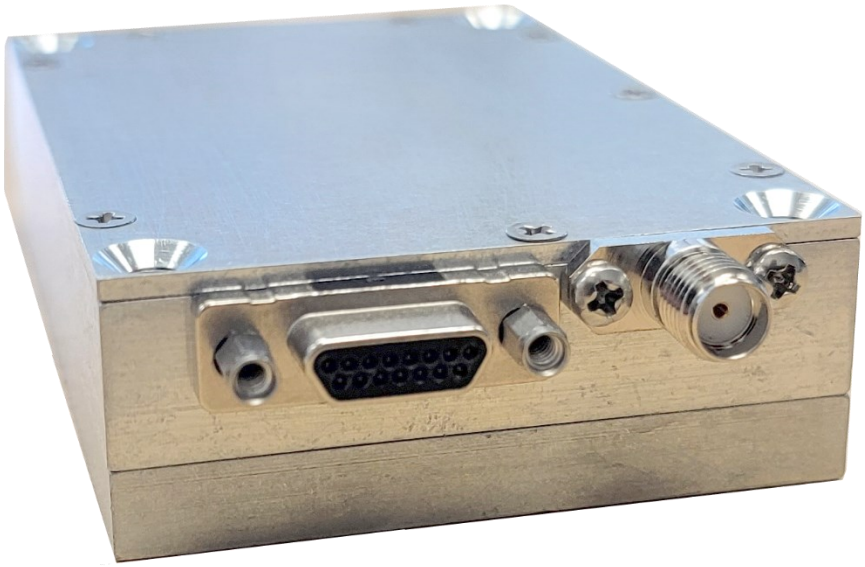
LS-19-M
Multi-Mode Multi-Band RF Test Transmitter
User's Manual



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Acronyms

BERT - Bit Error Rate Test
BPSK – Binary Phase Shift Keying
BW – Bandwdith
dB – Decibel
dBm – Decibel milliwatts
CLK – Clock
DAT – Data
DSP - Digital Signal Processor or Digtial Signal Processing
Eb/No - Energy per bit/Noise Energy
FEC – Forward Error Correction
FM - Frequency Modulation
GHz - Giga Hertz
GUI – Graphical User Interface
Hz - Hertz
INV - Invert
IRIG - Inter-Range Instrumentation Group
KB – Kilobyte
kHz - KiloHertz
LBW - Loop Bandwidth
LDPC - Low Density Parity Coding
LED - Light Emitting Diode
LSB - Least Significant Bit
Mbps - Mega Bits Per Second
MH-CPM - Multi-H Constant Phase Modulation
MHz - Mega Hertz
MSB - Most Significant Bit
PCMFM - Pulse Code Modulation Frequency Modulation
OQPSK - Offset Quadrature Phase Shift Keying
OS - Operating System
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 - Subminature Version A
SOQPSK-TG - Shapped Offset Quadrature Shift Keying - Task Group
USB - Universial Serial Bus

1 Introduction

1.1 General

The following document contains information on the Lumistar LS-19-M 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-19 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-19M-03-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-19 design
- Section 2 provides information on the hardware interfaces of the device
- Section 3 provides documentation of the LS19_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.

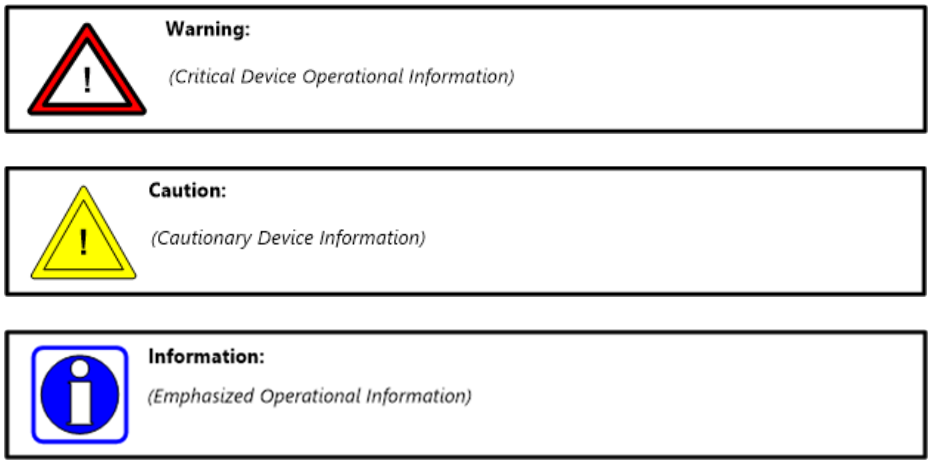

Figure 1-1 Document Flag Formats

1.3 Device Brief

The LS-19 is a sophisticated RF data modulator capable of modulating a single test data source in multiple RF bands. Modulation data sources include internal PRN sources as well as external clock and data sources in either a single-ended or RS422 differential format. The provided user software interface allows the user to tune the RF output frequency, select between licensed data modulation formats, select from licensed encoding techniques, and adjust output power levels.

The general LS-19 block diagram is shown in Figure 1-2.

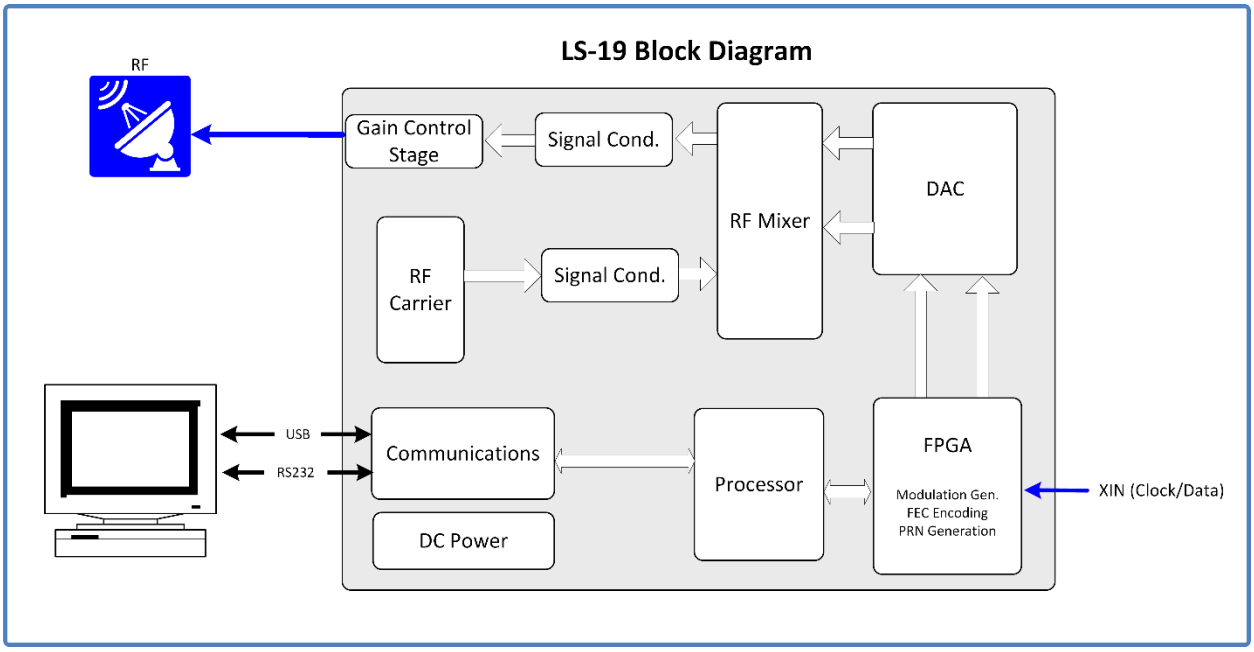

Figure 1-2 General Block Diagram of the LS-19 Configurations

Some of the primary design objectives of the LS-19 product line were to reduce the platform size, to provide The unit is controlled and monitored using either USB 2.0 or RS232 interfaces. Both interfaces are functional at the same time.

At the heart of the modular design is a flexible and extensible DSP Engine and an FPGA for real-time signal processing. The device construction is via two hardware sections, referred to as "slices": RF and Control Processing Engine. Licensing and some limited firmware updates can be updated in the field by the user. No need to return the unit for most modifications and updates.

The LS-19 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.

Certain licensed version of the LS-19 will be capable of accepting unencoded data and providing LDPC or convolutional encoding prior to transmission.

Table 1-1 provides specifications for the LS-19.

Category:	***Specifications:***	***Details:***
Mechanical	Envelope Dimensions ins. (mm.)	3.00 (76.2) L x 2.00 (50.8) W x 0.750 (19.05) H
	Form Factor	Modular Brick
	Weight oz. (kgs)	~ 9oz. (~0.26kgs.)
Electrical	Individual power requirements	9-36VDC
		Nom. +12VDC @ 1.0A max.
	Total Power (both during transmission)	~ 12 Watts (mode and data rate dependent)
Performance		
RF	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 Adjustment	0 to -31.5dBm in 0.25dBm steps
Modulation	Types (optional)	Group 1: PCMFM (Tier 0), SOQPSK (Tier 1), MHCPM (Tier 3) Group 2: BPSK, QPSK, OQPSK, Linear PM Group 3: AQPSK/AUQPSK, Linear PM with SubCarrier
FEC	LDPC (optional)	1024 and 4096 Block Sizes; Rates: 4/5, 2/3, 1/2
Connectors	RF Signal Output	(1) SMA Jack Receptacle
	Digital I/O / Power Connector	(1) MicroDSub-15 Plug
Environmental	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-19-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-19 system is delivered.

