TABOR ELECTRONICS

LUCID SERIES

Lucid Series RF Analog Signal Generator Benchtop Model User Manual

Rev. 1.6

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Document Revision History

Revision	Date	Description	Author
1.6	10-Dec-2024	• Release supporting Lucid Control Panel Ver. 1.3.500 and TE Update Tool Ver. 1.1.212, LS4091M SPI_SCPI Commands Rev 1.0, TESG SPI_SCPI Commands Rev 1.18, Lucid FPGA version 03092023. • Removed Lucid-X that now has a separate user manual. • Table 4.5 Modulation Specifications – Added note.	Jakob Apelblat
1.5	18-Oct-2023	• Updated document format. • Added Lucid-X Benchtop. • Release supporting Lucid Control Panel Ver. 1.3.400 and TE Update Tool Ver. 1.1.212, LS4091M SPI_SCPI Commands Rev 1.0, TESG SPI_SCPI Commands Rev 1.18, Lucid FPGA version 03092023 and Lucid-X FPGA version 03092023 or higher. • 1.2 Related Documentation – New. • Table 1.1 Ordering Information – Added Lucid-X series. • 2.3 Front Panel Connectors – Added “CH1…CH4 Lucid-X Up to four 2.4 mm…” • 2.4 Rear Panel Connectors – Added “100 MHz OUT Lucid-X – BNC type …”. • 4 Lucid Benchtop Specifications – Added Lucid-X series • Table 4.5 Modulation Specifications – Removed “Accuracy (1 kHz)”, changed “On/off Ratio” from 80 dB to 60 dB. • Table 4.6 Inputs Specifications – Removed “Locking Range”. • Table 4.8 General Specifications – Removed 1 year warranty.	Jakob Apelblat
1.4	04-May-2021	• Changed from A4 to Letter size	Jakob Apelblat
1.3	26-Jan-2021	• Supporting Lucid Benchtop SW version 1.8.15 or higher. • 1.3 Software Support – New. • Removed sections “Lucid Software Requirements”, “Installation, “PC Control Software”, ‘Troubleshooting”, and “FPGA Firmware Update” that are included in the new “Lucid Control Panel User Manual”. • Removed section SCPI Programming that is included in the new “Lucid Programming Manual”.	Jakob Apelblat

Revision	Date	Description	Author
1.2	10-Jan-2021	• Supporting Lucid PC application version 1.2.900, GUI version 1.15 or higher, and TE Update Tool version 1.0.500. • 3 Benchtop GUI – Reference field removed from the status bar. • 3.6 System Tab – Minor updates. • 4 PC Control Software, page 44 – Reference field removed from the status bar. • 5.3 IEEE-STD-488.2 Common Commands and Queries, page 67 – Changed SE5082 to device, and OPT? description. • Table 4.5 Modulation Specifications – Changed Sweep Dwell Time from “10 µs to 1,000 s” to “100 µs to 1,000 s”. • 8 Appendix FPGA Firmware Update, page 124 – New.	Jakob Apelblat
1.1	6-Aug-2020	• Minor typos. • Table 4.3 Amplitude Specification – Changed Amplitude Accuracy from +50 dBm to -50 dBm.	Jakob Apelblat
1.0	30-Jul-2020	• Original release supporting Lucid SW Rev. 1.2.12 and SPI & SCPI Commands List Summary Rev. 1.14	Jakob Apelblat

Acronyms & Abbreviations

Acronym	Description
µs or us	Microseconds
ADC	Analog to Digital Converter
AM	Amplitude Modulation
ASIC	Application-Specific Integrated Circuit
ATE	Automatic Test Equipment
AWG	Arbitrary Waveform Generators
AWT	Arbitrary Waveform Transceiver
BNC	Bayonet Neill–Concelm (coax connector)
BW	Bandwidth
CW	Carrier Wave
DAC	Digital to Analog Converter
dBc	dB/carrier. The power ratio of a signal to a carrier signal, expressed in decibels
dBm	Decibel-Milliwatts. E.g., 0 dBm equals 1.0 mW.
DDC	Digital Down-Converter
DHCP	Dynamic Host Configuration Protocol
DSO	Digital Storage Oscilloscope
DUC	Digital Up-Converter
DUT	Device Under Test
ENoB	Effective Number of Bits
ESD	Electrostatic Discharge
EVM	Error Vector Magnitude
FPGA	Field-Programmable Gate Arrays
FW	Firmware
GHz	Gigahertz
GPIB	General Purpose Interface Bus
GS/s	Giga Samples per Second
GUI	Graphical User Interface
HP	Horizontal Pitch (PXIe module horizontal width, 1 HP = 5.08mm)
Hz	Hertz
IF	Intermediate Frequency
I/O	Input / Output
IP	Internet Protocol
IQ	In-phase Quadrature
IVI	Interchangeable Virtual Instrument
JSON	JavaScript Object Notation
kHz	Kilohertz
LCD	Liquid Crystal Display
LO	Local Oscillator
MAC	Media Access Control (address)
MDR	Mini D Ribbon (connector)
MHz	Megahertz
ms	Milliseconds
NCO	Numerically Controlled Oscillator

