup detail on a single user tab. The two controls on different tabs will be correlated by the software. Changes at either source will be translated to the other control tab automatically.

### 4.1.5 Function Select Tab – Test

The Test tab provides the user with the ability to self-modulate the RF test modulator either internal PRN sources or IRIG106 PCM framed data.

The following sections contain descriptions of all TEST functionalities.

#### 4.1.5.1 Function Select Test - BERT



**Figure 4-14** LS18\_App – Test BERT Function Select Tab

**Enable TX BERT:** This check-box control enables the functions of the respective transmit (TX) BERT. Deselecting this control will disable the functions of the respective TX BERT.

**Bit Rate (Mbps):** Entry of the TX BERT bit rate is done via this dialog box. Entry of values between 1000 and 60Mbps are allowed although the RF modulation can only maintain 40Mbps reproduction.

**Pattern:** Data patterns for the TX BERT can be selected from this drop-down list. Pattern options include pseudo-random sequences, repetitive patterns and user patterns. The list is as follows: All 0's, All 1's,

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Alternating 0's and 1's, PN3, PN4, PN5, PN6, PN7, PN9, PN10, PN11, PN15, PN17, PN18, PN20, PN21, PN22, PN23 and a selectable User Pattern.

**User Pattern (Hex):** A user defined pattern of up to 31 bits can be entered in hexadecimal in this dialog box. For this pattern to be active, the Data Pattern window must be set to "User Pattern".

**Data Invert:** The TX BERT data pattern polarity can be altered via this left pane control radio button.

**Clock Invert:** The TX BERT clock polarity can be altered via this left pane control radio button.

**Continuous BER:** This status box provides the user with the calculated BER to expect during continuous error inject modes.

**Burst Errors:** This entry box allows the user to program bursts of errors to inject in the PRN stream. These burst errors are limited to a maximum of 64. Burst errors are injected each time the BURST error button is selected.

**Error Injection:** These radio buttons allow the user to select between the three TX BERT injection modes: Off, Continuous and Burst.

The left-pane controls also provide RX BERT settings. These controls include:

**Enable RX BERT:** This check-box control enables the functions of the respective receive (RX) BERT. Deselecting this control will disable the functions of the respective RX BERT.

**RX Pattern Select:** Data patterns for the RX BERT can be selected from this drop-down list. Pattern options include pseudo-random sequences, repetitive patterns and user patterns. The list is as follows: All 0's, All 1's, Alternating 0's and 1's, PN3, PN4, PN5, PN6, PN7, PN9, PN10, PN11, PN15, PN17, PN18, PN20, PN21, PN22, PN23 and a selectable User Pattern. In the case of User Pattern, the RX BERT user pattern will automatically match that of the associated TX BERT User Pattern.

**PCM Input Decoder:** The input data to the RX BERT has been assigned its own PCM decoder. The selection capabilities for this decode are listed in Figure 4-15.



PCM Input Decoder Selections	
NRZ-L	Non Return To Zero - Level
NRZ-M	Non Return To Zero - Mark
NRZ-S	Non Return To Zero - Space
RNRZ11-L	PRN11 Randomized Non Return To Zero - Level
RNRZ11-M	PRN11 Randomized Non Return To Zero - Mark
RNRZ11-S	PRN11 Randomized Non Return To Zero - Space
RNRZ15-L	PRN15 Randomized Non Return To Zero - Level
RNRZ15-M	PRN15 Randomized Non Return To Zero - Mark
RNRZ15-S	PRN15 Randomized Non Return To Zero - Space
RNRZ17-L	PRN17 Randomized Non Return To Zero - Level
RNRZ17-M	PRN17 Randomized Non Return To Zero - Mark
RNRZ17-S	PRN17 Randomized Non Return To Zero - Space
RNRZ23-L	PRN23 Randomized Non Return To Zero - Level
RNRZ23-M	PRN23 Randomized Non Return To Zero - Mark
RNRZ23-S	PRN23 Randomized Non Return To Zero - Space
BIO-L	Bi Phase - Level
BIO-M	Bi Phase - Mark
BIO-S	Bi Phase - Space
RZ	Return To Zero
DM-M	Delay Modulation (Miller Code) - Mark
DM-S	Delay Modulation (Miller Code) - Space
DBIO-M	Differential Bi Phase - Mark
DBIO-S	Differential Bi Phase - Space
MDM-M	Modified Delay Modulation (Miller Code) - Mark
MDM-S	Modified Delay Modulation (Miller Code) - Space

**Figure 4-15** RX BERT Input PCM Decoder Selections

**Data Source:** The input data to the RX BERT can be selected via this pull-down menu. One of two sources can be selected: The BERT clock and data input select, or the input can be directly connected to the TX BERT source in a loop-back arrangement.

The Test BERT right pane contains the results of the RX BERT functions.

**Lock State:** This LED indicator provides the present state of the RX BERT pattern correlator. A green indication indicates that the receive correlator is locked to the selected pattern. If the indicator is yellow, the correlator is unable to establish lock.

**Data Invert State:** This LED indicator provides the present status as to whether the data that the RX correlator is receiving is presently polarity inverted or non-inverted. In the inverted state, the LED indicator will be yellow. If the pattern is not inverted, the LED will contain no color.

**Lock Loss Count:** This status box contains a count of the number of times the RX BERT has lost lock since the last reset.

**Inversion Count:** This status box contains a count of the number of times the RX BERT has detected a pattern inversion since the last reset. This count includes all inversion counts including one to an inverted state and from an inverted state.

**Total Bit Count:** This status box contains the total number of bits that the RX BERT has counted since the last reset condition.

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**Total Error Bits:** This status box contains the total number of error bits that the RX BERT has counted since the last reset condition.

**BER:** This status box contains a calculation of the Bit Error Rate (BER). For this status box, the BER calculation takes the total number of errors counted and divides that number by the total number of bits counted. This calculated value is not a time-averaged value but a long-term trend calculation.

**Bit Rate (Mbps):** This status box provides the present bit rate being received for the specified stream. Values are provided in Mbps.

**Sample (Secs):** The lower area of the right pane contains an averaged BER calculation section. Each stream can be setup to calculate the BER over a programmed period of seconds. To set the averaging period, enter a value in seconds between 2 and 86400 (1 day) in the resulting dialog box.

**Sample Error Cnt:** The number of errors counted over the averaged period will be displayed in this status box.

**Avg BER:** The calculated average BER figure will be displayed in this status box. This will be a calculation of the number of bit errors accumulated in the Sample period divided by the number of bits counted in the averaging period.

**Progress:** The progress status bar provides visual feedback of the averaging process progression. The bar will fill from the left to the right of the display area.

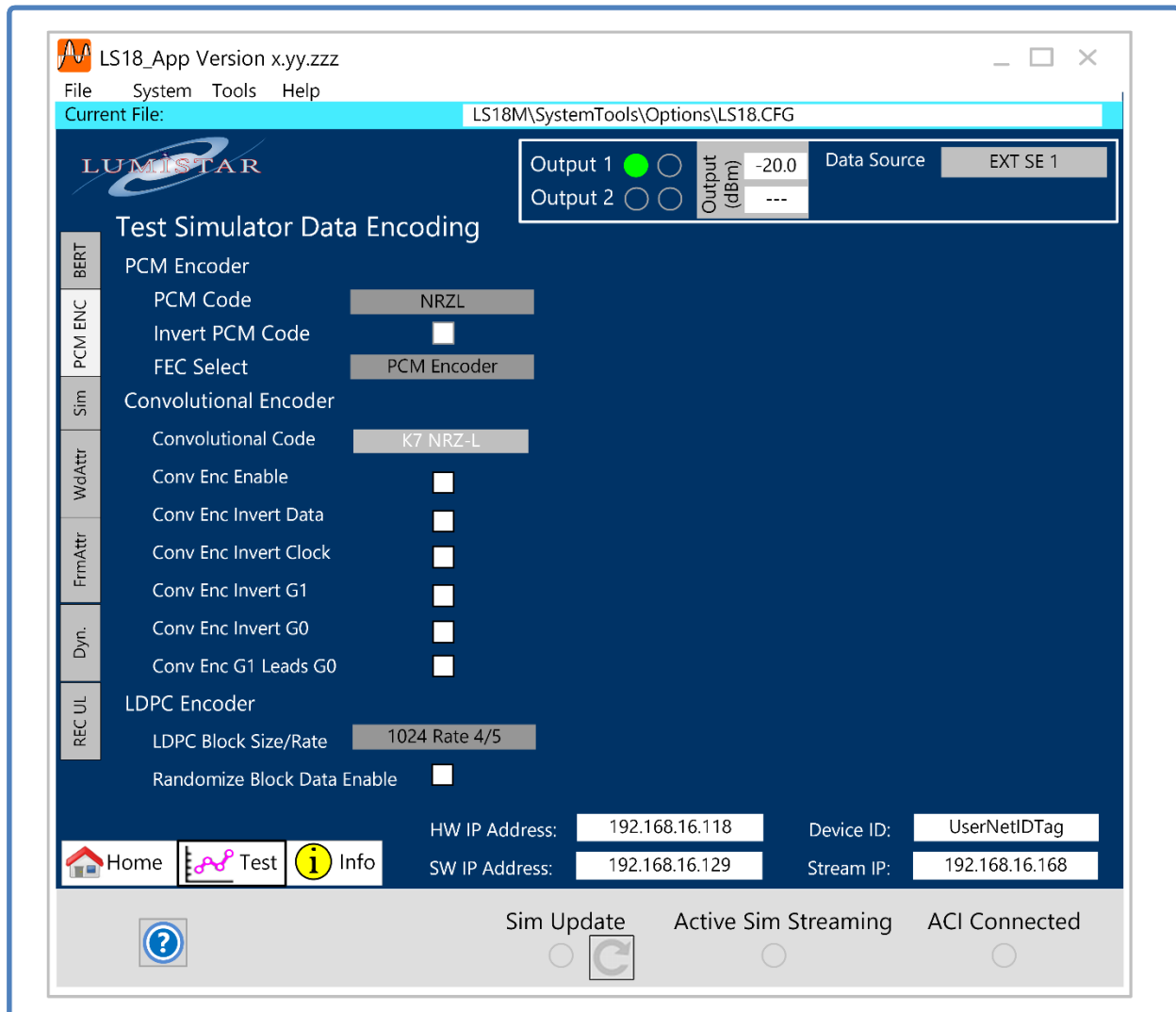
**Stop/Start Avg:** This toggle button is used to initiate and halt the averaged BER calculations for a selected RX BERT stream.

**Reset Stats:** This toggle button is used to clear the bit error and clock counts used for BER calculations on a selected RX BERT stream.

**Start Avg:** This toggle button is used to initiate and halt the BER calculations for the connected RX BERT stream.

**Reset Stats:** This toggle button is used to clear the bit error and clock counts used for all BER calculations.

#### 4.1.5.2 Function Select Test – PCM ENC



**Figure 4-16** LS18\_App – Test PCM Encoding Function Select Tab

**PCM Code:** The source of the PCM is provided in an encoded format. Figure 4-17 contains a list of the PCM code provisions of the LS-18. The user must select one of these formats via the drop-down menu.

PCM Input Decoder Selections	
NRZ-L	Non Return To Zero - Level
NRZ-M	Non Return To Zero - Mark
NRZ-S	Non Return To Zero - Space
RNRZ11-L	PRN11 Randomized Non Return To Zero - Level
RNRZ11-M	PRN11 Randomized Non Return To Zero - Mark
RNRZ11-S	PRN11 Randomized Non Return To Zero - Space
RNRZ15-L	PRN15 Randomized Non Return To Zero - Level
RNRZ15-M	PRN15 Randomized Non Return To Zero - Mark
RNRZ15-S	PRN15 Randomized Non Return To Zero - Space
RNRZ17-L	PRN17 Randomized Non Return To Zero - Level
RNRZ17-M	PRN17 Randomized Non Return To Zero - Mark
RNRZ17-S	PRN17 Randomized Non Return To Zero - Space
RNRZ23-L	PRN23 Randomized Non Return To Zero - Level
RNRZ23-M	PRN23 Randomized Non Return To Zero - Mark
RNRZ23-S	PRN23 Randomized Non Return To Zero - Space
BIO-L	Bi Phase - Level
BIO-M	Bi Phase - Mark
BIO-S	Bi Phase - Space
RZ	Return To Zero
DM-M	Delay Modulation (Miller Code) - Mark
DM-S	Delay Modulation (Miller Code) - Space
DBIO-M	Differential Bi Phase - Mark
DBIO-S	Differential Bi Phase - Space
MDM-M	Modified Delay Modulation (Miller Code) - Mark
MDM-S	Modified Delay Modulation (Miller Code) - Space

Figure 4-17 PCM Output Encoder Selections

**Invert PCM Data:** The LS-18 can invert the encoding data source via this control, effectively doubling the number of PCM code formats provided.

**FEC Select:** This control is used to select from the licensed FEC encoders. These can include convolutional encoding which is sourced to Viterbi decoding. It also can include IRIG106 specified Low Density Parity Coding (LDPC) styles. Based on selection, other sections of the controls on this tab will become functional.

The FEC selections are applied only to the STANDARD simulation operational mode. FEC encoding is not applied to external clock and data sources or streamed data sources.

**Conv Enc Enable:** The user may impose convolutional encoding on the internal test sources by selecting this control.

**Convolution Code:** This drop-down menu allows the user to select the convolutional encoder PCM code and constraint setup. There are four allowed selections implemented: K=7/NRZ-L, K=7/NRZ-M, K=4/NRZ-L, and K=4/NRZ-M. The constraint length of the Viterbi decoder in the DPE is fixed at K=7.

**Conv Enc Invert Data:** This selection box allows the convolutional encoder's data output polarity to be altered. If the box is checked, the convolutional encoder data output will be inverted. If deselected, the convolutional encoder data output will be normal polarity.

**Conv Enc Invert Clock:** This selection box allows the convolutional encoder's clock output polarity to be altered. If the box is checked, the convolutional encoder clock output will be inverted. If deselected, the convolutional encoder clock output will be normal polarity.

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**Conv Enc Invert G1/G0:** This selection box allows the convolutional encoder's G0 and G1 polynomial output polarities to be altered. If the box is checked, the convolutional encoder polynomial output polarity will be inverted. If deselected, the convolutional encoder polynomial output polarity will be normal.

**Conv Enc G1 leads G0:** This selection box allows the convolutional encoder's G1 and G0 polynomial output orders to be altered. If the box is checked, the convolutional encoder polynomial G1 will lead the G0 output. If deselected, the convolutional encoder G0 will lead the G1 output.