2.1 Mechanical Outline: Basic RF Modulator

The LS-19-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.

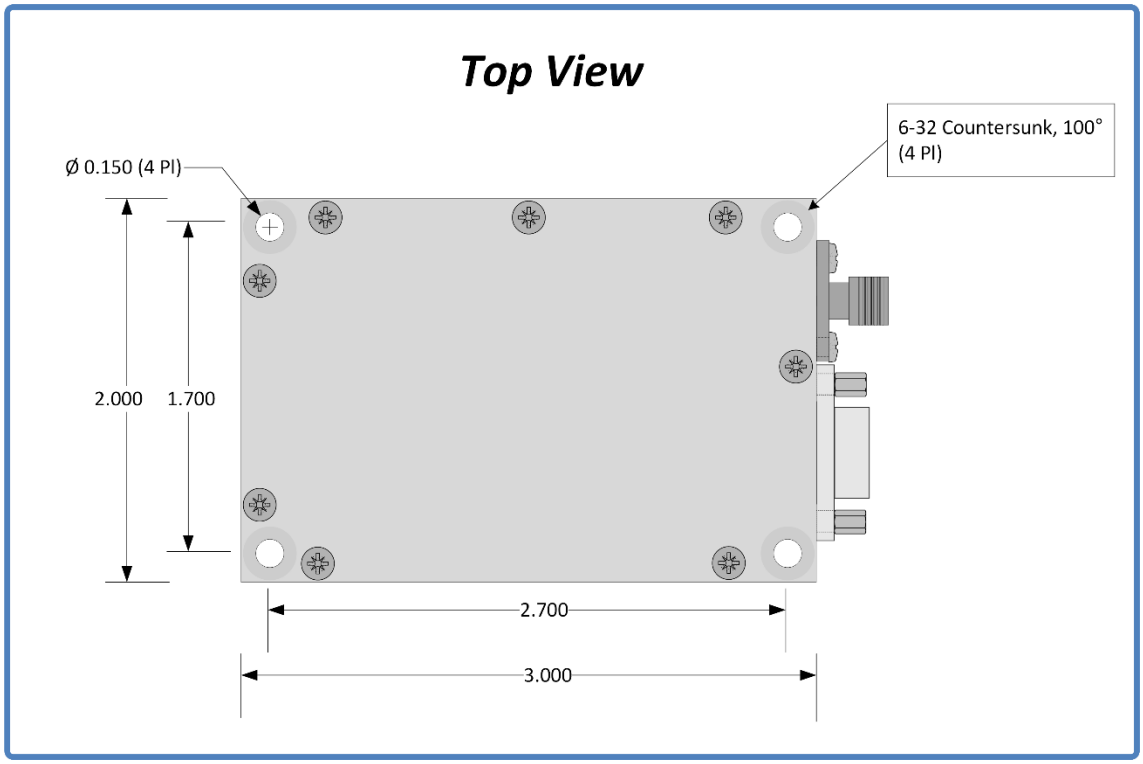

Figure 2-1 Representative Top View of the LS-19-M brick assembly

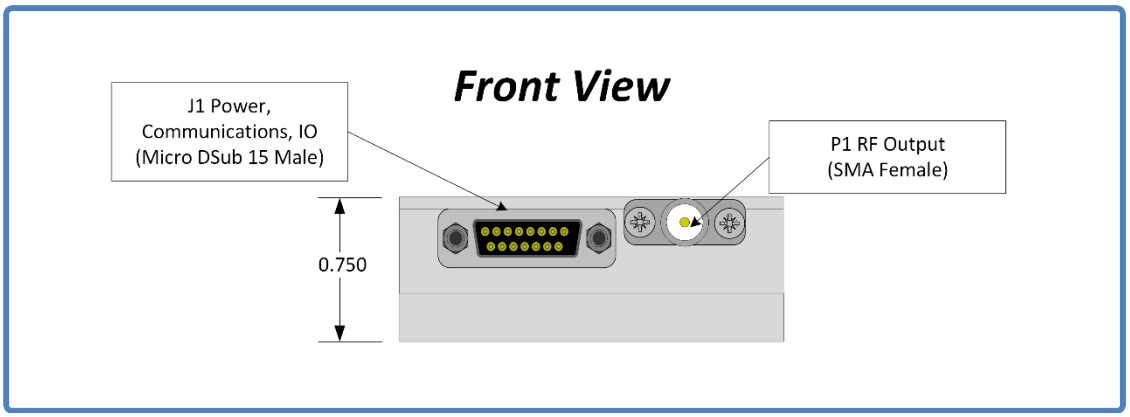

Figure 2-2 Front-View of the LS-19-M brick assembly

The device can be mounted using four UNC6-32 or Metric 3 or 3.5mm machine screws. Total device height does not exceed 0.75 inches so the length of the mounting screw will only depend on the desired number of mounting threads.

2.2 Interface Signals: Micro-D Sub Pin-outs

Figure 2-2 presents a front-view of the LS-19-M. connectors. Figure 2-3 provides detailed interface pinouts of the Micro-D connector of the LS-19-M.

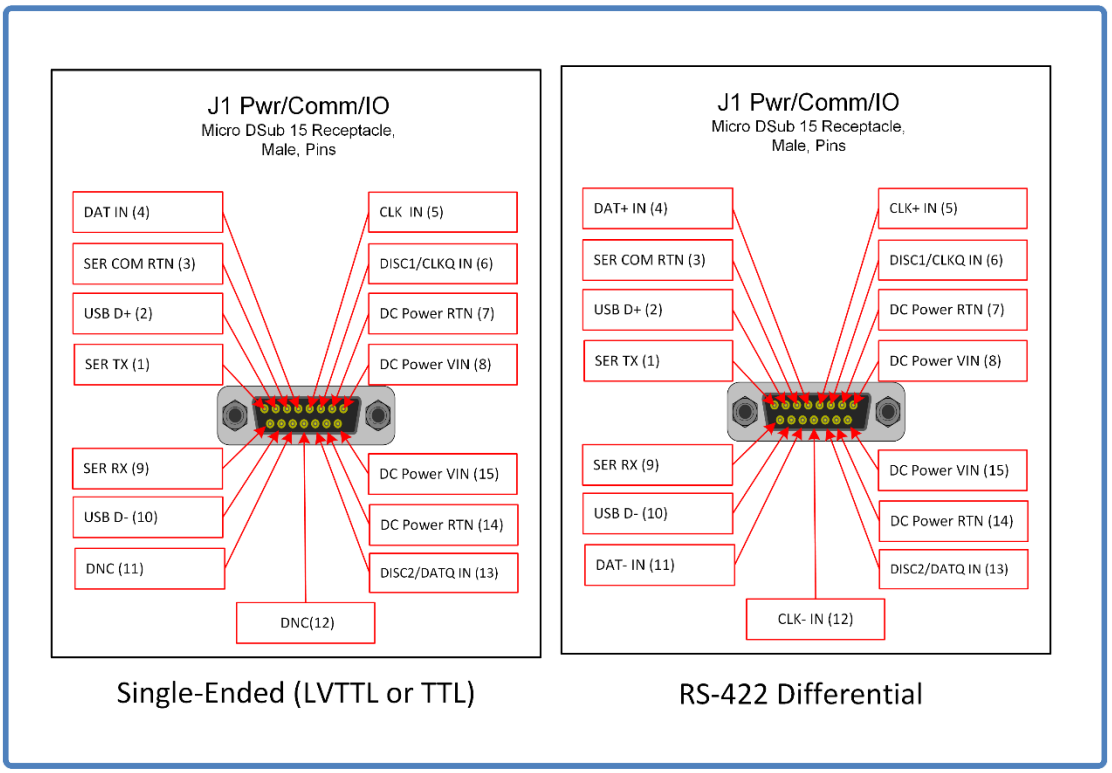

Figure 2-3 LS-19-M J1 Connector Pin-out Details

Information:

The user must select the interface type (Single-ended or RS422 Differential) for the unit at time of order. This is not a post delivery selectable option.

2.3 Interface Signals: Electrical Definitions/Characteristics

The interface signals of the LS-19-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 Ω	Output Voltage	Output Ω	See Note
CLK Input	I	Digital			5V		1
DAT Input	I	Digital			5V		1
CLK +/- Input	I	RS422			3.4V Diff	100Ω	2
DAT +/- Input	I	RS422			3.4V Diff	100Ω	2
9-42VDC In	PWR	Power	9-42VDC				3
Pwr Rtn	PWR	Power	GND				3
SER TX/RX	I/O	RS232					4
USB_D+/-	I/O	USB 2.0					5

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.) RS232 transceiver: SN75C3221E. This device is capable of 1Mbps transactions. Firmware limits the BAUD rate to 250kbps. Default data rate is 57.6K Baud.
5.) USB2.0 operation only. USB interface is active simultaneously with RS232 interface.

Table 2-1 Primary IO Signal Electrical Definitions

2.4 Cabling Interfaces

The LS-19-M assembly is typically delivered with a Lumistar interface cable. This cable interfaces with the Micro D-Sub connections to more commonly available interface connections such as BNC, RS232 Serial 9-pin connector, USB-B connections.

The supplied cable for single-ended connections is defined in Figure 2-4. The supplied cable for differential connections is defined in Figure 2-5. There are cabling options for single-ended connections and differential connections. Consult your Lumistar sales representative for available options.