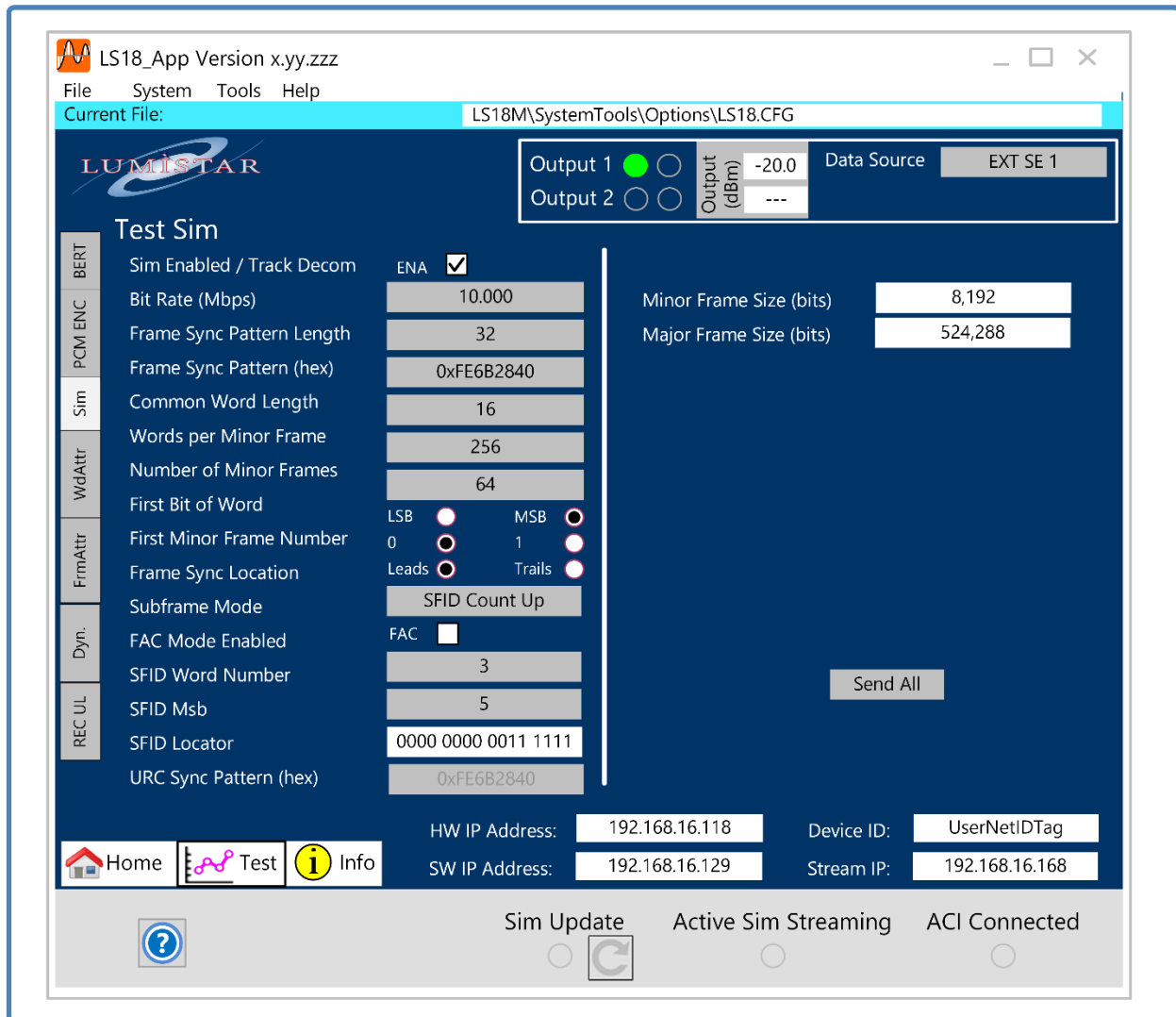
**LDPC Block Size/Rate:** If the FEC selection is for LDPC encoding, this control allows for the six selectable encoding formats specified in the IRIG106-20 documentation. These include Block Size 1024/Rate  $\frac{1}{2}$ , Block Size 4096/Rate  $\frac{1}{2}$ , Block Size 1024/Rate  $\frac{2}{3}$ , Block Size 4096/Rate  $\frac{2}{3}$ , Block Size 1024/Rate  $\frac{4}{5}$ , Block Size 4096/Rate  $\frac{4}{5}$ .

**Randomize Block Data Enable:** The user may impose randomization of the LDPC block data by selecting this control.

#### 4.1.5.3 Function Select Test – SIM: Standard Mode

There are two Test SIM modes: one for standard Simulator PCM mode, one for the NAND playback mode. The streaming mode does not require a Test SIM mode tab.

The following section relates to the standard Simulator PCM mode.



**Figure 4-18** LS18\_App – Test SIM-Standard Simulation Mode Function Select Tab

**Sim Enabled/Track Decom:** The SIM ENA check box allows the user to enable and disable the PCM minor/major data frame simulator functions on the LS-18. When the box is checked, the simulator is active. When unchecked, the simulator is disabled.

**Bit Rate (Mbps):** This control box allows the user to set the desired PCM simulator bit rate. Values from 1Kbps to 60Mbps are allowed. Note that RF modulation limits are 40Mbps.

**Frame Sync Pattern Length:** This control box allows the user to set the desired PCM Simulator Frame Sync pattern length. Values from 7 to 64 are supported. Values set in this window will cause the Frame Sync

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Pattern controls to be automatically filled with the IRIG-106 defined Barker code. However, this value can be altered manually by the user if desired.

**Frame Sync Pattern:** This control box allows the user to set a specific Simulator Frame Sync pattern as defined by the Frame Sync Pattern Length control. As indicated, this value will be automatically filled with the IRIG-106 specified Barker code based on the Frame Sync Pattern length entry. However, it is possible for the user to alter this pattern if desired.

**Common Word Length:** This control box allows the user to set a specific Simulator Common Word Length. Values from 3 to 16 bits may be entered.

**Words Per Minor Frame:** This control box allows the user to set the number of words defined in a minor frame. Values from 3 to 65536 words may be entered.

**Number of Minor Frames:** This control box allows the user to set the number of minor frames that make up a major frame. Values from 1 to 65536 words may be entered.

**First Bit of Word:** This radio button control allows the user to set up the meaning of the first bit in a given word. Selections of Most Significant Bit (MSB) and Least Significant Bit (LSB) are provided.

**First Minor Fame Number:** Simulator minor frames can be numbered starting with 0 or 1. This radio button control allows the user to select the number of the first frame.

**Frame Sync Location:** The user can specify the location of the frame sync pattern within the simulation frame by the use of this radio button. If the frame sync pattern is at the front of the frame the user should select LEADS. Conversely, if the frame sync pattern is at the end of the data transmission the user should select the TRAILS option.

**Subframe Mode:** To implement a Simulation subframe synchronization scheme, telemetry designers often add one or more "special" words to each minor frame. The frame synchronizer then uses the special words to establish the location of the first minor frame in the major frame. The simulator supports five options in terms of subframe synchronization modes: None, SFID Counting Up, SFID Counting Down, FCC, and URC.

When NONE is select, the PCM simulator will consider that no sub-frame mode is implemented.

When SFID Counting Up is selected, the simulator will assume that the unit is utilizing a Subframe ID (SFID) Counter that is counting up in value. The count will start from 0 or 1 as directed by the First Minor Frame Number setting.

When SFID Counting Down is selected, the simulator will assume that the unit is utilizing a Subframe ID (SFID) Counter that is counting down in value. The count will terminate in either 0 or 1 as directed by the First Minor Frame Number setting.

Frame Code Compliment (FCC) mode is a method where the complement (inverted) synchronization pattern is placed in the FSP location in minor frame 0 by the PCM simulator. All other frame sync patterns are not inverted. Because the complement of the frame synchronization pattern exhibits the same correlation

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properties as the true pattern, frame sync lock will not be compromised. Minimum sync overhead is attained using this method, although it requires longer subframe acquisition time than the SFID method.

Unique Recycling Code (URC) mode is a variation of FCC mode. For URC, a unique word is added anywhere in the first minor frame. A unique synchronization pattern not related to the primary synchronization pattern is used. This can replace the frame sync pattern or be at a different location in the first minor frame.

**FAC Mode Enabled:** This simulator control places the PCM simulator in FAC mode. If this box is selected, the FAC mode is enabled. Deselecting this box disables the FAC mode.

**SFID Word Number:** The location of the subframe identification (SFID) word(s) is arbitrary within the simulation minor frame and may be specified by the user with this control dialog box. As the LS-68-M can support up to 65,536 words per minor frame, the user may thus locate the SFID word anywhere within this range, provided it does not overlap or coincide with the simulator frame synchronization pattern location.

**SFID MSB:** The PCM Simulator SFID acts as a frame counter, but it is not always the case that all of the bits in the SFID word are used for this purpose. For example, the SFID word might be 16-bits in length, but there might only be 512 minor frames in the major frame. In this scenario, a 9-bit counter ( $2^9 = 512$ ) would be required. The user would specify the location of the counter within the larger 16-bit word by setting the Sync ID most significant bit (MSB) command and selecting the appropriate bit position for the most significant bit of the SFID counter.

**SFID Locator:** The Simulator SFID Locator is a status display that graphically illustrates where the Subframe Sync ID MSB is located within the minor frame SFID word.

**URC Sync Pattern (hex):** If the Simulator URC mode has been selected in the Subframe Mode control list, the URC pattern must be defined. Up to a 64-bit URC pattern can be defined by the user.

The Test PCM Simulator left pane area contains status for the LS-18 internal PCM Simulator and a "Send All" control button.

**Minor Frame Size (bits):** This status window provides a calculation of the simulator's minor frame size in bits.

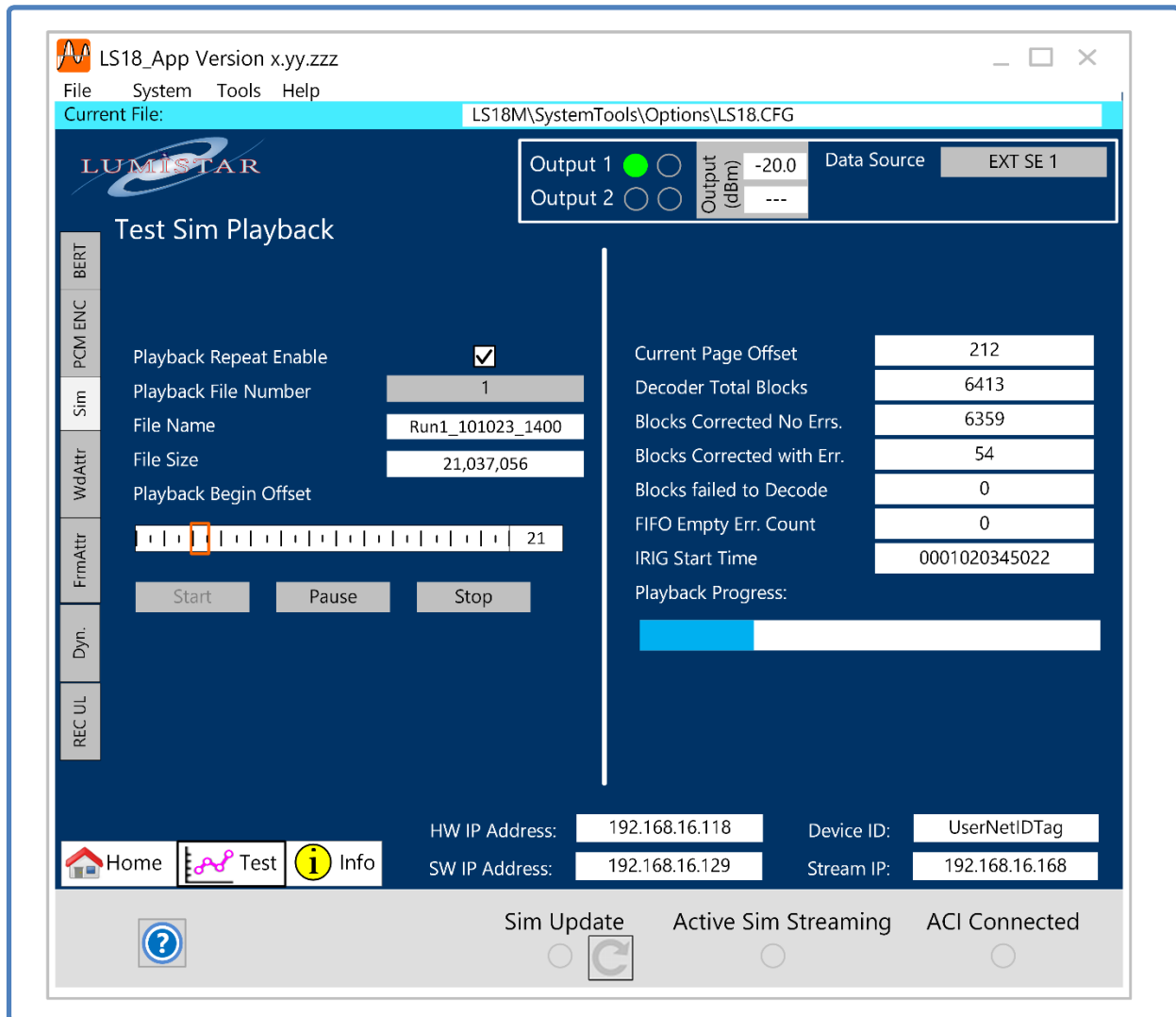
**Major Frame Size (bits):** This status window provides a calculation of the simulator's major frame size in bits.

**Send All:** This control button is used to send all related Simulator setup parameters to the internal firmware for setup. If a change has been made, a message is placed in the left pane stating "Changes have been made that need to be sent". At the same time the Sim Updates LED on the Real-time Controls banner will be illuminated green and the Sim Update button will be colored orange.



#### 4.1.5.4 Function Select Test – SIM: Playback Mode

The following section relates to the standard Simulator file playback mode.



**Figure 4-19** LS18\_App – Test SIM NAND Playback Function Select Tab

**Playback Repeat Enable:** If it is desired to have the playback file selected to be repeated, selection of this check box will cause the file to be repetitively executed.

**Playback File Number:** Selecting this control will bring up a list of the playback files available to choose from. Selecting the file will fill with this control with the file number, file name, and file size that will be played back.

**File Name:** This status window is filled with the File name of the selected recording file.

**File Size:** This status window is filled with the File size of the selected recording file.

---

**Playback Begin Offset:** This slider control allows the user to select an offset location in the loaded recording file to begin playing. The slider has a data entry box at the right end of the slider allowing the percentage to be directly entered by the user.

**START/PAUSE/STOP:** The START button begins the playback process. The playback can be paused with the PAUSE button and then stopped with the STOP button.

**Current Page Offset:** This status window shows the NAND memory page that is presently being played back.

**Decoder Total Blocks:** When data is stored in NAND memory, due to its particular memory construction, it must first be encoded with a form of Forward Error Correction (FEC). When the playback process begins, the stored data must be decoded prior to serialization. This status window shows the number of blocks that have been decoded for the present file playback.

**Blocks Converted No Errs:** This status window provides a count of those decoded blocks.

**Blocks Corrected With Errs:** This status window provides a count of the decoded blocks that contained errors that were corrected by the FEC encoding.

**Blocks Failed to Decode:** If file FEC decoding fails, this status window will provide a count of these occurrences. In practical terms, this status should always be zero. Values greater than zero indicate potential recording file corruption.

**FIFO Empty Err Count:** This status provides a count of error conditions where playback retrieval is outpaced by the serialization of the data stream. This value should always be zero.

**IRIG Start Time:** When the playback function begins, this status window is updated with the present IRIG time reader value as reference.