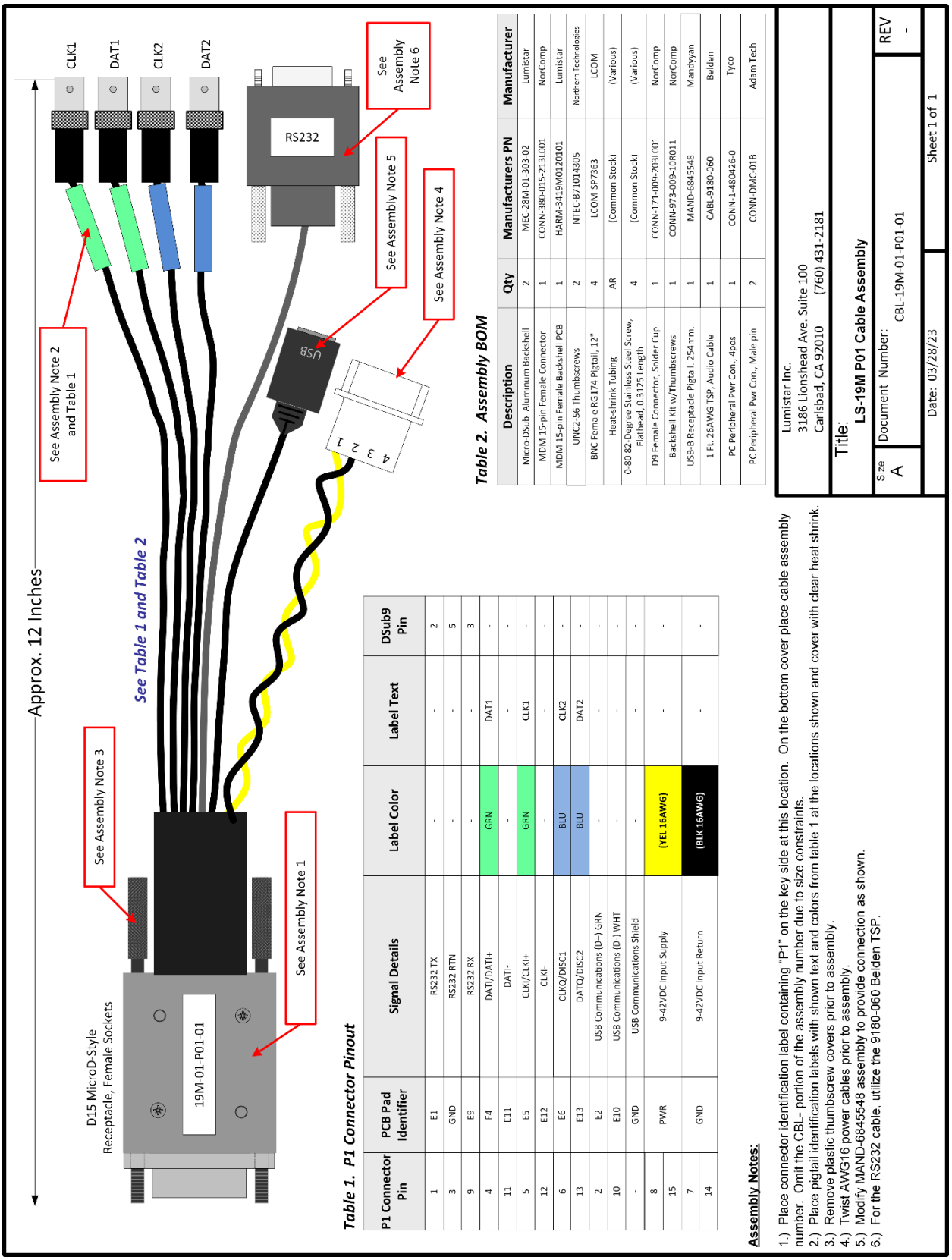

Table 1. P1 Connector Pinout

P1 Connector Pin	PCB Pad Identifier	Signal Details	Label Color	Label Text	DSub9 Pin
1	E1	RS232 TX	-	-	2
3	GND	RS232 RTN	-	-	5
9	E9	RS232 RX	-	-	3
4	E4	DAT/DAT+	GRN	DAT1	-
11	E11	DAT-	-	-	-
5	E5	CLK/CLK+	GRN	CLK1	-
12	E12	CLK-	-	-	-
6	E6	CLKQ/DISC1	BLU	CLK2	-
13	E13	DATQ/DISC2	BLU	DAT2	-
2	E2	USB Communications (D+) GRN	-	-	-
10	E10	USB Communications (D-) WHT	-	-	-
-	GND	USB Communications Shield	-	-	-
8	PWR	9-42VDC Input Supply	(YEL 16AWG)	-	-
15					
7	GND	9-42VDC Input Return	(BLK 16AWG)	-	-
14					

Table 2. Assembly BOM

Description	Qty	Manufacturers PN	Manufacturer
Micro-DSub Aluminum Backshell	2	MEC-28M-01-303-02	Lumistar
MDM 15-pin Female Connector	1	CONN-380-015-213L001	NorComp
MDM 15-pin Female Backshell PCB	1	HARM-3419M0120101	Lumistar
UNC2-56 Thumbscrews	2	NTEC-B71014305	Northern Technologies
BNC Female RG174 Pigtail, 12"	4	LCOM-SP7363	LCOM
Heat-shrink Tubing	AR	(Common Stock)	(Various)
0-80 82-Degree Stainless Steel Screw, Flathead, 0.3125 Length	4	(Common Stock)	(Various)
D9 Female Connector, Solder Cup	1	CONN-171-009-203L001	NorComp
Backshell Kit w/Thumbscrews	1	CONN-973-009-10R011	NorComp
USB-B Receptacle Pigtail. 254mm.	1	MAND-6845548	Mandyyan
1 Ft. 26AWG TSP. Audio Cable	1	CABL-9180-060	Belden
PC Peripheral Pwr Con., 4pos	1	CONN-1-480426-0	Tyco
PC Peripheral Pwr Con., Male pin	2	CONN-DMC-01B	Adam Tech

Assembly Notes:

1.) Place connector identification label containing "P1" on the key side at this location. On the bottom cover place cable assembly number. Omit the CBL- portion of the assembly number due to size constraints.
2.) Place pigtail identification labels with shown text and colors from table 1 at the locations shown and cover with clear heat shrink.
3.) Remove plastic thumbscrew covers prior to assembly.
4.) Twist AWG16 power cables prior to assembly.
5.) Modify MAND-6845548 assembly to provide connection as shown.
6.) For the RS232 cable, utilize the 9180-060 Belden TSP.

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Title: LS-19M P01 Cable Assembly