**Playback Progress:** This gauge shows the progress of the present recording playback.

## 4.1.5.5 Function Select Test – WdAttr

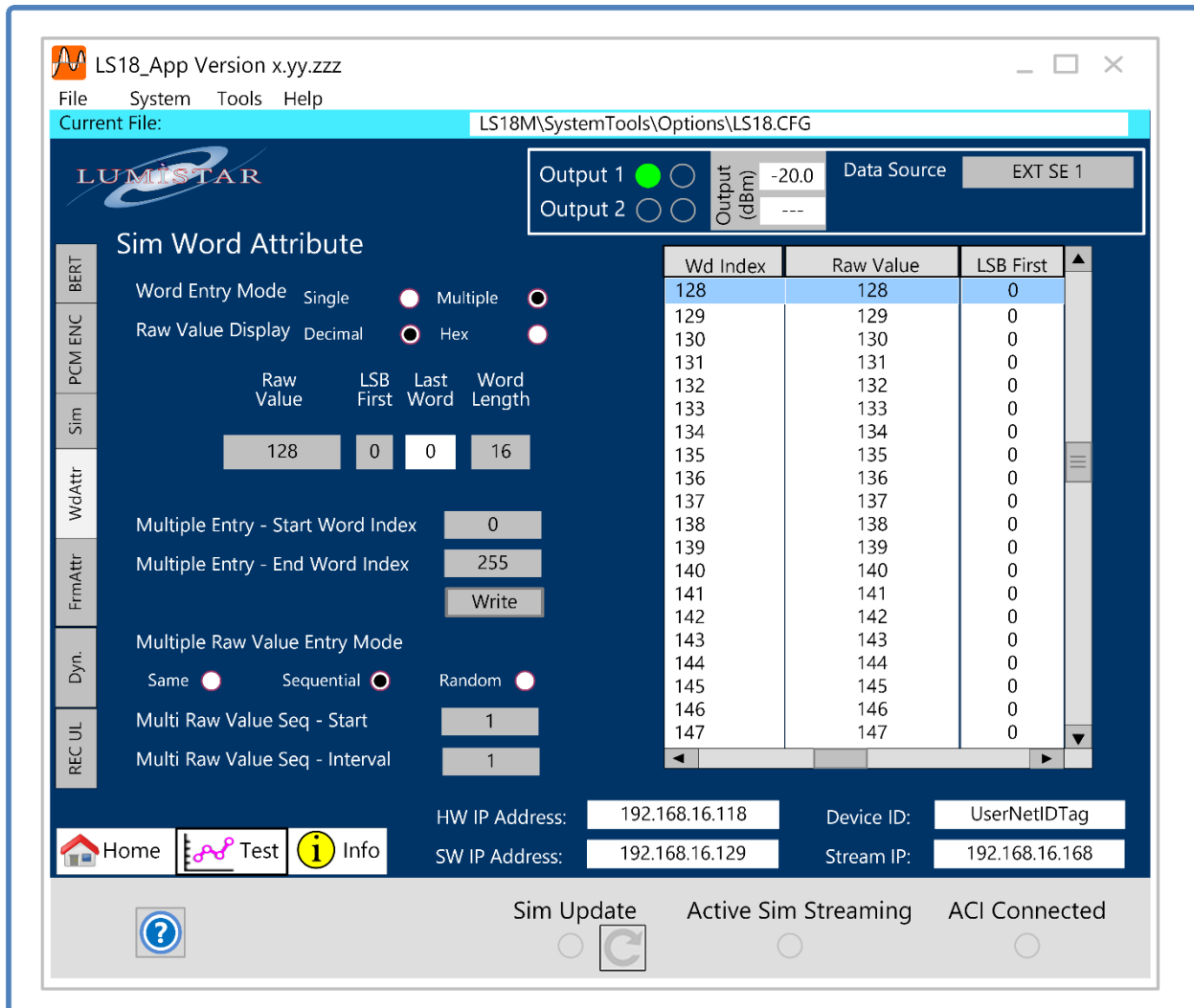


Figure 4-20 LS18\_App – Test Word Attribute Function Select Tab

**Word Entry Mode:** These radio button controls allow the user to select whether the word entry mode is a single word at a time or multiple words will be setup at a given write.

**Raw Value Display:** These radio button controls allow the user to select whether data is displayed in the right pane Simulator Display as a hexadecimal or decimal values.

**Word Index:** This numerical number relates to the position within the simulator frame that has been selected by the user.

**Raw Value:** When a word index position within the Simulator Display window is selected, the control line Raw Value entry window will be filled. This value can then be modified, as desired, based on the word length.

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**LSB First:** Upon selection of a word index position within the Simulator Display window, the control line LSB First entry window will appear. Setting the value of this control to 1 sets the associated word to LSB First configuration. If this value is set to 0, the bit orientation is MSB first configuration.

**Last Word:** Upon selection of a word index position within the Simulator Display window, a control line Last Word status window will appear. A value of 1 within this status window indicates that value selected is marked as the last word in the frame. A value of 0 within the status window indicates that the value selected is not the last word of the frame.

**Word Length:** Upon selection of a word index position within the Simulator Display window, the control line Word Length control window will appear. This window allows the user to set the number of bits allowed for the selected word index. Values between 3 and 16 can be entered. This entry box allows the user to set simulator word lengths that vary from the simulator common word length definition.

**Multi Entry – Start Word Index:** This control window allows the user to select the simulator frame index location to start multi entry updates.

**Multi Entry – Stop Word Index:** This control window allows the user to select the simulator frame index location to end multi entry updates.

**Multiple Raw Value Entry Mode:** These radio buttons select the simulator Multiple Entry mode. There are three selectable sub modes. The SAME mode allows a user to program a set of word values to the same value as provided in the Raw Value setting from the start to stop word index. The SEQUENTIAL mode allows the user to program a sequential sequence of values with a given interval from the start to stop word index. The RANDOM mode allows the user to program values to be set with random values from the start to stop word index.

**Multiple Raw Value Sequential – Start:** This control window entry box allows the sequential start location used for simulator word entry during sequential entry mode.

**Multiple Raw Value Sequential – Interval:** This control window entry box allows the sequential step values used for simulator word entry during sequential entry mode.

**Write:** This control button allows the user to initiate the selected programming sequence of minor frame contents.

The Test SimWdAttr right tab provides a status window that shows the contents of the PCM Simulator frame. Word Index, Raw Value, LSB First, Last Wd and Word Length are provided in a scrolling window. This window is also used to select word index positions for the left control pane. Selection of a word index can be made by selecting an entry line. The line selected will be highlighted (blue) once selected and the contents will be loaded in the left pane control window.

## 4.1.5.6 Function Select Test – FrmAttr

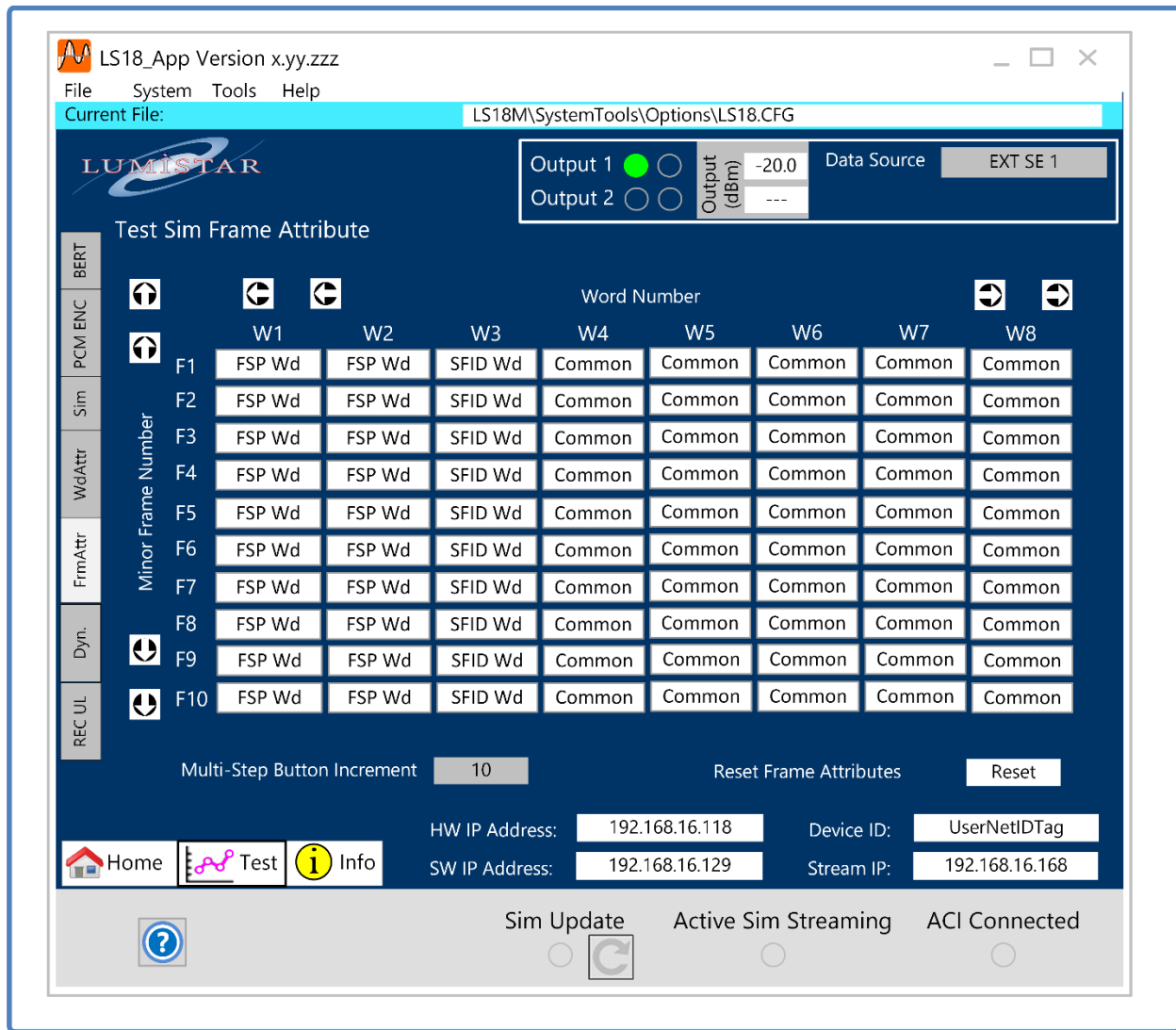


Figure 4-21 LS18\_App – Test Frame Attribute Function Select Tab

**Multi-Step Button Increment:** This control window allows the user an entry dialogue box to set the Multi-Step button control. Values can be set between 1 and 1000.

**Reset Frame Attributes:** This control allows the user to reset all frame attributes to "Common Word".

**Simulator Frame Attributes Array:** Each of the boxes in the Simulator Frame Attributes array can be selected and will bring up controls for that word position within a frame. An example of the controls is illustrated in Figure 4-22.

The figure displays three sequential screenshots of the 'Word Definitions' dialog box, which is used for configuring word definitions in the LS-18-P/R system. Each dialog box has a title bar with a close button (X) and a help icon (?). The dialog is divided into two main sections: 'Word Definitions' and 'Do For A Single Entry'.

**Dialog 1 (Top):**

- Word Definitions:**
  - PRN1 Pattern: ☐ (selected)
  - PRN2 Pattern: ☐
  - Wave Word: ☐
  - Unique Word: ☐
  - Common Word: ☐
- Do For A Single Entry:**
  - Do For A Single Entry: ☐
  - Use Word and Frame Stop: ☐
- Fields:**
  - PRN Pattern: PN15
  - Word Start: 1
  - Word Interval: 0
  - Frame Start: 1
  - Frame Interval: 0

**Dialog 2 (Middle):**

- Word Definitions:**
  - PRN1 Pattern: ☐
  - PRN2 Pattern: ☐
  - Wave Word: ☐ (selected)
  - Unique Word: ☐
  - Common Word: ☐
- Do For A Single Entry:**
  - Do For A Single Entry: ☒
  - Use Word and Frame Stop: ☐
- Fields:**
  - Wave Word Number: Wave Word 1
  - Word Start: 1
  - Frame Start: 1

**Dialog 3 (Bottom):**

- Word Definitions:**
  - PRN1 Pattern: ☐
  - PRN2 Pattern: ☐
  - Wave Word: ☐
  - Unique Word: ☐ (selected)
  - Common Word: ☐
- Do For A Single Entry:**
  - Do For A Single Entry: ☐
  - Use Word and Frame Stop: ☒
- Fields:**
  - Unique Word Number: Unique Word 1
  - Word Start: 2
  - Word Interval: 0
  - Frame Stop: 3
  - Frame Start: 1
  - Frame Interval: 0
  - Frame Stop: 2

Figure 4-22 FrmAttr Array - Controls

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**PRN1/ PRN2:** The radio button control allows the user to select between two potential PRN simulation streams for a given major frame word location: PRN1 and PRN2. The PRN pattern assignment is made via the control window in the upper right portion of the control window. Just for clarification, these PRN injections are not related to the TX BERT settings from the Test BERT Tab.

**Wave Word :** This radio button allows the user to select a predefined wave word for a given common word location within a major frame. There are six wave words that can be defined. When this selection is made, select the desired wave word in the upper right-hand portion of the control window.

**Unique Word:** This radio button allows the user to select a predefined unique word for a given common word location within a major frame. There are 56 unique words that can be defined. When this selection is made, select the desired unique word in the upper right-hand portion of the control window.

**Common Word:** This radio button allows the user to select that a word for a given location within a major frame revert to the common word definition as defined in the WdAttr tab.

**Do for A Single Entry:** This selection box sets the entry mode to a single value at a time. When this box is selected, word interval, word stop, frame interval and frame stop entry boxes will be removed from the right half of the control window.

**Use Word and Frame Stop:** This selection box sets the entry mode to be a multiple setup. When this box is checked, the entry can be placed in the word and frame based on start, stop and interval settings in the right half of the control window.