Size A | Document Number: CBL-19M-01-P01-01 | REV -

Date: 03/28/23 | Sheet 1 of 1

Figure 2-4 P1 User Interface Cable – Single-Ended CLK/DAT Inputs

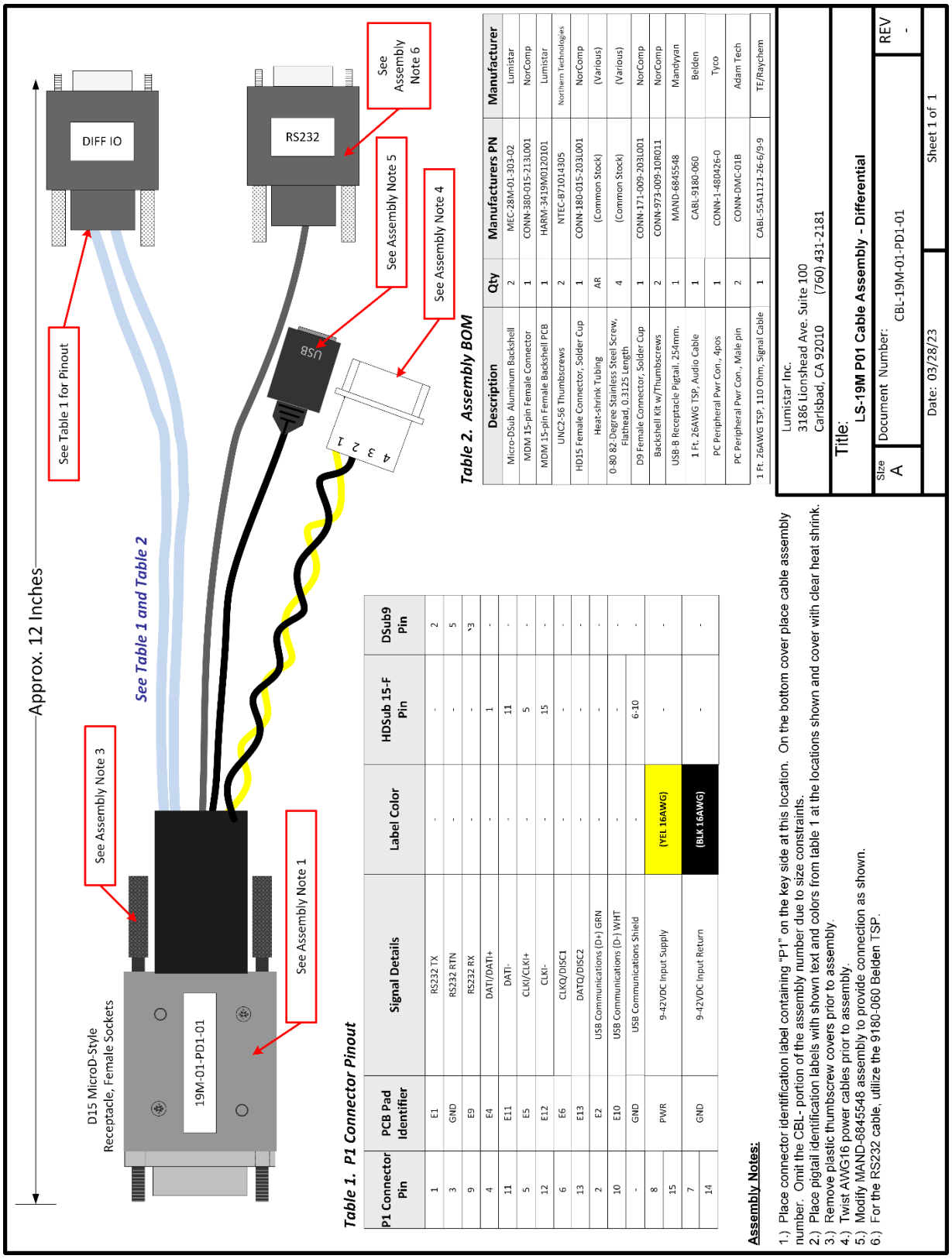

Table 1. P1 Connector Pinout

P1 Connector Pin	PCB Pad Identifier	Signal Details	Label Color	HDSub 15-F Pin	DSub9 Pin
1	E1	RS232 TX	-	-	2
3	GND	RS232 RTN	-	-	5
9	E9	RS232 RX	-	-	3
4	E4	DATI/DATI+	-	1	-
11	E11	DATI-	-	11	-
5	E5	CLKI/CLKI+	-	5	-
12	E12	CLKI-	-	15	-
6	E6	CLKQ/DISC1	-	-	-
13	E13	DATQ/DISC2	-	-	-
2	E2	USB Communications (D+) GRN	-	-	-
10	E10	USB Communications (D-) WHT	-	-	-
-	GND	USB Communications Shield	-	6-10	-
8 15	PWR	9-42VDC Input Supply	(YEL 16AWG)	-	-
7 14	GND	9-42VDC Input Return	(BLK 16AWG)	-	-

Table 2. Assembly BOM

Qty	Description	Manufacturers PN	Manufacturer
2	Micro-DSub Aluminum Backshell	MEC-28M-01-303-02	Lumistar
1	MDM 15-pin Female Connector	CONN-380-015-213L001	NorComp
1	MDM 15-pin Female Backshell PCB	HARM-34419M00120101	Lumistar
2	UNC2-56 Thumbscrews	NTEC-B71014305	Northern Technologies
1	HD15 Female Connector, Solder Cup	CONN-180-015-203L001	NorComp
AR	Heat-shrink Tubing	(Common Stock)	(Various)
4	0-80 82-Degree Stainless Steel Screw, Flathead, 0.3125 Length	(Common Stock)	(Various)
1	D9 Female Connector, Solder Cup	CONN-171-009-203L001	NorComp
2	Backshell Kit w/Thumbscrews	CONN-973-009-10R011	NorComp
1	USB-B Receptacle Pigtail, 254mm.	MAND-6845548	Mandyyan
1	1 Ft. 26AWG TSP, Audio Cable	CABL-9180-060	Belden
1	PC Peripheral Pwr Con., 4pos	CONN-1-480426-0	Tyco
2	PC Peripheral Pwr Con., Male pin	CONN-DMC-01B	Adam Tech
1	1 Ft. 26AWG TSP, 110 Ohm, Signal Cable	CABL-55A1121-26-6/9-9	TE/Raychem

Assembly Notes:

1.) Place connector identification label containing "P1" on the key side at this location. On the bottom cover place cable assembly number. Omit the CBL- portion of the assembly number due to size constraints.
2.) Place pigtail identification labels with shown text and colors from table 1 at the locations shown and cover with clear heat shrink.
3.) Remove plastic thumbscrew covers prior to assembly.
4.) Twist AWG16 power cables prior to assembly.
5.) Modify MAND-6845548 assembly to provide connection as shown.
6.) For the RS232 cable, utilize the 9180-060 Belden TSP.

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Title:
LS-19M P01 Cable Assembly - Differential

Size A | Document Number: CBL-19M-01-PD1-01 | REV -

Date: 03/28/23 | Sheet 1 of 1

Figure 2-5 P1 User Interface Cable – Differential CLK/DAT Inputs

2.5 Cooling and Thermal Conditioning

The LS-19 must maintain a satisfactory operating temperature range to ensure sustainable functionality. It is **recommended** that provisions for cooled air are used during operation. The unit itself provides a heat load during typical operations which typically reaches 12 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. All surfaces should be considered as heat sinking area. The center of the mechanical assembly is the main internal heat sink.

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 operating temperature. 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.

Warning:

If the unit temperature exceeds 70 degree Celsius, the INFO tab will be displayed. Steps should be taken to provide properly cooling to ensure continued operation.

3 Communications Interface

The LS-19-M hardware communicates through USB and RS232 interfaces. Lumistar provides a Windows Driver install for the USB interface. No driver installations are required for the RS232 interface. Both interfaces will appear as a standard Windows COM port. The default BAUD rate is set to 57.6K for both interfaces.

Both serial interfaces are active simultaneously. The unit does not prioritize one interface over the other. It is possible to have both interfaces connected to a host target at the same time. In such case, the unit will act on the commands for which interface commanded last.

The unit will respond, on either interface, to two different protocols. Lumistar has a consolidated interface referred to as a "Modular Command" protocol. This protocol is software command/status friendly and less "hyper-terminal" in nature. The unit will also interface to protocols defined in IRIG106-22 Appendix 2-C. This protocol is intended for hyper-terminal style controls.

The Modular Command protocol allows for full control of the device, including all functions where no Appendix 2-C equivalent command is present. All User GUI software and example software provided by Lumistar will primarily employ and utilize the Modular Command protocol. It is beyond the intent of this document to illustrate either communications protocol. Refer to the device ICD for additional details.

4 Software Application: LS19_App

The LS-19 Network Application (LS19_APP) is the primary software deliverable for the LS-19-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.

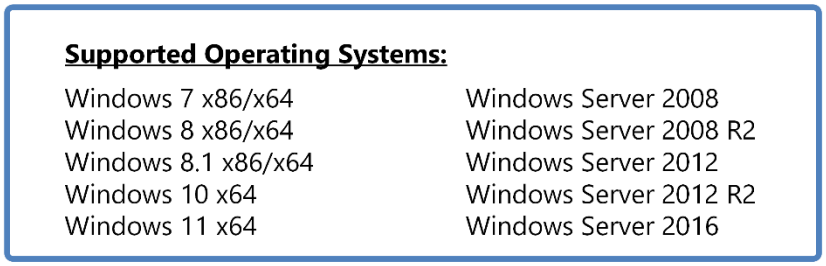

Figure 4-1 Network User Application – Supported Operating Systems

Lumistar suggests that the user installs 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 4th generation Intel i7 processor.

4.1 Application Operation

Install the LS19_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 LS19_App.

4.1.1 Communications Setup Launch Windows

When the application is launched, the application will examine host available COM ports and attempt to communicate with each of them. The application will query each port in attempt to determine if it is an LS-19. If it only finds a single LS-19 connected to a host, the application will launch to the HOME tab. If there is more than one unit available, the application will allow the user to select which unit they are interested in communicating with.

4.1.2 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 4-2. 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 LS19_App (in the c:\lumistar\LS19M\UserTools directory).