## 4.1.5.7 Function Select Test – Dyn

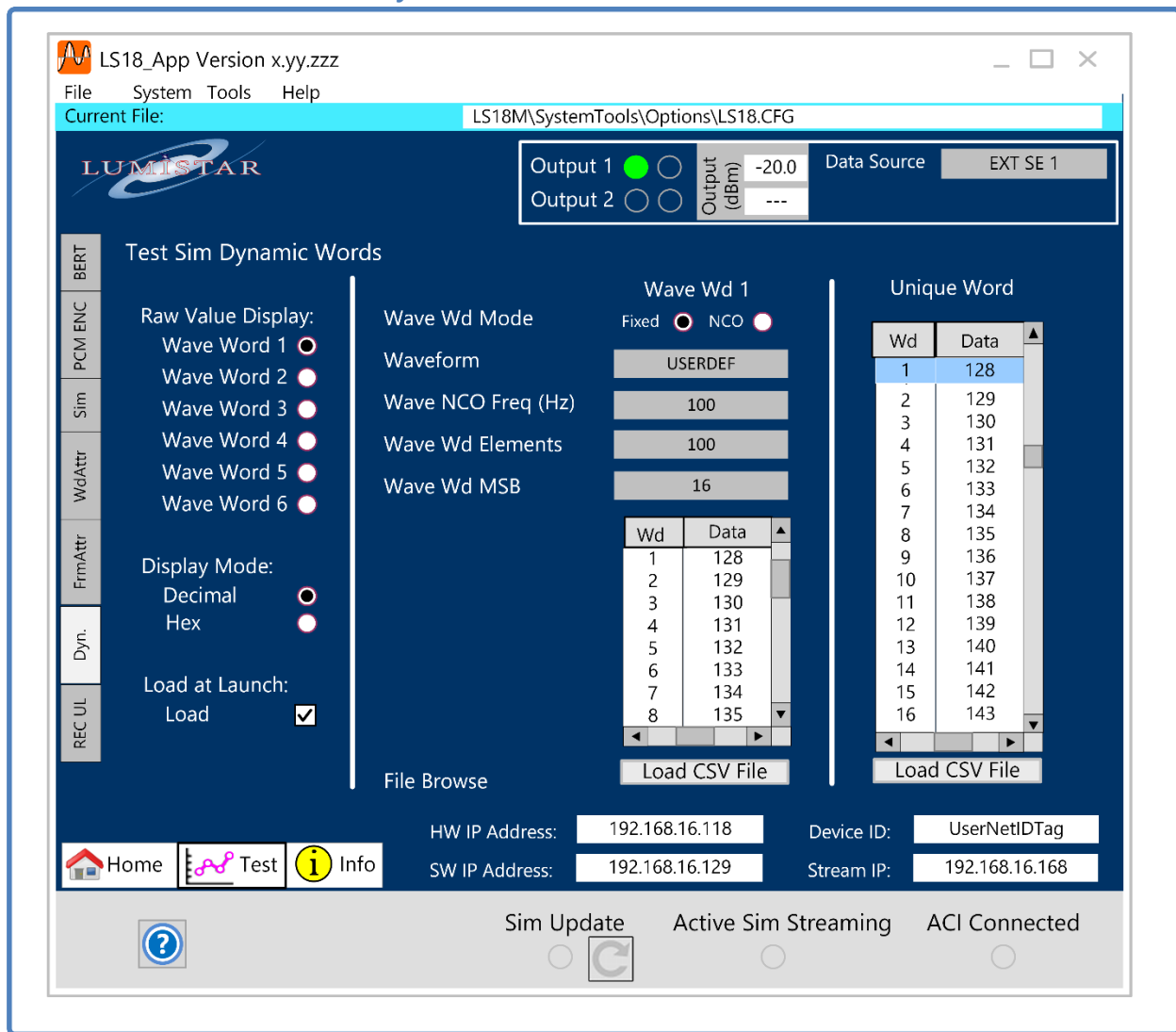


Figure 4-23 LS18\_App – Dynamic Word Function Select Tab

**Raw Value Display:** This set of six radio buttons selects which of the six wave word definitions are being updated in the center of the screen. The user should select the button for the appropriate wave word definition being made.

**Display Mode:** The radio button control allows the user to select between hexadecimal and decimal displays in the control matrix of the tab.

**Load at Launch:** The initialization of all dynamic data can dramatically extend the amount of time to launch the DPE application. By deselecting this control box, the dynamic word definitions will not be reloaded automatically during startup.

**Wave Wd Mode:** The radio button control allows the user to select between the fixed and NCO modes of Wave Word data output control. In fixed mode, the data contents of the wave word definitions are provided



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based on the fixed rate as derived from the frame definitions. The NCO mode outputs data values based on a specifically programmed data rate and thus relieve the confinement to frame parameters and rates. Values for the NCO are limited from 0 to 63 Hertz.

**Waveform:** The drop-down menu allows the user to select between nine different predefined waveform selections: NOTHING, SINE, COSINE, SQUARE, TRIANGLE, RAMP UP, RAMP DOWN, RANDOM, and USERDEF. NOTHING setting disables the wave word. Six mathematical functions are provided as well as random data values can be selected. In addition, using the USERDEF selection, a custom waveform can be defined via a comma separated file that the user can load. Up to 4096 values can be entered.

**Wave NCO Freq (Hz):** This control box allows the user to set the NCO frequency rate for use in NCO waveform mode. Frequencies between 0 and 63 Hertz can be programmed.

**Wave Wd Elements:** This control window allows the user to enter the number of elements being used to define the specific waveform. Values between 1 and 4096 can be entered in this window.

**Wave Wd MSB:** The control window allows the user to define the MSB position of the data being used in the waveform definition. Values between 3 and 16 can be set.

**Scrolling Word Entry Window:** This screen area allows the user to scroll through wave word indices and values. The user can select individual data values and modify them locally.

**Scrolling Unique Word Window:** This screen area allows the user to scroll through wave word indices and values. The user can select individual data values and modify them locally.

**Load CSV File:** Waveforms and Unique Word values can be loaded via common separated files. These files are flat and can be held in any directory locations.

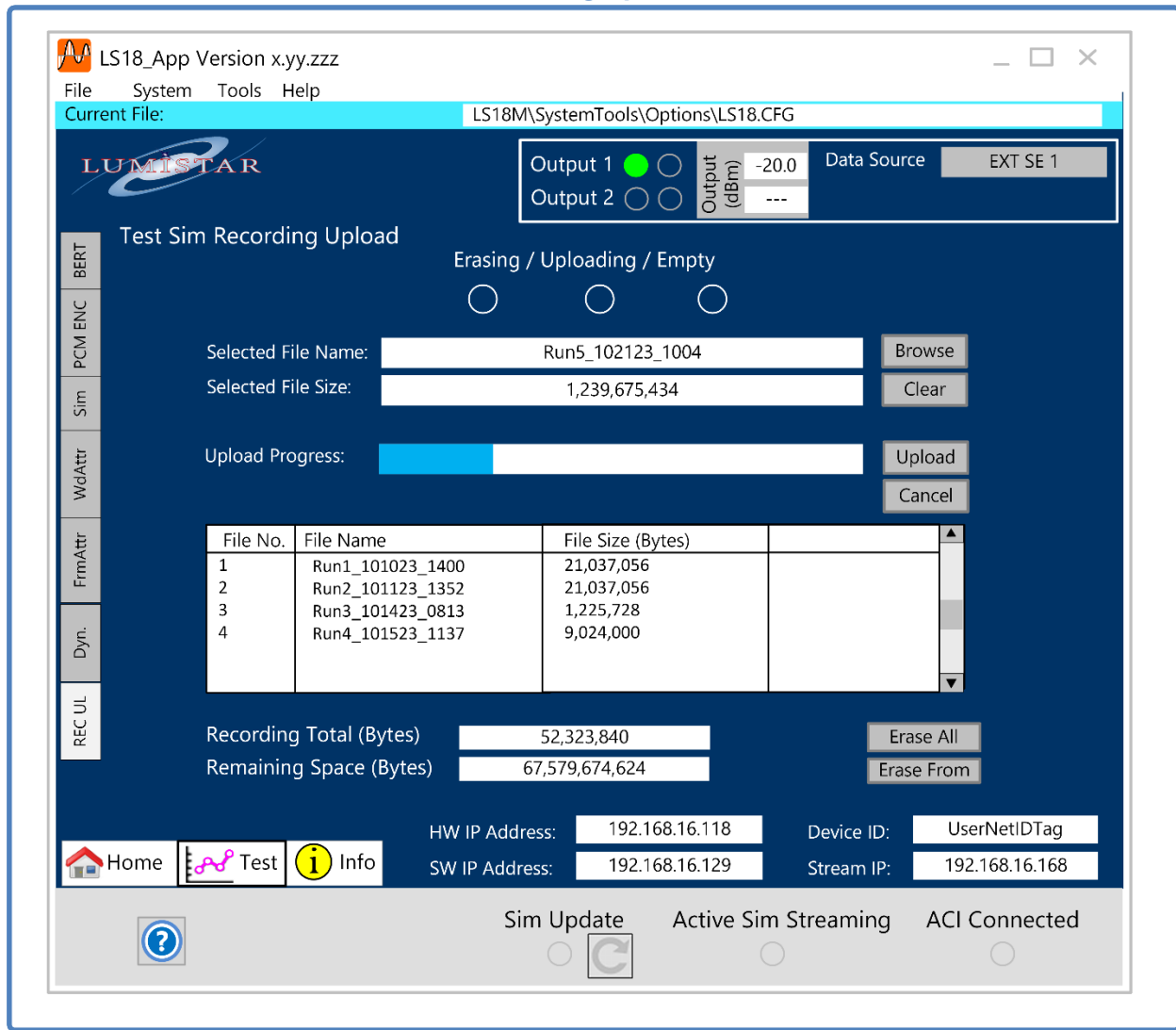
**Load Page Updates:** After changes have been made on this tab, the changes are not automatically load. This button is required to be selected to upload any changes that have been made on this tab.



**Warning:**

The **Load Page Updates** button must be selected to perform the loading of changes on this tab. This will be denoted by the label *"Changes have been made that need to be sent"* that will be located right next to the button.

#### 4.1.5.8 Function Select Test – REC UL (Recording Upload)



**Figure 4-24** LS18\_App – Test NAND Function Select Tab

This tab contains a mix of controls and status.

**Erasing/Uploading/Empty:** This series of LEDs indicates the present state of the upload memory. If the memory is presently in an erase mode the Erasing LED will be green. If the memory is completely empty, the Empty LED will be green. If uploading of recorded data is active, the Uploading LED will be green until the file upload completes. Completion of any activity will result in the LED being clear.

**Browse Button:** Selecting the browse button allows the user to select binary playback files for storage on the unit. Once selected, file that will be uploaded will appear in the "Selected File Name" status bar. The clear button will eliminate this file selection.

**Selected File Name/Size:** These two status bars display select files to be uploaded by name and size.

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**Upload Button/Upload Progress:** Once a file has been selected for upload, selecting the Upload button will begin the process. The upload progress bar will indicate a gauge of how much of the file has been uploaded and how much remains. Once file loading has completed, the upload status bar will be removed. The Cancel button will stop uploads.

**File Repository Status:** Once a file has been selected for upload, selecting the Upload button will begin the process. The upload progress bar will indicate a gauge of how much of the file has been uploaded and how much remains. Once file loading has completed, the upload status bar will be removed. The Cancel button will stop uploads. However, uploads that have been started will remain in the file repository because uploads are being written to non-volatile memory while the upload process is active. This file will still be able to be utilized for playback purposes, it just won't be the intended length.

**Recording Total/Remaining Space:** Towards the bottom of the tab are indicators of the amount of upload memory presently occupied and the amount remaining.

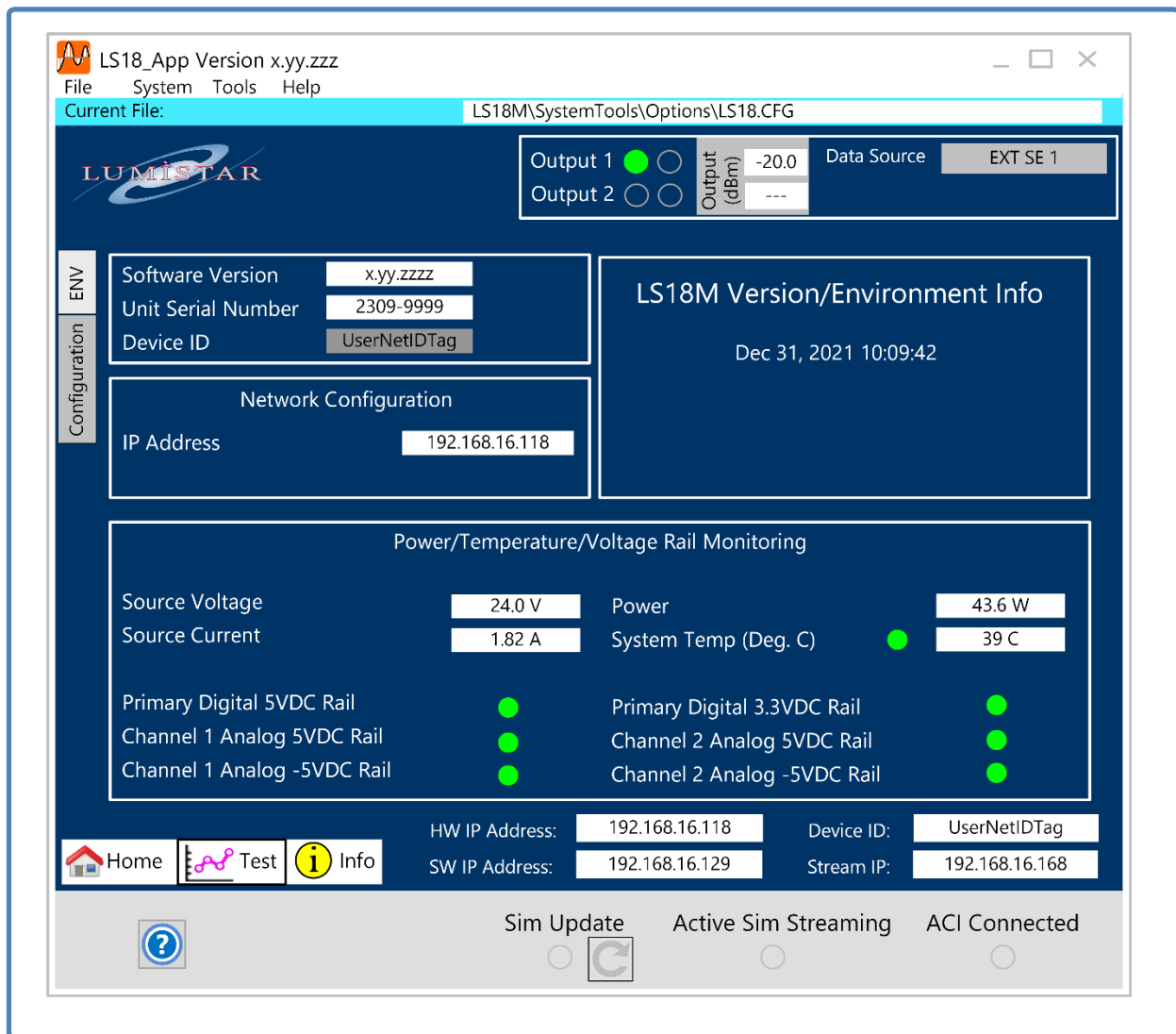
**Erase All/Erase From:** The erase all button will erase all on-board memory of stored content. The Erase From button will begin erasing from the file selected in the repository to the end of the storage memory. It is not possible to remove individual files from the storage memory.

### 4.1.6 Function Select Tab – Info

The Info select tab provides the user primarily with status on operating conditions and device configuration information. Controls and status are split between two sub-function tabs: ENV and CONFIGURATION.

#### 4.1.6.1 Info Sub-function Select Tab - ENV

The ENV sub-function tab provides the user value information concerning real-time operations as well as information pertaining to communications setups and firmware versions. Refer to Figure 4-25 for tab layout.



**Figure 4-25** LS18\_App – Info Sub-function Select: ENV

**Software Version:** In the upper left-hand box, an indication of the LS18\_App version being used is displayed.

**Unit Serial Number:** This box provides the serial number of the unit attached. This number is important for discussions with Lumistar support and is essential for license upgrades.

**Device ID:** In the upper left-hand box of this tab is a control entry entitled device ID. This control allows the user to enter up to 16 ASCII characters to identify the device on a network by name.

**IP Address:** The IP address of the unit of the LS-18 being controlled is shown in this window.

**Power/Temperature/Voltage Monitoring Window:** This area of the status window provides information on the source voltage, source current, power consumption, temperature and power rail operational status. Green LED displays indicate that the voltage rails and operating temperature are within normal range. If any of these LEDs are out of normal range, the LED will be yellow and an INFO flag will be displayed in the operational status window.

#### 4.1.6.2 Info Sub-function Select Tab - Configuration

The CONFIGURATION sub-function tab provides the user value information concerning information on what functions and capabilities are enabled on the LS-18-M. Refer to **Error! Reference source not found.** for tab layout.

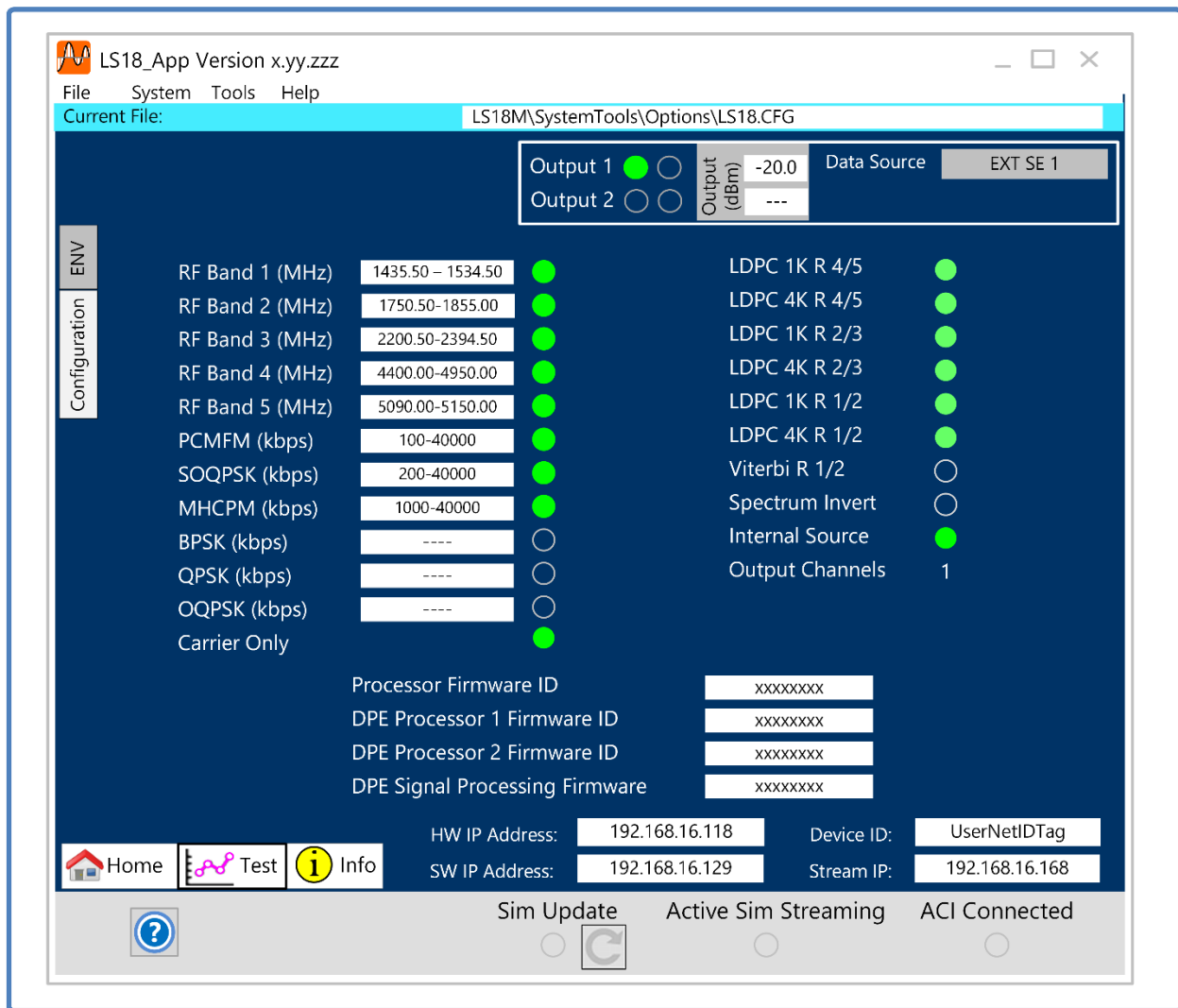


Figure 4-26 LS18\_App – Info Sub-function Select: Configuration

Active functions are indicated by green LEDs. LED indicators that are blank indicate that a function may be available but not licensed for this particular device. Consult with Lumistar Sales if a function is required but not enabled.

Processor firmware identification is also displayed on this tab. If the unit is configured in configuration 2A, the DPE processor identification will not be present. This information is often necessary when consulting with Lumistar Customer Service.

**Warning:**

LEDs on the license tab that appear clear are indications that the license option is not installed. The LED may be clear due to other factors such as hardware configurations of the attached device or general availability of the option. Clear license LEDs do not necessarily indicate that an option is available for the connected device.

**Information:**

Most, but not all, license options can be added via field upgrade. Consult Lumistar customer service for more details.

## 5 Operational Examples:

The final three sub sections of this manual provides example operational setups of the three operational modes of configuration 2B of the LS-18 system. These modes include the standard PCM setup mode, the streaming data mode on the on-board playback mode.

The 2B configuration of the LS-18 system offers the most extensive set of capabilities that can be provided. The 2A configuration shares many of the same setup scenarios of the standard PCM setup mode but lacks the streaming or internal playback mode.

### 5.1 Standard Mode of Operation

This mode of operation makes use of the on-board IRIG106 PCM Simulator and PRN generator which are integrated into the LS-18 system hardware design. This PCM simulator is pseudo-dynamic in that data provided to the frame is contained in the simulator setup firmware. Individual common words within the frame are not necessarily reflective of data previously recorded from a mission or gathered in real-time. Some frame values can be provided as specific unique values, as waveform data or as PN sequences to show some dynamic data. For the most part, this data within the frame is predetermined and static during reproduction.

This mode is very useful in examining spectral content of a perspective frame, and ensuring that data can be frame locked via receiving elements.

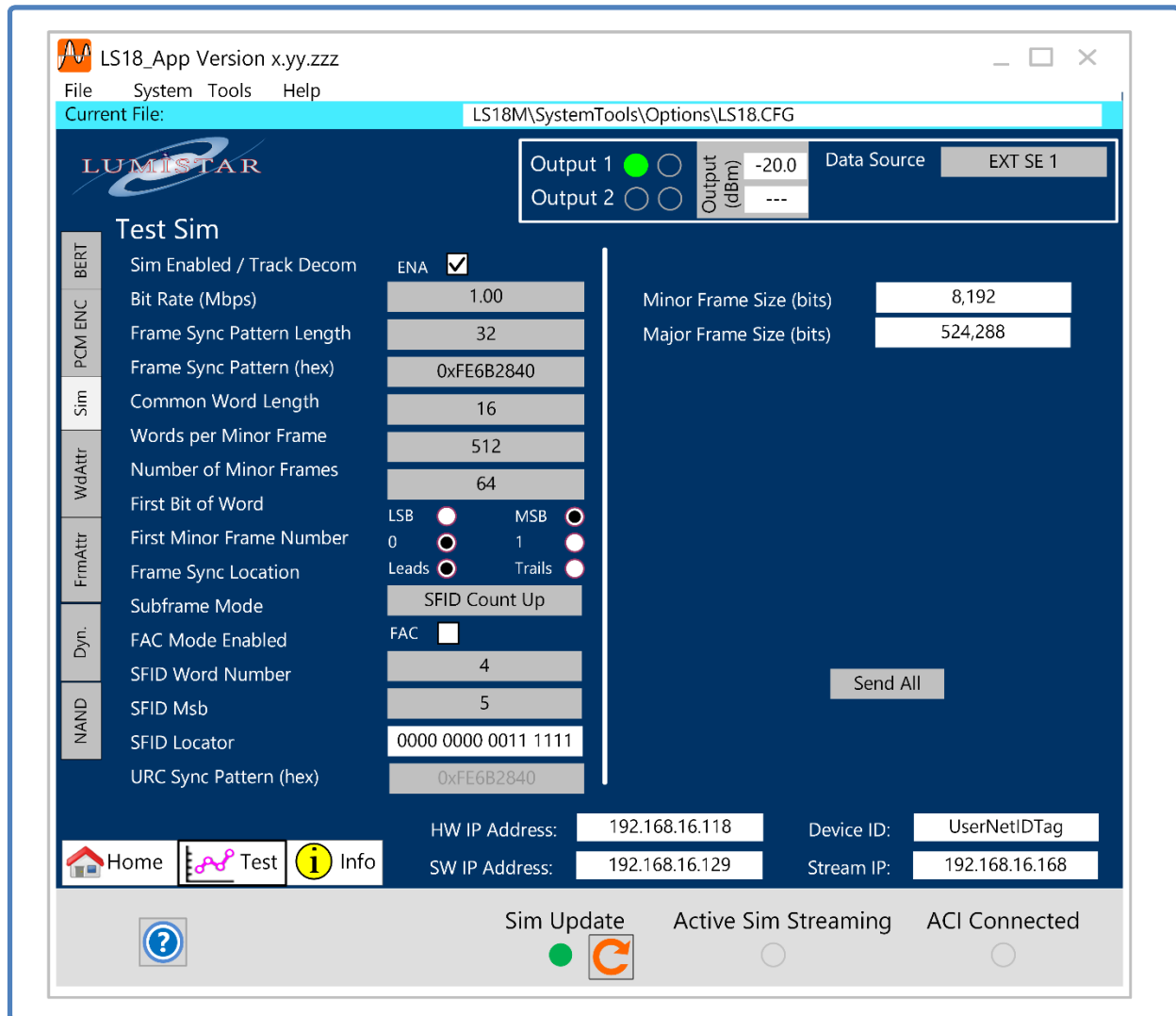
To setup a common PCM frame of data, let's assume a rather typical frame of data. Specifications are as follows in Table 5-1.

Data rate:	1Mbps
Frame Sync Pattern Length:	32bits
Frame Sync Pattern:	0xFE6b2840
Common Word Length:	16 bits
Number of words per minor frame:	512 words
Number of minor frames in a major frame:	64
First bit of Word:	MSB
First Minor Frame Number:	0
Subframe Mode:	SFID Counting Up
SFID Word Number:	4
SFD MSB	5

**Table 5-1** Example PCM Frame Setup – Standard Mode

Using the data above, follow the list of steps below:

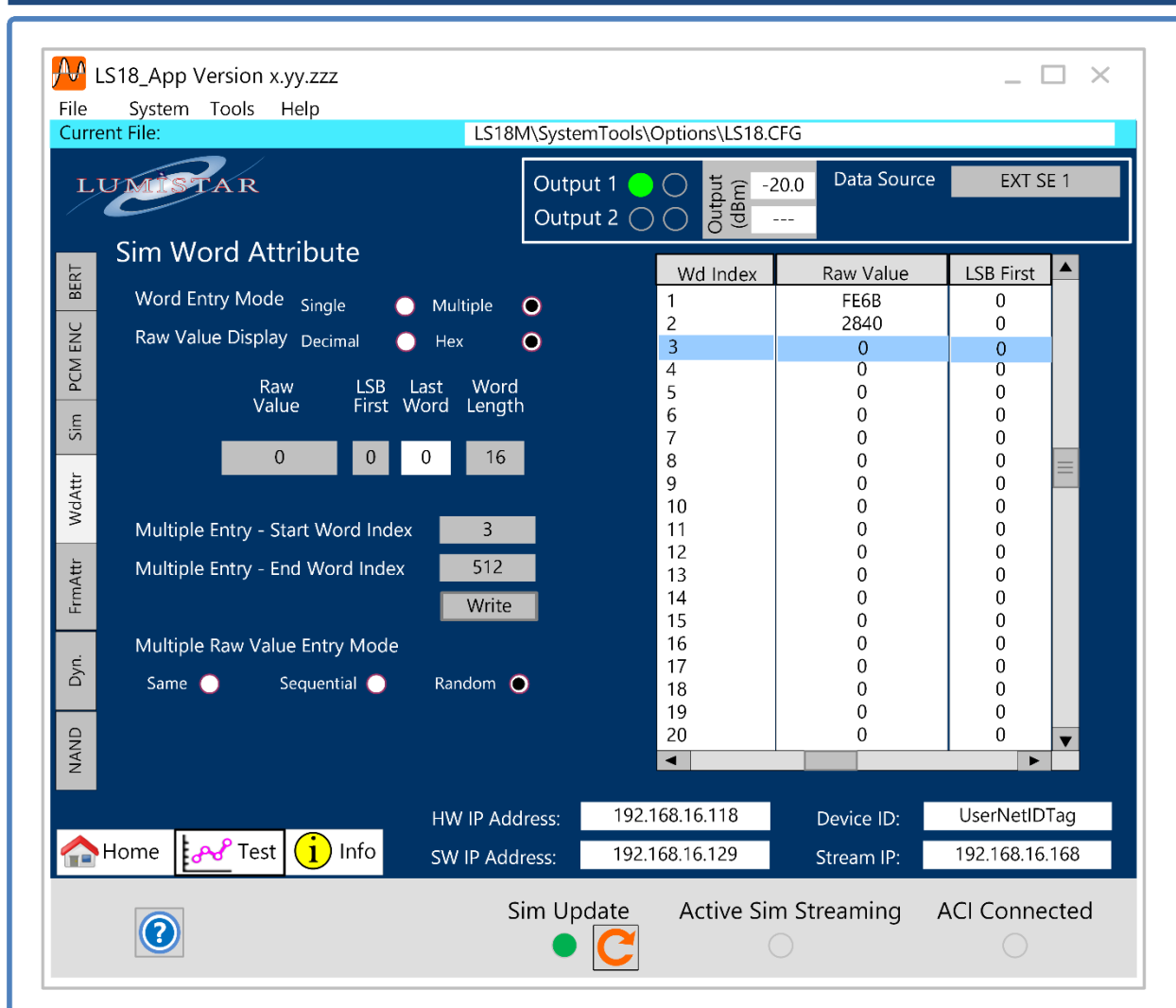
- 1.) Select the HOME function select tab.
- 2.) On the right-hand pane, select the *SIM Enabled* check box and select the *Simulator Mode* to standard mode of operation.
- 3.) Select the TEST function select tab followed by the SIM sub-function select tab.
- 4.) Enter all values from Table 5-1 into the appropriate controls of this tab. When complete, the tab should appear as shown in Figure 5-1.



**Figure 5-1** Test – SIM tab for Standard Telemetry Frame Setup

- 5.) Note that in the figure above that the orange SIM Update button and green LED are active. This means that values have been setup to be sent to the simulator but have not been downloaded yet. Depress this button whenever illuminated to update the simulator operations. Once updates are complete, these indicators will return to clear indications.
- 6.) The steps to this point have created a structure for the PCM frame but not the actual frame content for the common words. This content is constructed on the WdAttr sub-function select tab. Select this tab.
- 7.) Once selected, a window similar to the one shown in Figure 5-2 will appear.





**Figure 5-2 Test – WdAttr tab for Standard Telemetry Frame Setup**

- 8.) Select word 3 in the display window on the right until highlighted. Now select all settings in the WdAttr sub function select tab as shown above to fill random 16-bit values in all common frame words. Sequential data and the same data are also enterable. Once it is setup as shown in Figure 5-2, be sure to depress the button to cause the simulator updates to be loaded.
- 9.) For this simple example, frame format changes and dynamic word additions will not be activated.
- 10.) Return to the HOME function select tab which will appear similar to that shown in Figure 5-3.
- 11.) Controls for the standard mode functions that are typically of interest are shown in Figure 5-3.
- 12.) The other output PCM mode in standard mode is the PRN output. This is selected by selecting the TEST function select tab and then the BERT sub function select tab. The PRN outputs are shared with the PCM simulator outputs so only one functionality at a time may be active. If the ENABLE TX 1 BERT tab is selected on the BERT sub function select tab, the SIM Enabled/Track Decom select box on the SIM sub function select tab will be automatically deselected. The opposite is also true. Figure 5-4 illustrates the BERT controls.