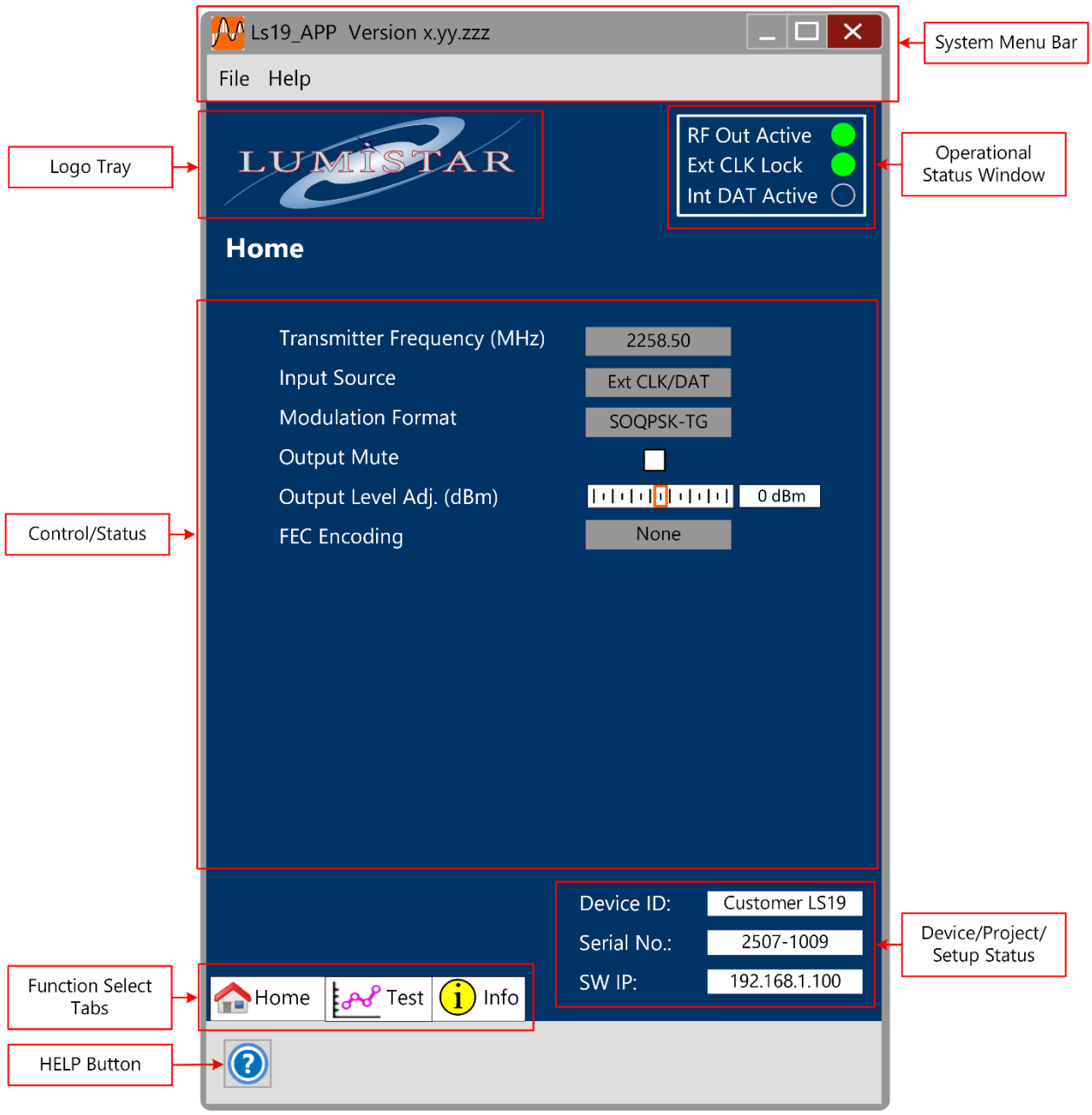

Figure 4-2 LS19_App – General Screen Layout

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-19-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\LS19\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.

Control/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 filed 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 **Error! Reference source not found.**.

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-19-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.) **Help**:

a. 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 Output Status and whether the external clock and data PLL is locked. It also indicates the internal modulation source is active.

Device/Setup Status: In the lower right-hand half of the screen is an area which indicates that software IP address of the target host, the user selected device network ID tag, and the unit's serial number.

Function Select Tabs: At the bottom of all pages, function select tabs are located along the bottom left side of the screen. The LS19_App contains three function select tabs: HOME, TEST, INFO. These tabs represent the main functional capabilities of the device. Selecting any of these tabs will change the window layout to the selected function.

HELP Button: At the bottom left of each window pane is a blue help button. If you have Adobe Acrobat installed (available on the provided software install DVD in the "Utilities" folder), selection of this button will open this manual to the related user manual page. This is referred to as context sensitive help. Certain versions of Acrobat do not support this functionality. The version on the distribution DVD does support this issue.

Sub-Function Select Tabs: On the TEST and INFO tabs, sub function select tabs, a series of vertical tabs placed on the left side of the pane, provide the user the ability to address specific functions within the primary tab function.

4.1.3 Function Select Tab – HOME

The HOME select tab is one of the three function select tabs and likely the most utilized. From this tab, most users can setup 95% 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 is shown in Figure 4-3.

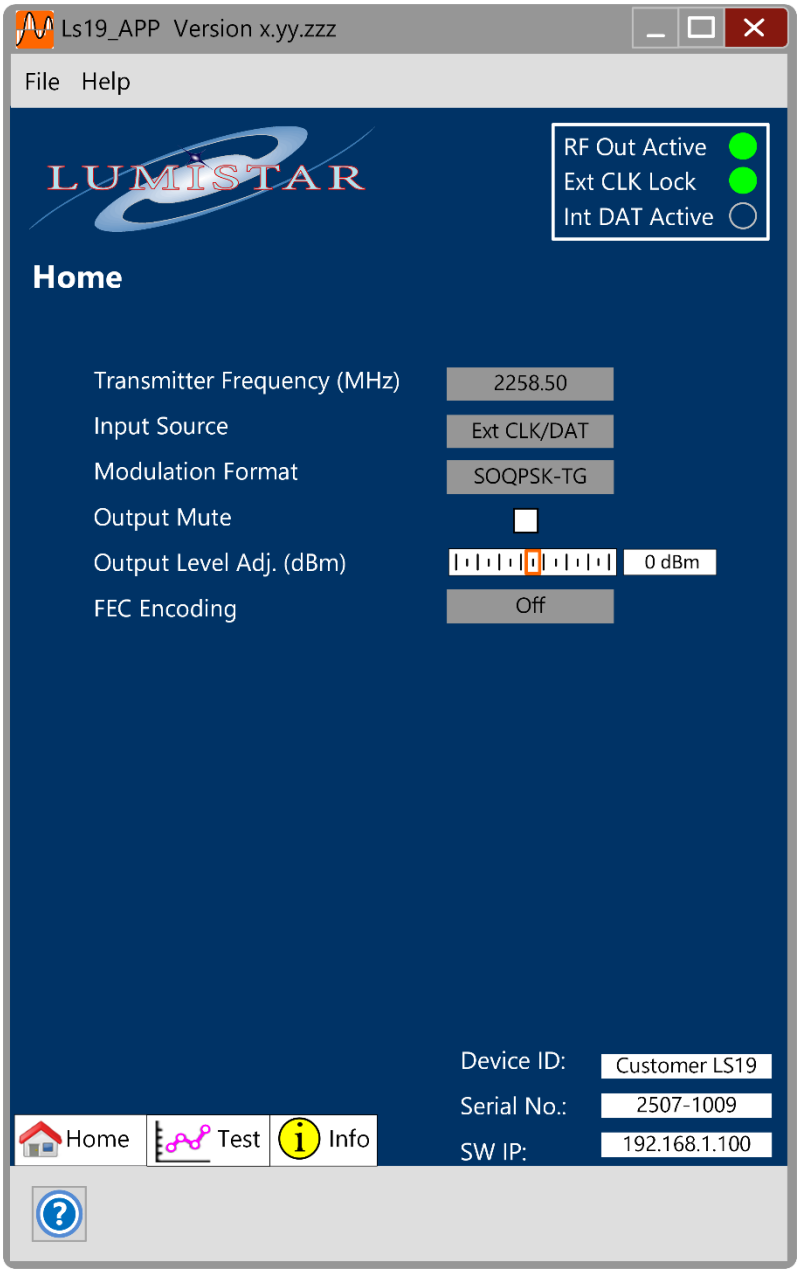

Figure 4-3 LS19_App – Home Tab for Configuration

Transmitter 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.

Input Source: There are two data sources for the LS-19 system. The unit contains an internal PCM/PRN data source, as well as a single-ended clock and data input or a RS422 differential clock and data input.

Information:

The user must select the interface type (Single-ended or RS422 Differential) for the unit at time of order. This is not a post delivery selectable option.

Modulation Format: The unit can provide several different RF modulation techniques for the source data tuned to the output center frequency. These typically 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.

Output Mute: This select box enables and disables the RF Modulation output. When enabled (checked), the output will be disabled and no RF will be output from the SMA connector. When disabled (unchecked), all output controls will be active.

Caution:

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.

Output Level Adjust: This control allows the user to attenuate the RF output power by as much as 31.75dB in 0.25dB steps.

FEC Encoding: This drop-down menu allows the user to select encoding, if licensed, for the incoming data. The FEC setup has further controls on the TEST function tab.

4.1.4 Function Select Tab – TEST

The Test tab provides the user with the ability to self-modulate the RF test modulator with internal PRN sources or other patterns.

The following sections contain descriptions of all TEST functionalities.

4.1.4.1 TEST Sub-Function Select Tab – Pattern Generator

Reference Figure 4-4 for the following section.