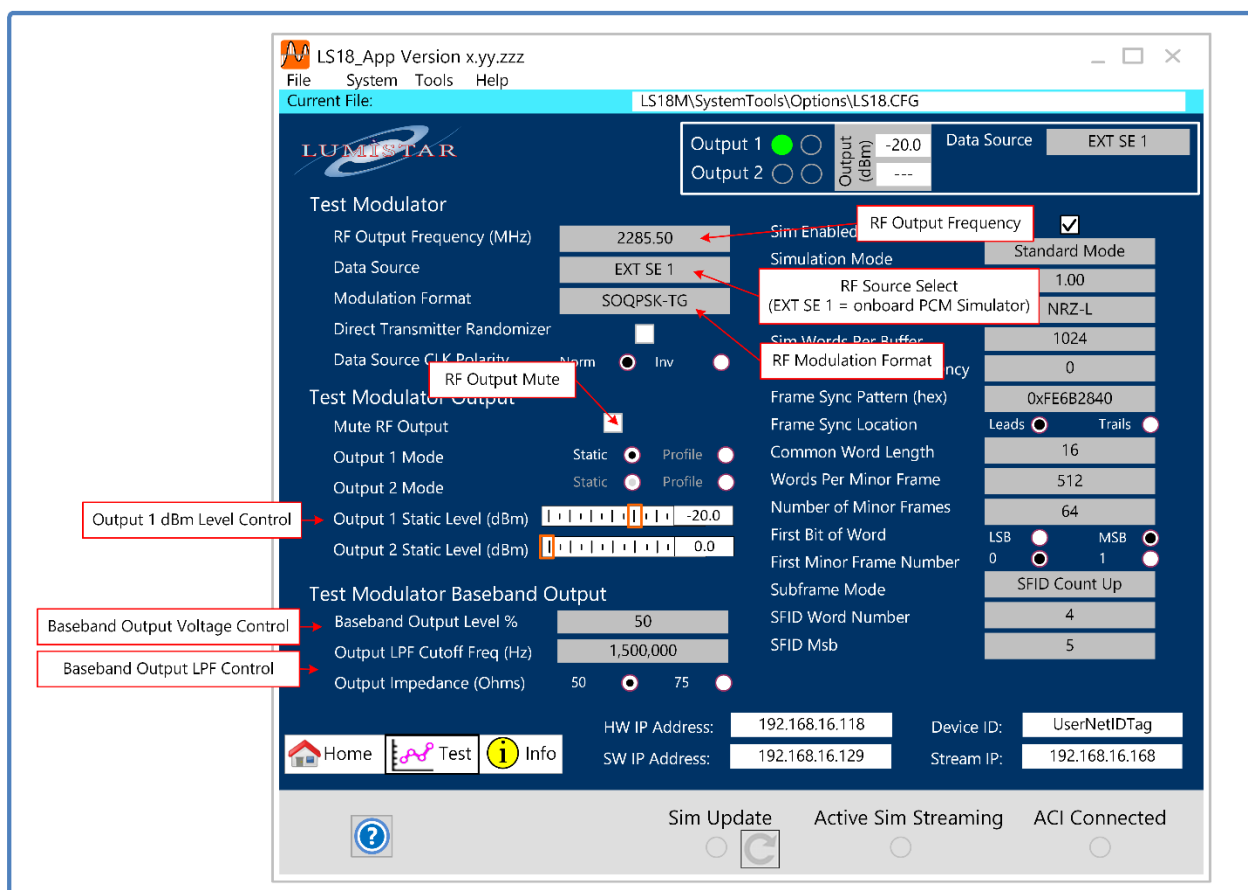
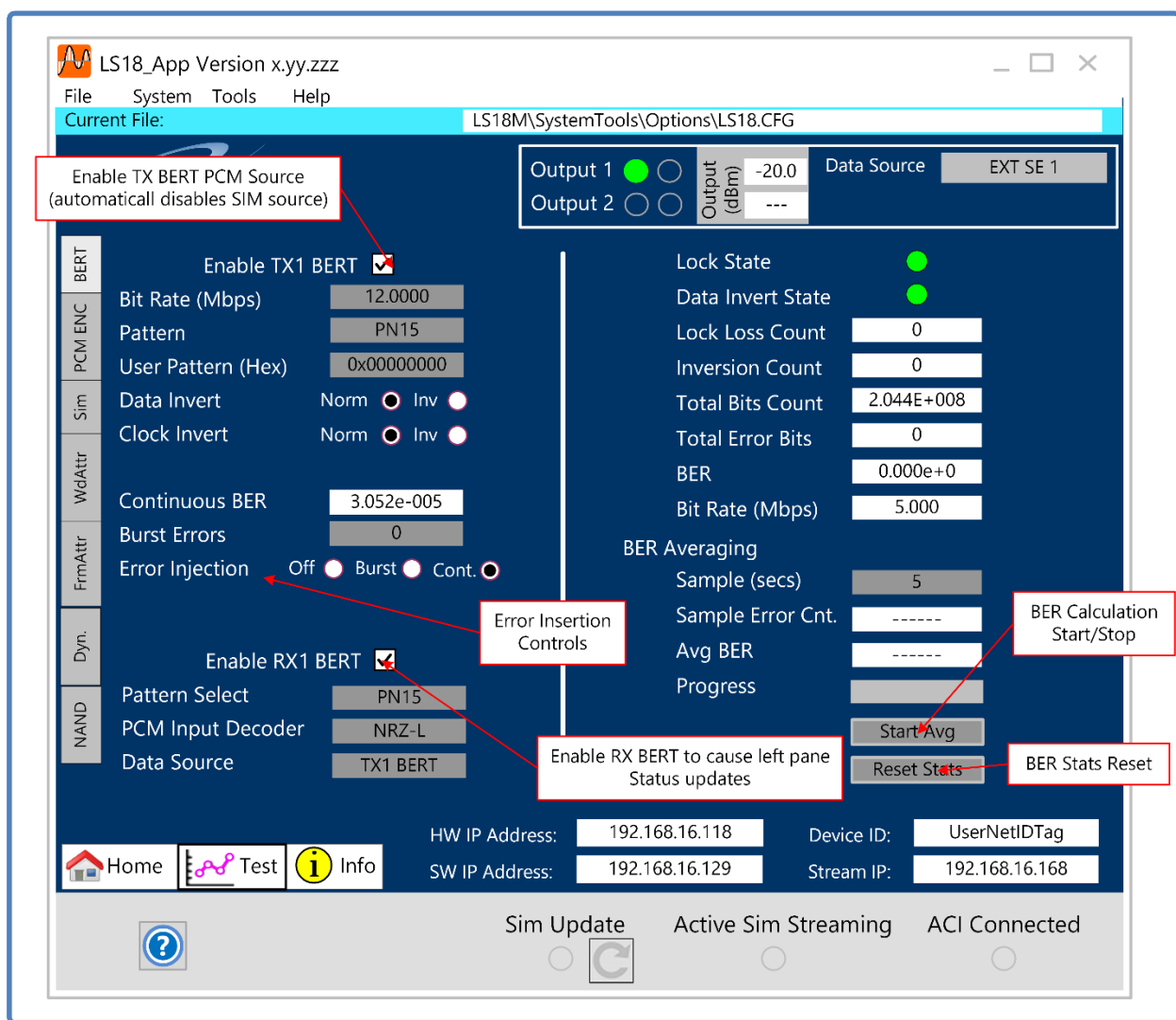


Figure 5-3 HOME tab for Standard Telemetry Frame Setup



**Figure 5-4** BER tab operations for Standard Telemetry Frame Setup

13.) Controls for the standard mode functions that are typically of interest are shown in Figure 5-3.

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## 5.2 Streaming Data Mode of Operation

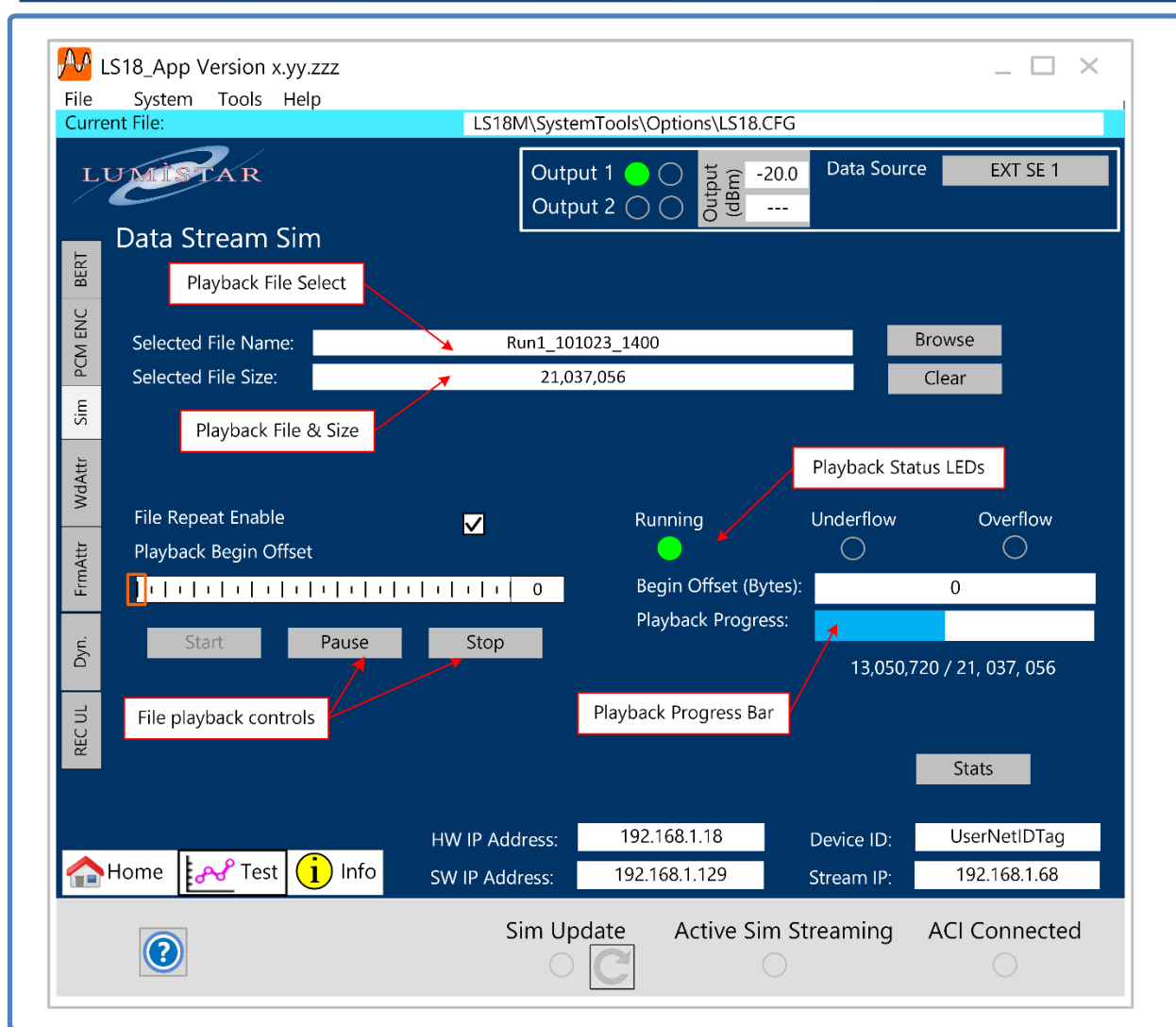
This mode of operation makes use of the LS-18 on-board static memory. Files of data will be packaged and sent via network transmissions from a software server to the LS-18 system for output reproduction. Data that is being transmitted is not retained inside the unit after power is cycled to the system. File lengths are virtually unlimited in this mode and can be as close to real-time as network transmitted data allows.

To stream data to the LS-18, two different modes exist to do so. The most direct method is the "point and click" method which allows the streaming of a binary converted or created file to the modulator.

To use the "point and click" method of data streaming, assuming that a binary playback file is ready for streaming (consult section 4.1.3 Step 3), perform the following steps:

- 1.) Ensure that the LS18\_App is launched and select the HOME tab.
- 2.) On the right-hand pane, select the Simulation mode as STREAMING.
- 3.) Select the TEST | SIM tab. A window similar to the one in
- 4.) Select the Browse button and browse to the file for streaming.
- 5.) If it is desired to loop the file being streamed, select the file repeat button.
- 6.) Select the START button.

Once streaming playback begins, the modulator output will be active as will the simulator outputs. Indications of network issues are indicated by the underflow and overflow status LEDs. If these are active, press the STATS button for further details. Consult your network IT professionals and/or Lumistar support for assistance.



**Figure 5-5** Point and Click Streaming Mode – SIM Control

A more complex, yet more capable method of data streaming is to use a “data server” application to provide a stream of data via network packets. Lumistar provides the **TDynaSim** application to stream data to the LS-18. This application is included on the DVD provided with the shipment of the LS-18. The **TDynaSim** application will need to be installed on the target host and a firewall hole will need to be provided for the application for proper operation. This application can, and should, reside on the same target PC as the LS18\_App. The application must be executed in Administrator mode if the application is being run under Windows 10 or Windows 11.

**TDynaSim** streams network data to the LS-18 system using UDP network protocol. This streaming process requires a series of handshaking signals be passed between the LS18\_App and the **TDynaSim** application. It is beyond the scope of this manual to describe the technical aspects of the data server application and the LS-18 system.

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This example explains the process of streaming binary data to the LS-18 system. Since the application provides for conversion of Lumistar recording files, as well as chapter 10 files, this functionality is similar to abilities provided by the recording playback mode in cases where on-board storage memory is not allowed due to security concerns.

Assuming binary playback file is ready for streaming, perform the following steps:

- 1.) Ensure that the LS18\_App is launched and select the SYSTEM – HW SETUP-Networking tab is open.
- 2.) Ensure that the TDynaSim application is launched. Once the application is launched the first time, hardware configuration options must be selected. Reference Figure 5-6 for the startup options screens.
- 3.) Make the selection on the hardware configuration screen for the LS68SS and select the Accept button.
- 4.) Restart the TDynaSim data server application.
- 5.) On the subsequent application launches, select the Streaming Status button at the upper right corner of the application to open the ACI Network configuration tab. Reference Figure 5-7 and follow the steps shown in this figure for connection between the LS18\_App and TDynaSim. This connection is being made via the Alternate Control Interface (ACI).
- 6.) Once connected, the status LEDs at the top of the application will both appear green.
- 7.) Perform the initial streaming setups in TDynaSim. Select the "S" button from the launch banner window and then follow the steps outline in Figure 5-8.
- 8.) Next, TDyna Sim must be setup to accept a binary data file for streaming. These files can be the same files as used for recording upload.