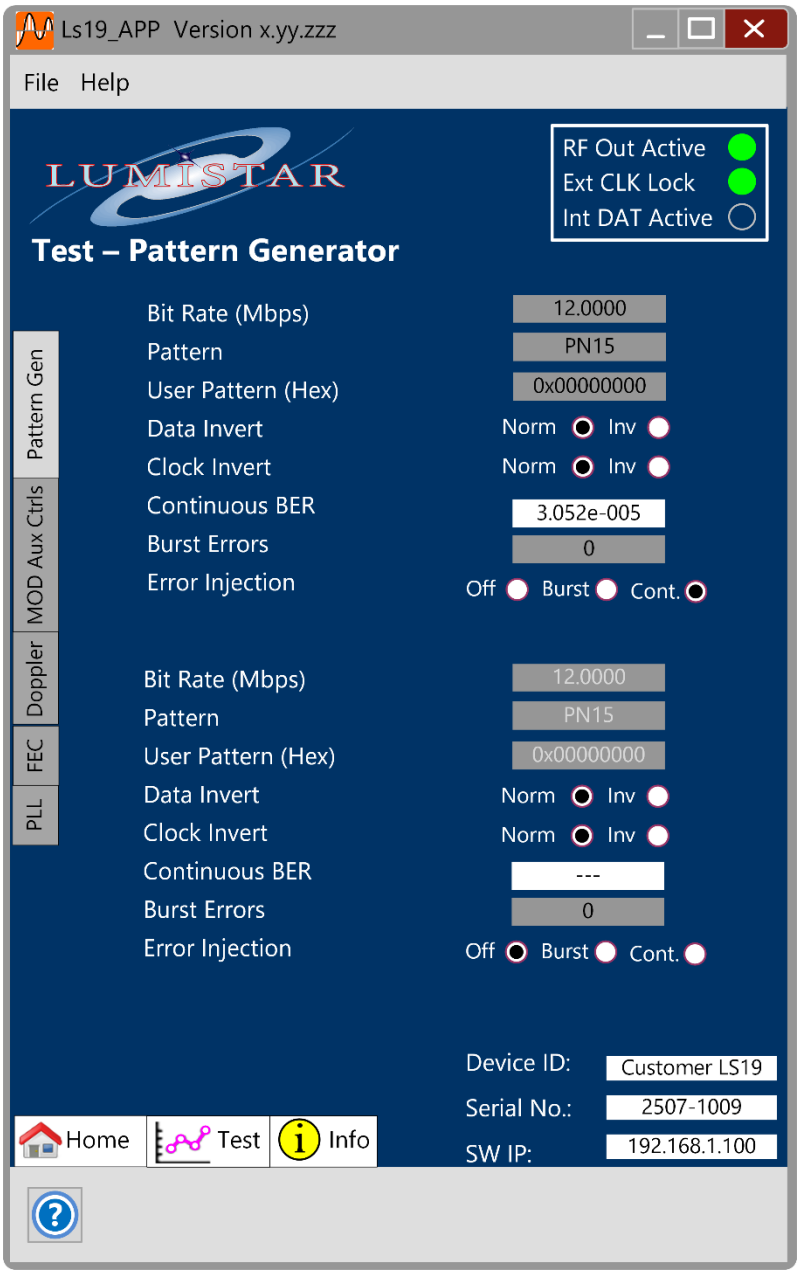

Figure 4-4 LS19_App – Sub-Function Select Tab: Pattern Generator

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

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, 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 bottom of this tab contains a second set of controls which would only be useful for AUQPSK and AQPSK simulation modes. All controls will be disabled unless in these two specific modulation modes. The specific functions of the controls and status are identical to those defined above.

4.1.4.2 TEST Sub-Function Select Tab – Modulation AUX Controls

Reference Figure 4-5 for the following section.

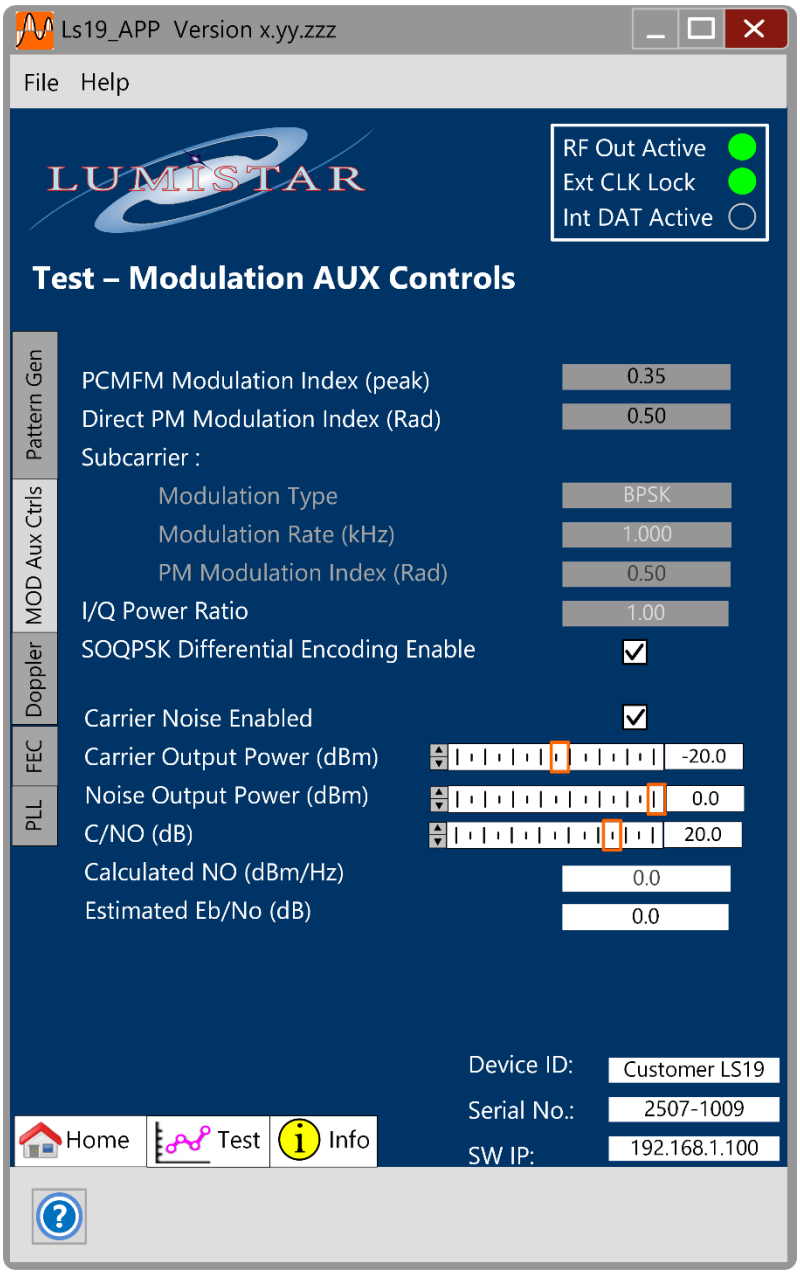

Figure 4-5 LS19_App – Sub Function Select Tab: Test Modulation AUX Controls

PCMFM Modulation Index (peak): When the PCMFM modulation mode is selected, this control setting allows the user to adjust the FM modulation index for values between 0.1 and 4.0. The default and normal setting is 0.35.

Direct PM Modulation Index (Rad): When the Direct PM modulation mode is selected, this control setting allows the user to adjust the PM modulation index between 0.00001 and 3.14159 radians. Nominal settings are 0.500 radians.

Subcarrier - Modulation: When the modulation mode is selected as Subcarrier PM/PSK, this value allows the user to select between the BPSK, QPSK and OQPSK subcarrier modes.

Subcarrier – Modulation Rate (MHz): To select the Sub-carrier modulation rate, this control box allows the user to set the rate from 0.001 and 10MHz.

Subcarrier – PM Modulation Index (Rad): When the Subcarrier PM Modulation mode is selected, this control setting allows the user to adjust the PM modulation index between 0.00001 and 3.14159 radians. Nominal settings are 0.500 radians.

I/Q Power Ratio: This control entry box allows the user to adjust the I/Q power ratios in the AUQPSK and AQPSK modes. The ratio of I signal power to Q signal power can be set between 0.00001 and 100. The nominal power setting ratio is 1.00.

SOQPSK Differential Encoding Enable: This check box allows the enabling and disabling of the differential encoding provided by the IF Test modulator. The LDPC mode requires that SOQPSK differential encoding be disabled. Standard SOQPSK-TG and SOQPSK-MIL require that differential encoding be enabled.

Carrier Noise Enable: The IF modulator contains an on-board Average White Gaussian (AWG) noise source which can be mixed directly into the modulator output. This control check-box is provided to enable and disable the AWGN source.

Carrier Output Power (dBm): This slide bar and dialog box allows the user to adjust the modulator's IF output level over a range from -2dBm to -90dBm.

Noise Output Power (dBm): This slide bar and dialog box allows the user to adjust the modulator's IF output level over a range from -2dBm to -90dBm.

C/No (dB): This slide bar and dialog box allows the user to adjust the modulator's carrier additive noise output level. *(This function will be available in the future.)*

4.1.4.3 TEST Sub-Function Select Tab – Doppler

The LS-19 can have the licensed capability to apply doppler sweeping to the modulated RF output.

Reference Figure 4-6 for the following section.

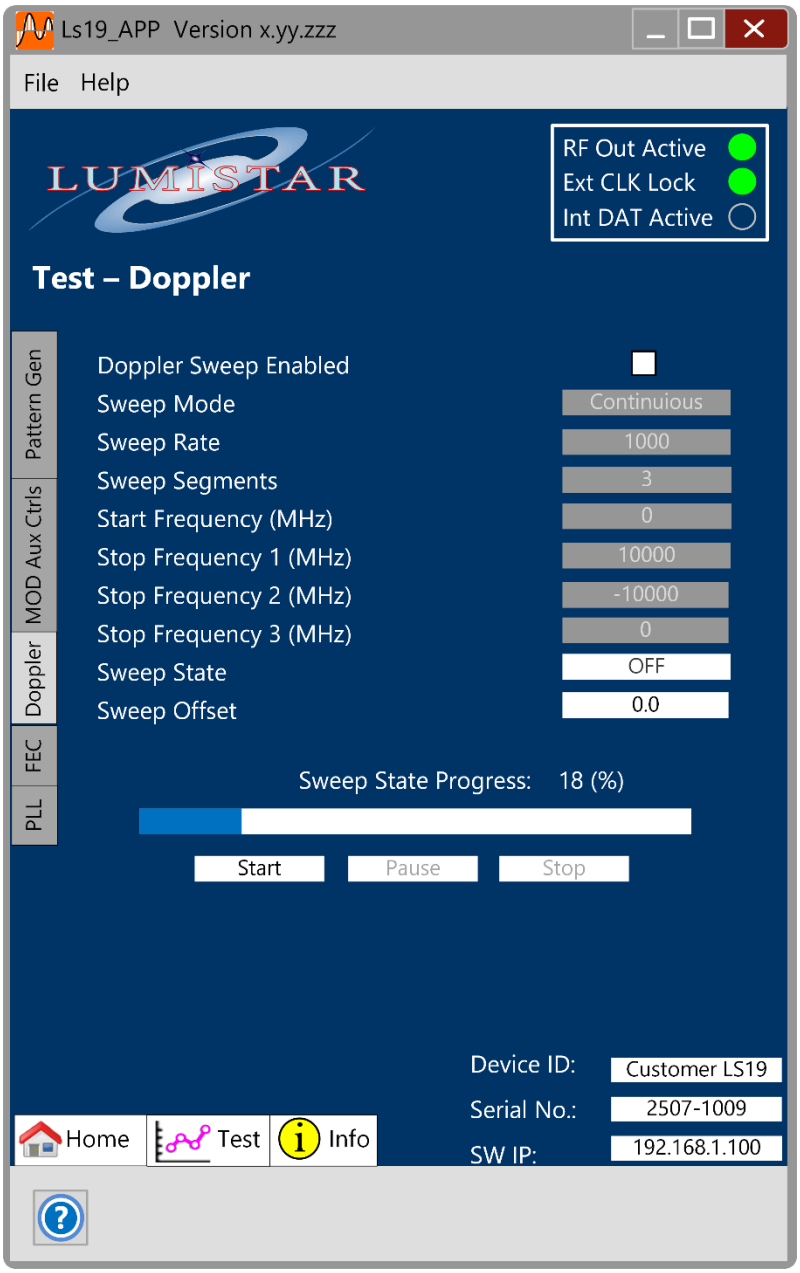

Figure 4-6 LS19_App – Sub-Function Select Tab: Doppler

Doppler Sweep Enabled: This control enables the Doppler Sweep functionality.

Sweep Mode: The control selects the sweep modes. Two modes are allowed: Single/Continuous. Setting this value to single will run the number of sweep segments programmed one time and then halt. Continuous mode allows for the process to cycle and repeat until paused or stopped.

Sweep Rate: This allows the user to set the step rate to a value between 1 and 20,000 Hertz/Sec

Sweep Segments: Up to three segments are allowed in a single sweep. The segments will start from the start frequency, proceed to the first stop frequency at a rate specified. If more segments have been

programmed, the sweep process will continue on to the next defined stop frequency and then on to a third stop frequency if so programmed.

Start Frequency (MHz): This entry is the starting frequency of the sweep segment.

Stop Frequency 1 (MHz): This entry is the stop frequency of the first sweep segment.

Stop Frequency 2 (MHz): This entry is the stop frequency of the second sweep segment.

Stop Frequency 3 (MHz): This entry is the stop frequency of the third sweep segment.

Sweep State: This status window will indicate the state of the sweep process.

Sweep Offset: This status displays the present offset frequency being modulated.

Sweep State Progress: This is both a control and status control. It graphically displays the present percentage of the entire sweep process. It also supplies the user with controls to start, stop and pause the sweep process.

4.1.4.4 TEST Sub-Function Select Tab – Forward Error Correction (FEC)

Reference Figure 4-7 for the following section.

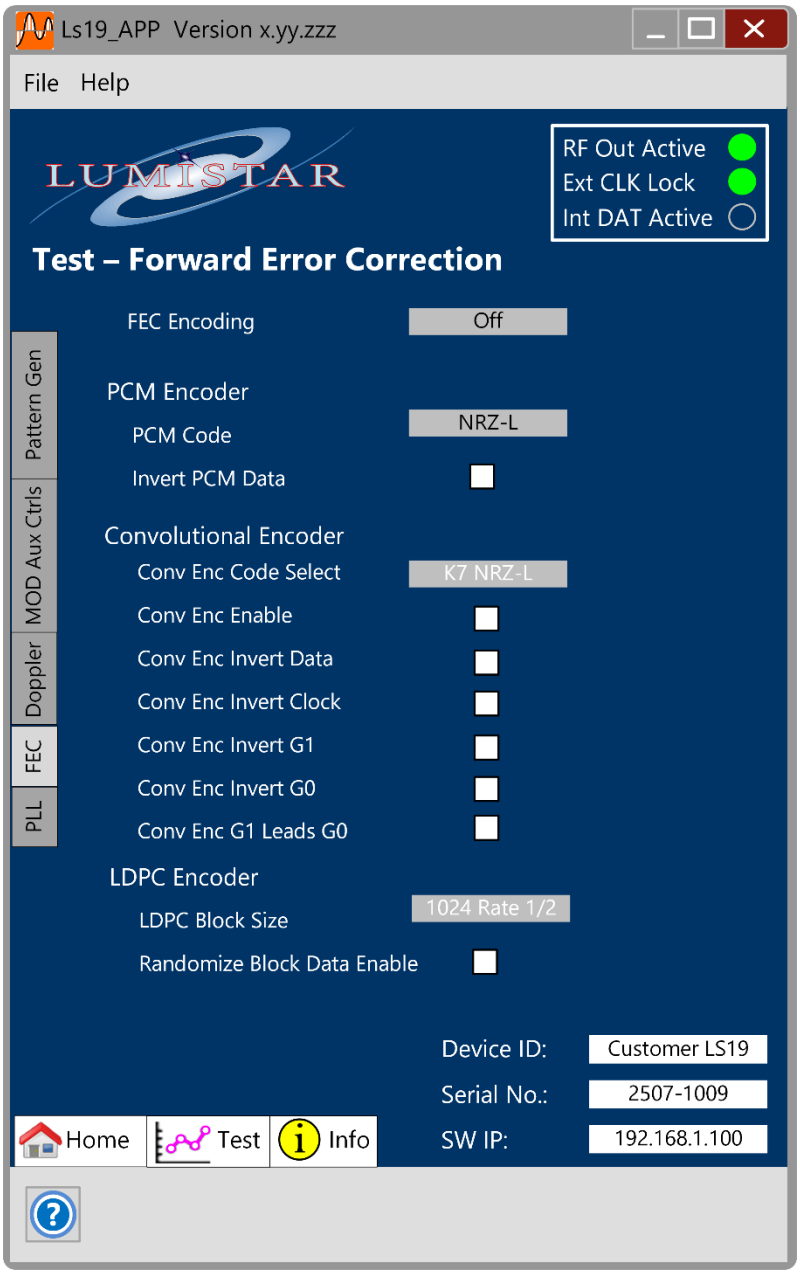

Figure 4-7 LS19_App – Sub Function Select Tab: Forward Error Correction (FEC)

FEC Encoding: This control selects which FEC controls are active.

PCM Code: This control allows the user to select the PCM encoding to apply to the data. Shows the encoding methods provided.

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 Encoder Selection Table

Invert PCM Data: The LS-19 can invert the encoding data source via this control, effectively doubling the number of PCM code formats provided.

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 is fixed at K=7.

Convolution Code Enable: This check box control enables the convolutional encoding process.

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.

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 ½, Block Size 4096/Rate ½, Block Size 1024/Rate 2/3, Block Size 4096/Rate 2/3, Block Size 1024/Rate 4/5, Block Size 4096/Rate 4/5.

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

4.1.4.5 TEST Sub-Function Select Tab – PLL Controls and Status

Reference Figure 4-8 for the following section.

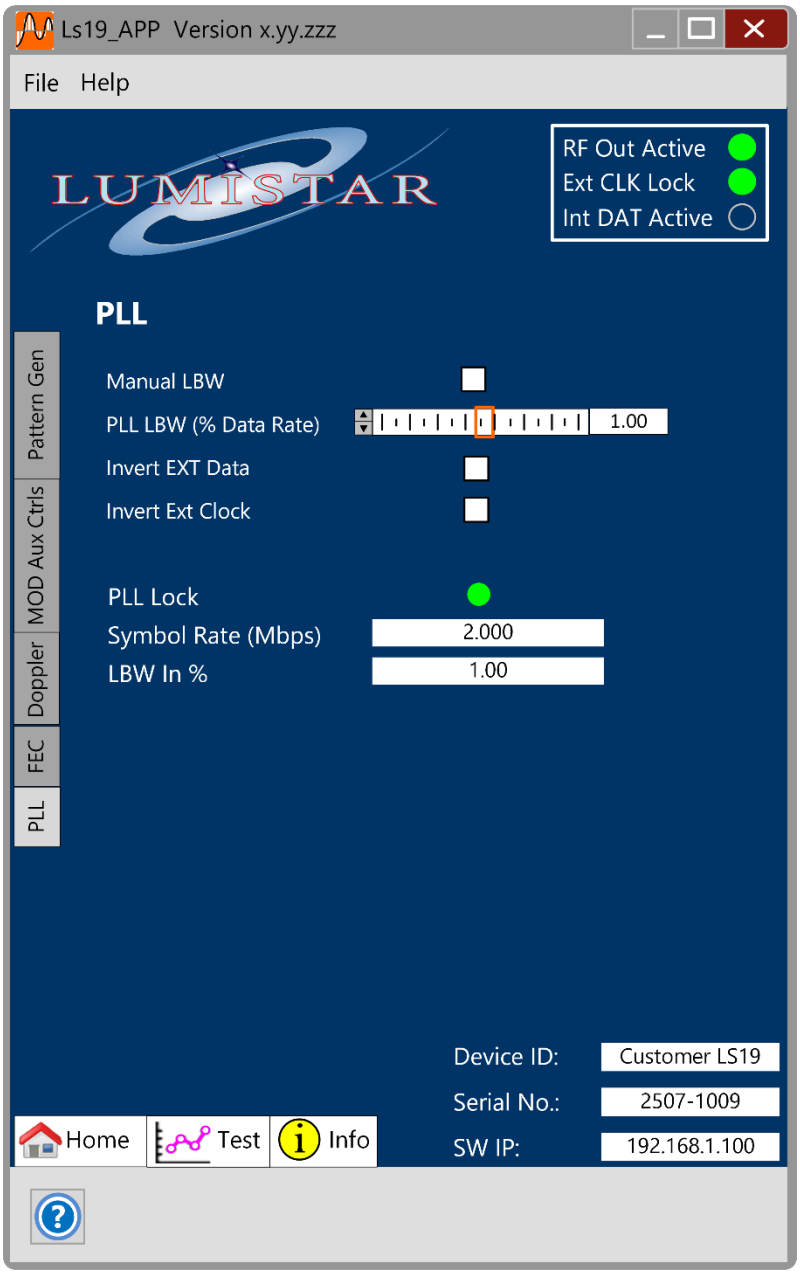

Figure 4-8 LS19_App – Sub-Function Select Tab: PLL

Information:

The LS-19 design contains a very sophisticated PLL interface for external data and clock sources. This PLL allows for, and corrects, duty cycle variations in the sources feeding the transmitter to allow for properly modulated output results. The PLL runs by default in automatic mode but can be placed in manual mode for specific adaptations.