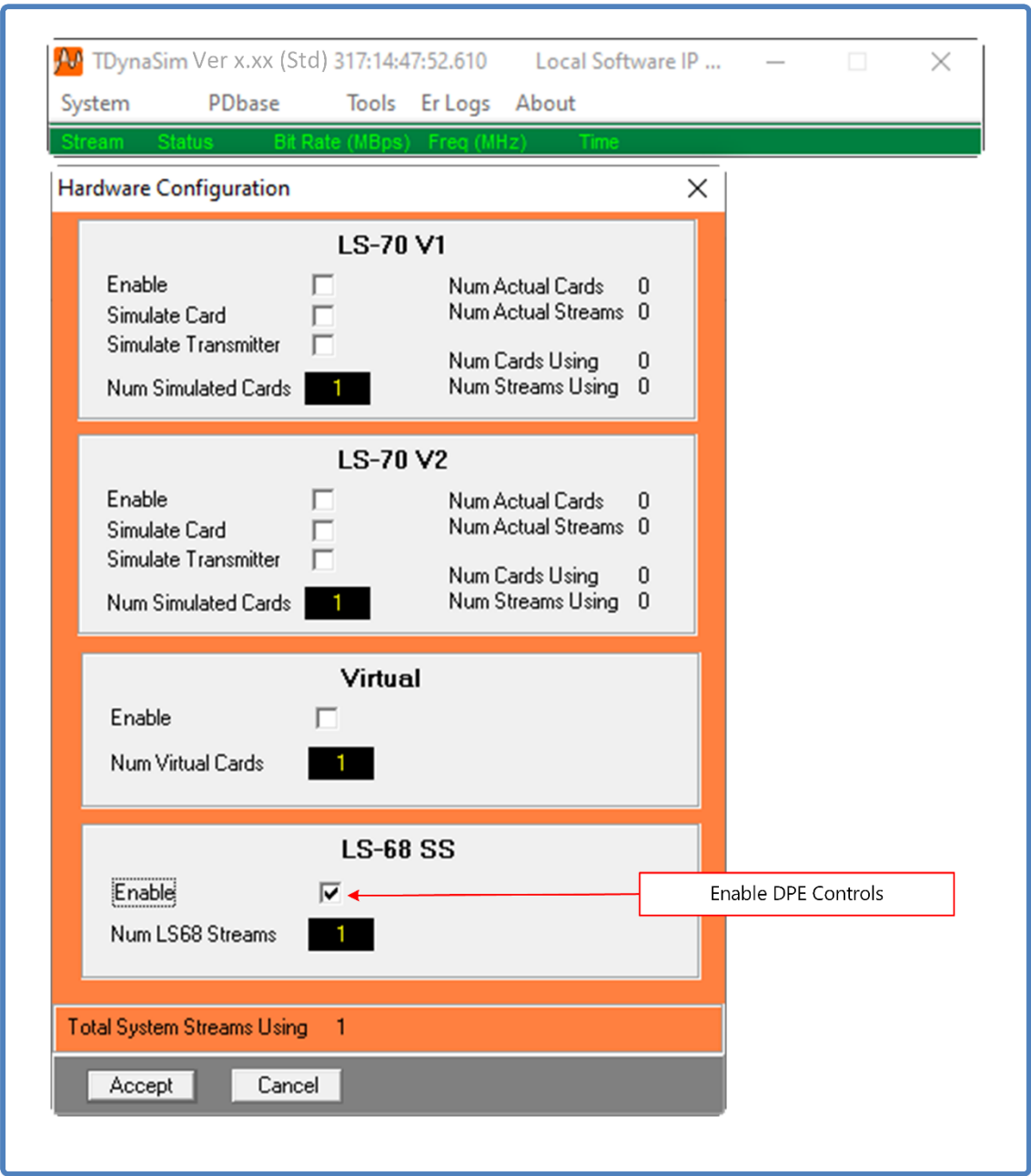


Figure 5-6 TDynaSim Initiation – Hardware selections

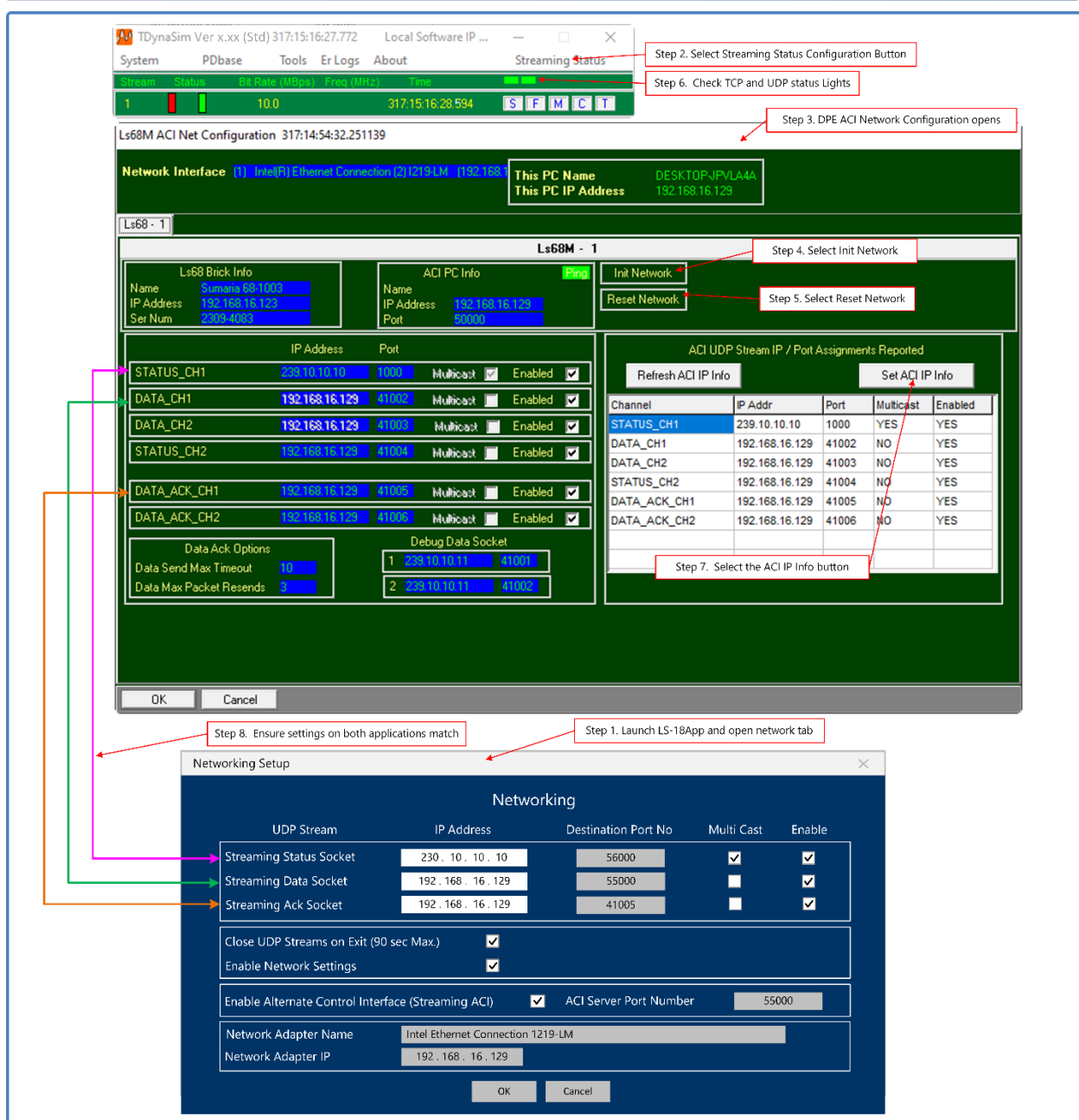


Figure 5-7 TDynaSim ACI Network Configuration Tab



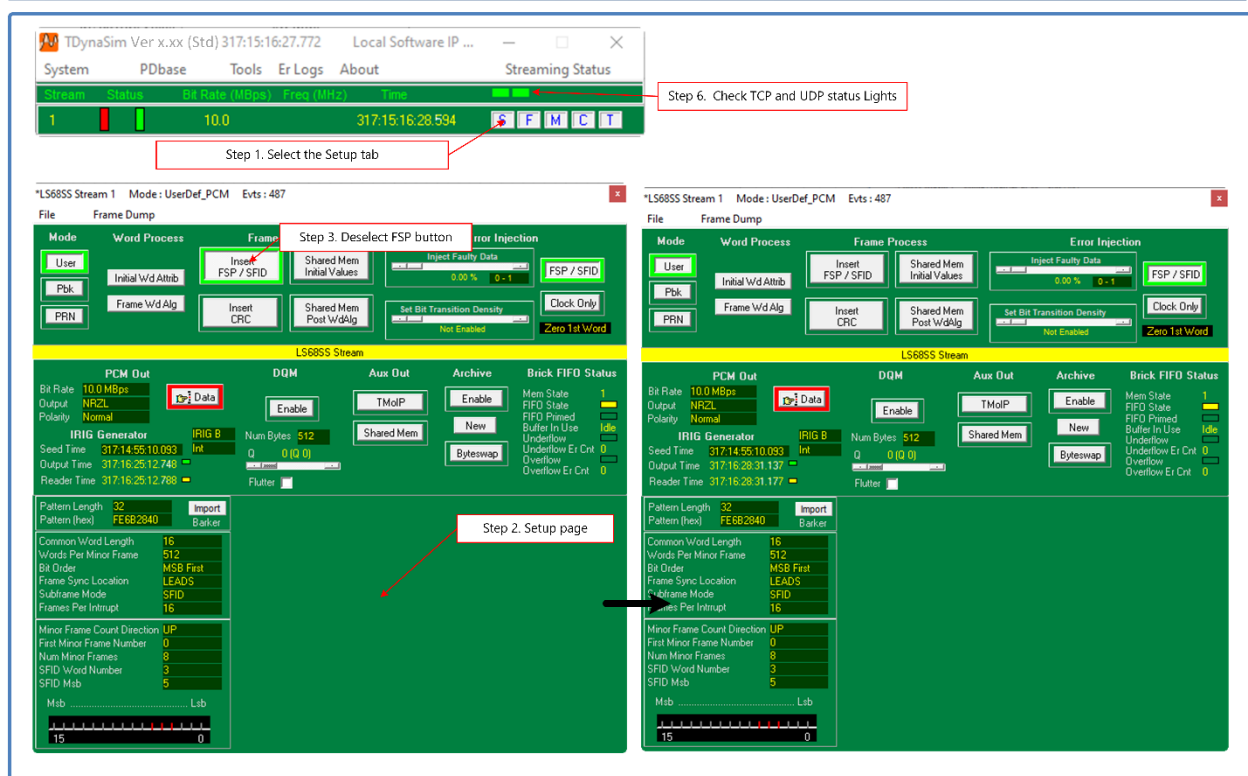


Figure 5-8 TDynaSim Initial Setup Steps

- 9.) Select FrameWdAlgo button on the setup page above.
- 10.) Use the Frame Word Editor to setup the streaming file settings. Follow the steps in Figure 5-9 to perform the setup.
- 11.) Once the algorithm editor setup is complete, streaming data is ready. Set the data rate that the data should be streamed using the bit rate field on the setup page. You can ignore the frame data and all other data shown on the left lower half of the tab because the streaming source is the binary file that has been loaded.
- 12.) Refer to Figure 5-10 for the final steps to start streaming data.