Manual LBW: This control allows the user to switch the incoming clock and data PLL to manual control mode versus the default automatic mode.

PLL LBW (% of Data Rate): This control allows the user to program the PLL loop bandwidth in 0.01% increments from 0.01 to 2.00%.

Invert EXT Data: This control box allows the user to invert the polarity of the externally received data.

Invert EXT CLK: This control box allows the user to invert the polarity of the externally received clock.

PLL Lock: This LED lock indicator will provide status on whether the PLL is locked on the external clock and data source.

Symbol Rate: This status window indicates the detected external clock rate being applied to the unit.

LBW In (%): This status window indicates the present LBW setting being used to accurately track the external data.

4.1.5 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.

4.1.5.1 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 4-9 for tab layout.

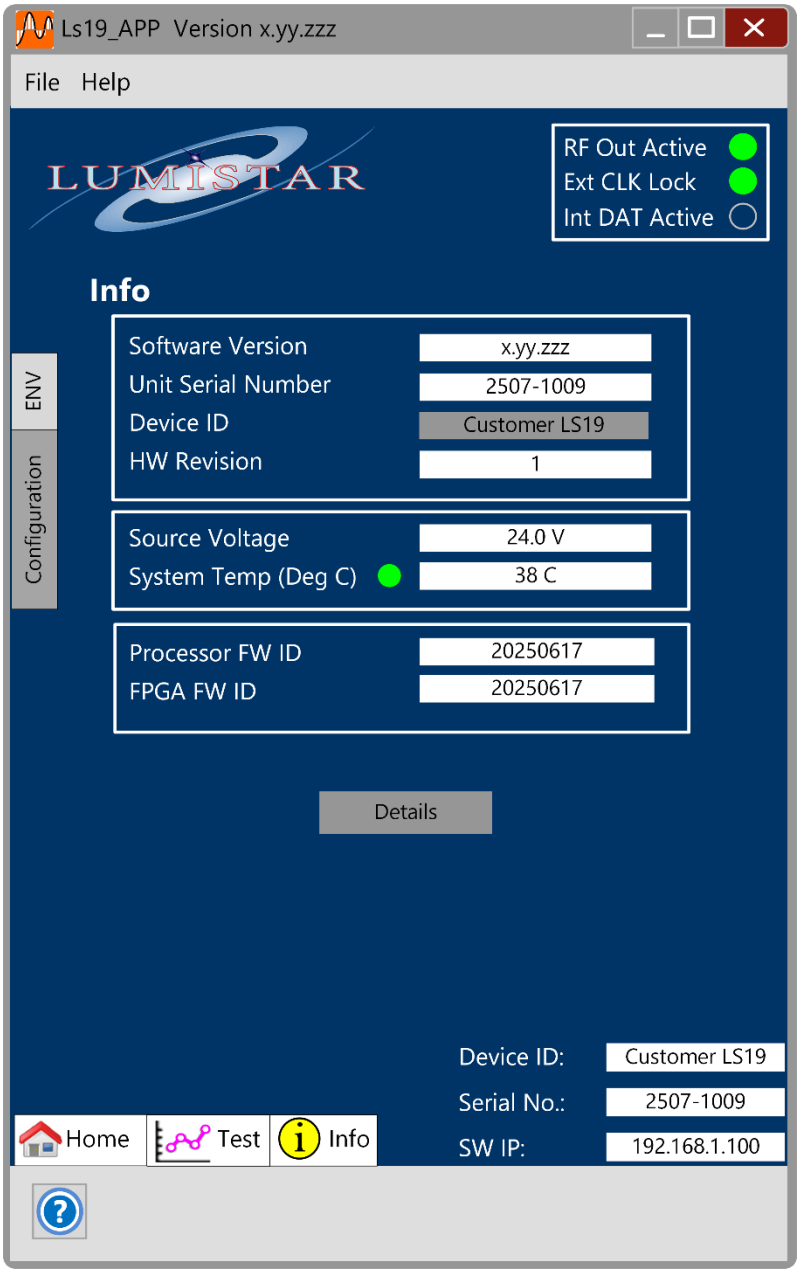

Figure 4-9 LS19_App – Sub-function Select Tab: ENV

Software Version: In the upper left-hand box, an indication of the LS19_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.

Hardware Revision: This status tab shows the detected internal hardware configuration. This information is helpful for coordination of capabilities and support tasks.

Temperature/Voltage Monitoring Window: This area of the status window provides information on the source voltage and temperature. The Green LED displays if the unit is operating at 70 degrees C or less.

Processor FW ID: This status lists the on-board processor firmware. This information may be useful during support requests.

FPGA FW ID: This status lists the on-board FPGA firmware. This information may be useful during support requests.

4.1.5.2 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-19-M. Refer to Figure 4-10 for tab layout.

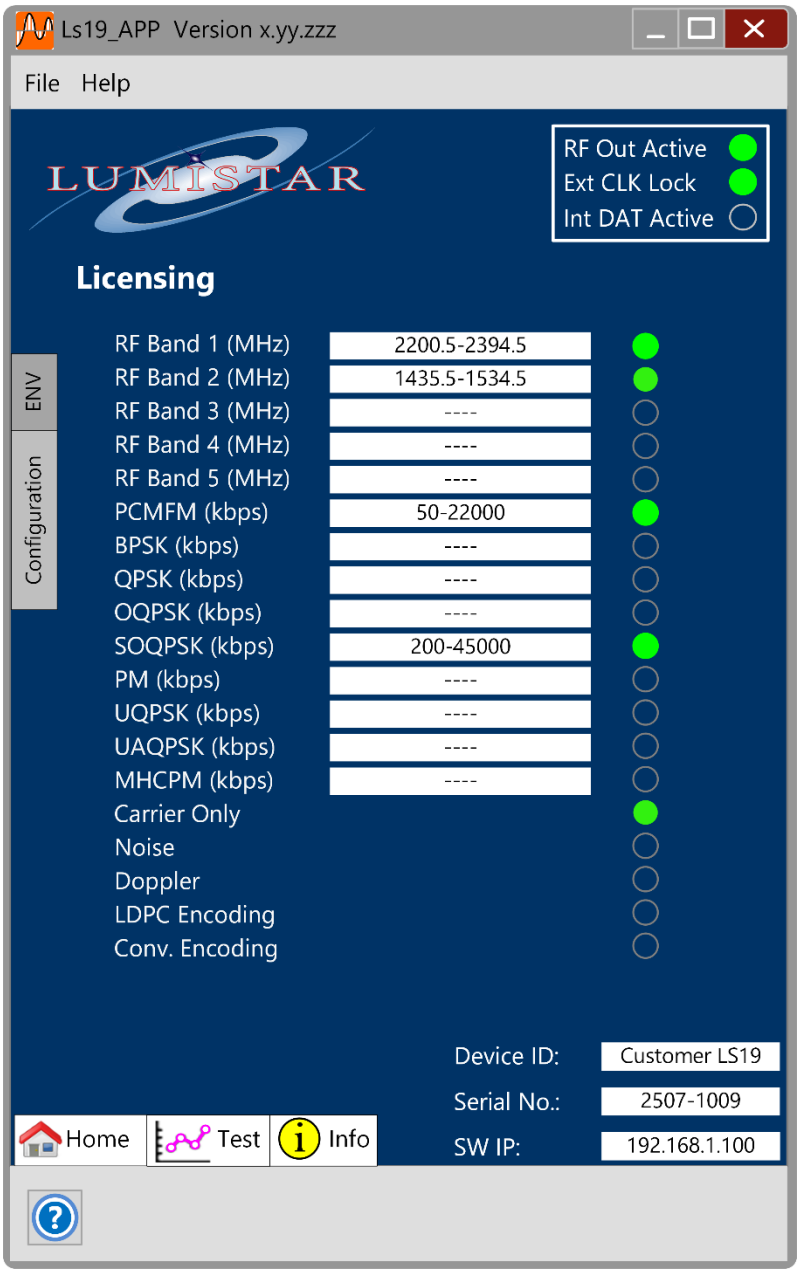

Figure 4-10 LS19_App – Sub-Function Select Tab: Configuration

This sub-function tabs displays various capabilities and license options for the LS-19. Displayed data may include band limits and data limits. The LEDs in the right column indicate if the connected device contains these functions.

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 necessary 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.