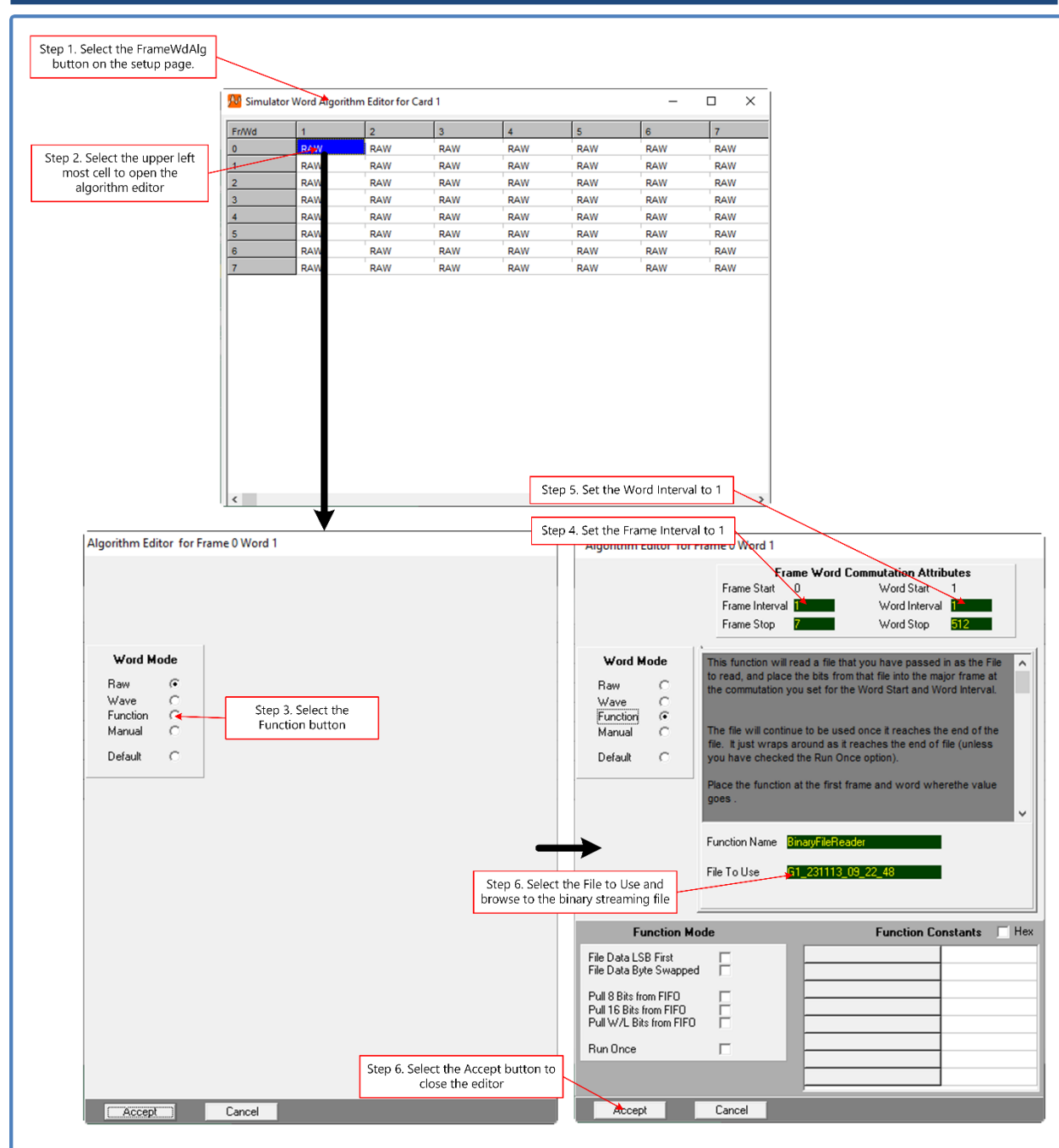


Figure 5-9 TDynaSim FrameWdAlgo Editor Steps

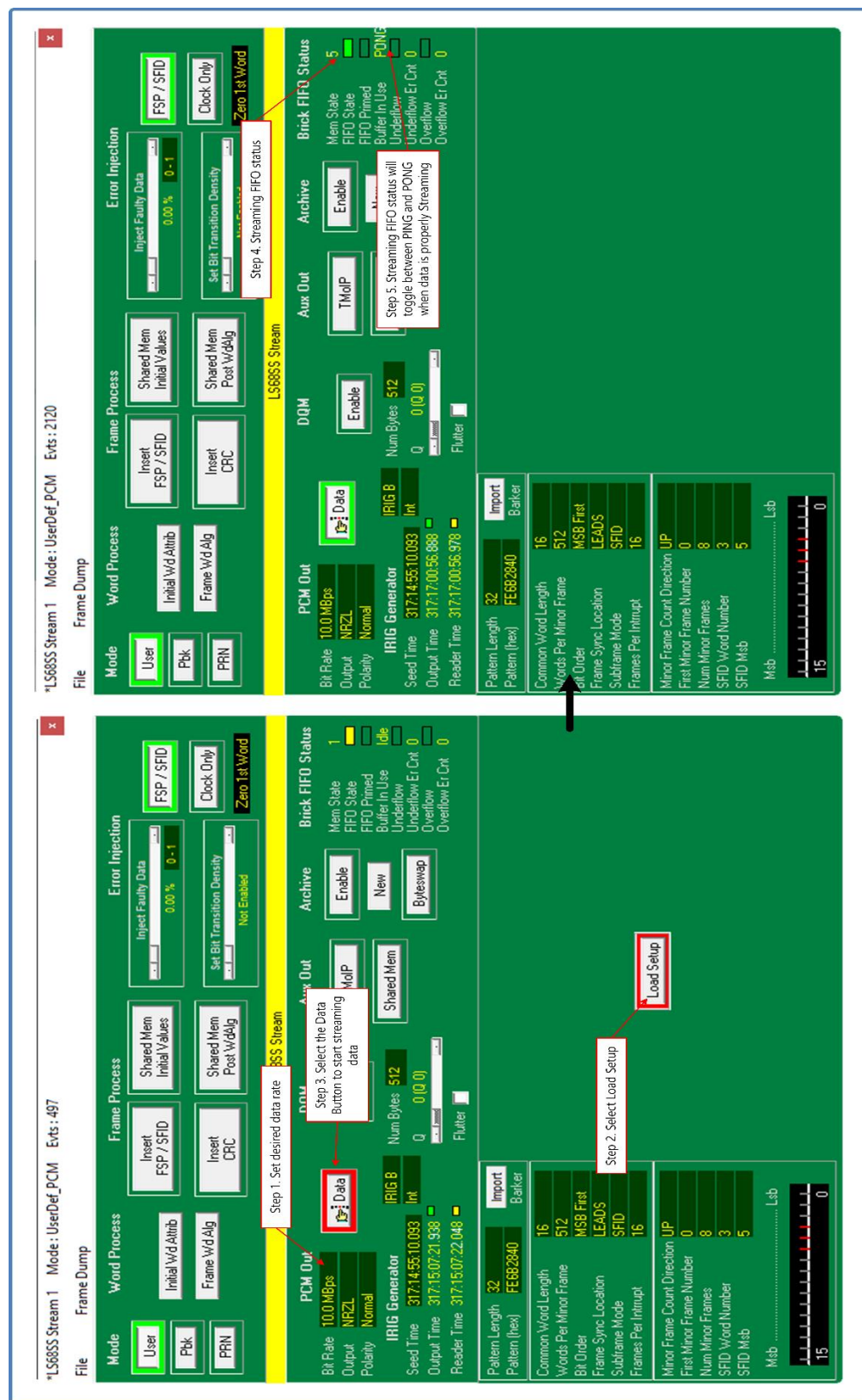


Figure 5-10 TDynaSim Final Streaming Data Steps

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## 5.3 Internal Recording Playback Mode of Operation

This mode of operation makes extensive use of the LS-18 on-board non-volatile memory. Files of data will be uploaded to on-board memory and then used as a play-back source for the PCM outputs, baseband outputs and RF modulated output(s).

### 5.3.1 Playback Data File Sources

The playback of data in this mode requires no format knowledge. This means that data uploaded and stored to on-board memory must be binary and have all time-tags and framing overhead either removed or not present from the origination. Data that is located in individually stored files is simply serialized, a PCM format as selected by the user is applied, a clocking rate is applied, and the data is reproduced at the digital, baseband and RF modulation outputs.

There are several methods of creating playback files by converting other file formats. File formats for which Lumistar provides converters include the following:

- 1.) Lumistar LS-28M Recording Files: *Tools Tab – File Converters – Rec File to Raw Binary*
- 2.) Lumistar LS-48/68M Recording Files: *Tools Tab – File Converters – Rec File to Raw Binary*
- 3.) CH10 Recording Files: *Tools Tab – File Converters – CH10 to Raw Binary*

The Lumistar LS-18 **Tools** tab provides direct access to these utilities.

Of course, the user can create their own binary files that can be directly uploaded. There are few if any restrictions on these file formats other than the contents are pure data, ready for serialization and contain no superfluous “non-data” content.

### 5.3.2 Uploading Playback files

Once a binary playback file is ready for upload, perform the following steps:

- 13.) Select the HOME function select tab.
- 14.) On the right-hand pane, set the Simulator mode selection to Playback Mode.
- 15.) Select the TEST function select tab followed by the REC UL sub-function select tab.
- 16.) Refer to Figure 5-11 for the remaining steps.
- 17.) To upload a recording file, select the Browse button and select a converted file for upload.
- 18.) Once the file is selected, the file to be uploaded will populate the *Selected File Name* and *Selected File Size* fields in the center of the screen.
- 19.) Select the *Upload* button to begin the upload process. Uploading will occur at approximately 70-80Mbps. The progress bar will provide a visual gauge of the progress.
- 20.) Once uploaded, the file will appear in the list at the bottom of the page. Recording space use will also be listed at the bottom of the tab.
- 21.) Files are loaded sequentially into non-volatile memory. As the files are loaded, data within the file is encoded with forward error correction (FEC) information. FEC data is automatically added to the binary data to ensure that data retrieved from the memory is error free at retrieval before being serialized for data production.
- 22.) Files that have been uploaded can be erased in only two modes: all files erased or files beginning at a specific file to the end of storage can be removed. Unlike standard disk storage, data being

stored and removed have to follow different operating principles. Data stored in internal memory is not subject to a “disk operating system” therefore individual areas of memory can not be freed and reused easily.

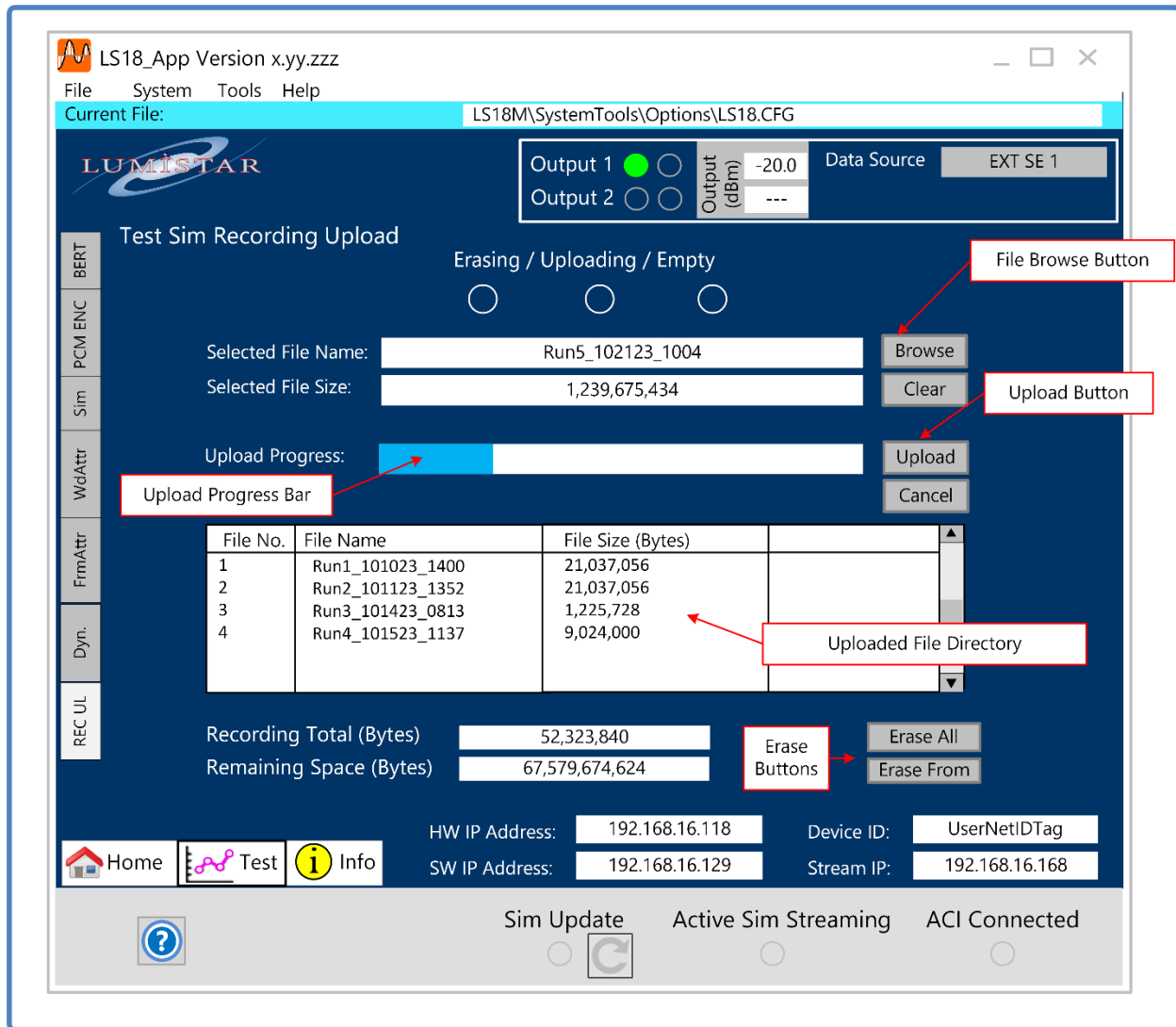


Figure 5-11 Playback Upload Controls

### 5.3.3 Selecting and Playing Recorded files

Once a binary playback file is uploaded, perform the following steps to launch a selected playback file:

- 1.) Select the HOME function select tab.
- 2.) On the right-hand pane, set the Simulator mode selection to Playback Mode.
- 3.) Set the playback bit rate on this same tab and the PCM output code desired.
- 4.) Further encoding options, including FEC options (if licensed), can be set on the TEST function select tab, under the PCM ENC sub function tab.
- 5.) Refer to Figure 5-12 for the remaining steps.
- 6.) To start a recording file playback, select the *Playback File Number* control. This will bring up a file browser and allow the user to select the file number of the desired playback file.

- 7.) Once the file is selected, the file name and size will appear below the file selection number.
- 8.) If it is desired that the playback file repeat at the end of the playback file, select the *Playback Repeat Enable* check box.
- 9.) Once uploaded, the file will appear in the list at the bottom of the page. Recording space use will also be listed at the bottom of the tab.
- 10.) To start the playback process, select the START button. To pause playback, select the PAUSE button and to stop the playback, select the STOP button.
- 11.) Playback from a paused file can be resumed using the START button. If it is desired to move the playback location, the slider control can be used to get to an approximately location within a file and then playback can resume.
- 12.) No reverse playback is possible.
- 13.) Playback of the recorded file will automatically invoke the FEC decoding process required to decode the encoded data that was stored. Status on the right-hand pane show the progress of the decoding and errors that have been corrected.

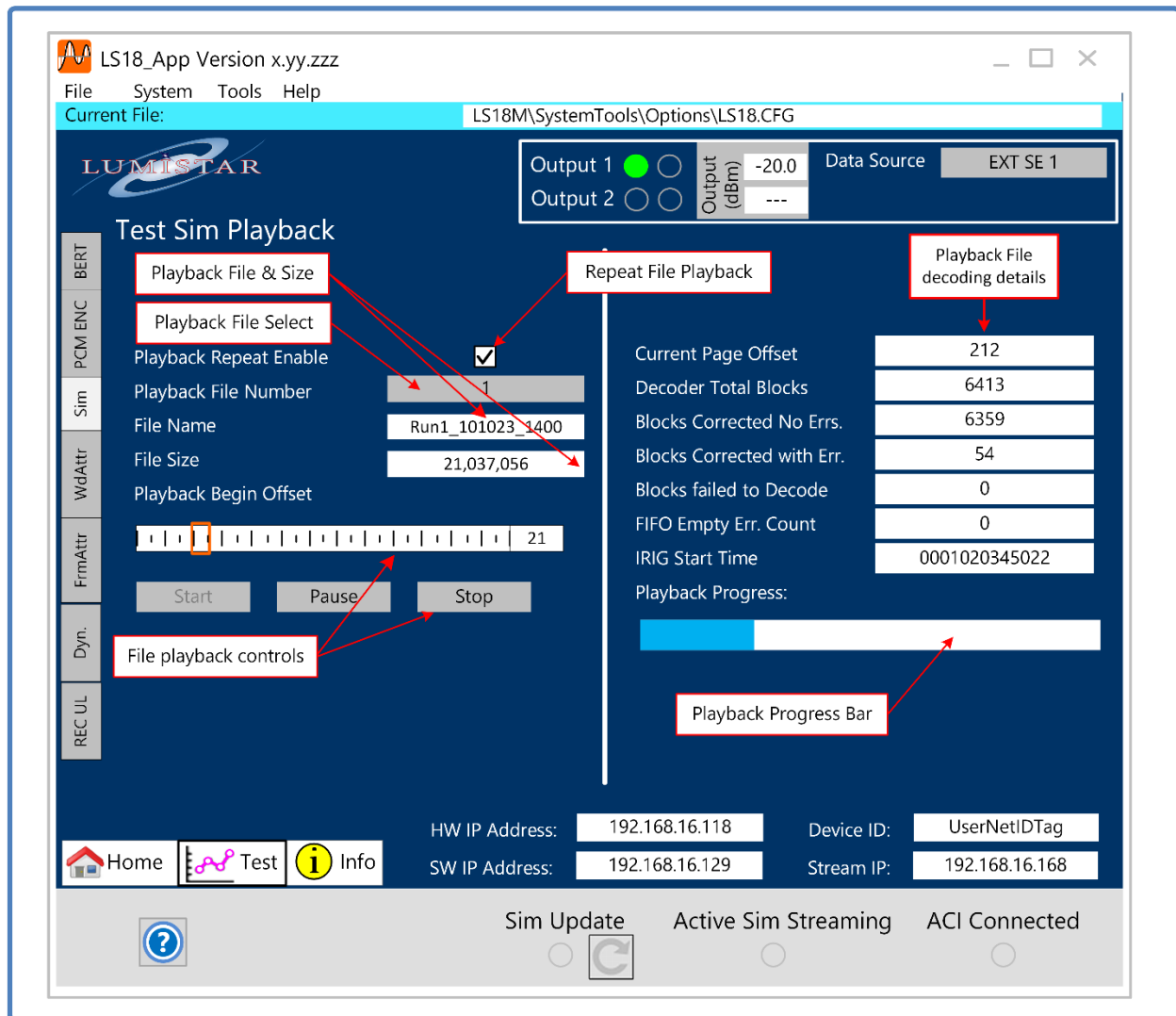


Figure 5-12 File Playback Controls

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- 14.) There should never be a case where uncorrected errors occur. If status indicates that there were blocks that failed to decode, the associated status window will indicate this number that failed.
  - 15.) When a file is resumed from a paused playback, there is no guarantee that all bits associated with the recorded file will be played or that some might not be played more than once. Data is stored in blocks in non-volatile memory. Playback is also on these boundaries. Therefore, it is possible to miss bits that were not played in a paused block or begin again a block that was being played when paused.
  - 16.) The playback progress bar will provide a visual gauge of the amount of the file that has been played and how much remains.