Acronym	Description
ns	Nanoseconds
PC	Personal Computer
PCAP	Projected Capacitive Touch Panel
PCB	Printed Circuit Board
PCI	Peripheral Component Interconnect
PXI	PCI eXtension for Instrumentation
PXIe	PCI Express eXtension for Instrumentation
QC	Quantum Computing
Qubits	Quantum bits
R&D	Research & Development
RF	Radio Frequency
RT-DSO	Real-Time Digital Oscilloscope
s	Seconds
SA	Spectrum Analyzer
SCPI	Standard Commands for Programmable Instruments
SFDR	Spurious Free Dynamic Range
SFP	Software Front Panel
SINAD	Signal-to-Noise-And-Distortion Ratio
SMA	Subminiature version A connector
SMP	Subminiature Push-on connector
SPI	Serial Peripheral Interface
SRAM	Static Random-Access Memory
TFT	Thin Film Transistor
T&M	Test and Measurement
TPS	Test Program Sets
UART	Universal Asynchronous Receiver-Transmitter
USB	Universal Serial Bus
VCP	Virtual COM Port
Vdc	Volts, Direct Current
V p-p	Volts, Peak-to-Peak
VSA	Vector Signal Analyzer
VSG	Vector Signal Generator
WDS	Wave Design Studio

Contents

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Tables

1 General

1.1 Scope

The scope of this manual is to describe the setup and operating procedures of the Lucid Series RF Analog Signal Generator. The manual covers the following models listed in the below ordering information.

Table 1.1 Ordering Information

Model	Description
LS3081B	3 GHz, 1 channel, benchtop RF analog signal generator
LS3082B	3 GHz, 2 channels, benchtop RF analog signal generator
LS3084B	3 GHz, 4 channels, benchtop RF analog signal generator
LS6081B	6 GHz, 1 channel, benchtop RF analog signal generator
LS6082B	6 GHz, 2 channels, benchtop RF analog signal generator
LS6084B	6 GHz, 4 channels, benchtop RF analog signal generator
LS1291B	12 GHz, 1 channel, benchtop RF analog signal generator
LS1292B	12 GHz, 2 channels, benchtop RF analog signal generator
LS1294B	12 GHz, 4 channels, benchtop RF analog signal generator
Options	
PLS	Pulse modulation
PAT	Pattern modulation
ELP	Extended low power range (-150 dBm)
EPR	Extended power range (-130 dBm to +27 dBm)
FS	Fast switching
EMU	Emulator for Keysight, R&S, Anapico, and Holzworth
W-Rack	Rack-mount kit

Figure 1.1 LS1294B – 12GHz Four Channel RF Analog Signal Generator

1.2 Related Documentation

- Lucid Control Panel User Manual
- TE Update Tool User Manual
- Lucid Programming Manual
- Tabor Lucid Multi-Channel RF Signal Generators White Paper
- Lucid Series Performance Verification Manual

1.3 Software Support

The **Lucid Control Panel** is a software package that enables full control and programming of your Tabor Electronics Lucid series RF analog signal generators via a user-friendly graphical user interface. The **TE Update Tool** is a utility for updating the Lucid device FPGA. The **Lucid Programming Manual** lists and describes the set of SCPI-compatible (Standard Commands for Programmable Instruments) remote commands used to operate the Lucid devices.

The programs and the user manuals can be downloaded from the Tabor Electronics website at http://www.taborelec.com/downloads.

1.4 Document Conventions

Convention	Description	Example
Bold Writing	Indicates an item/message in the User Interface.	Click the On button.
<Angled and Bolded Brackets>	Indicates a physical key on the keyboard.	Press <Ctrl>+<B>.

Caution!

- A Caution indicates instructions, which, if not followed, may result in damage to the equipment or to the loss of data.

Note

A Note provides additional information to help obtain optimal equipment performance.

Idea

An Idea provides an alternate procedure to obtain the same results.

1.5 Safety

To avoid Electrical Shock, fire, or personal injury:

- Use only the proper power cord and certified for the country of use.
- This product is grounded through the grounding conductor of the power cord. To avoid electrical shock, the grounding conductor must be connected to the ground. Before connecting to the power input or output, ensure that the product is properly grounded.
- Do not operate this product with removed covers or panels.
- Observe all the ratings and markings on the product. Search this manual for further rating information, before connecting to it. Do not apply potential that is higher than the maximum rating.
- Do not operate in dark or wet conditions.
- Do not operate in an explosive environment. Keep product clean and dry.

1.6 Maintenance

1.6.1 Preventive Maintenance

There are no hardware adjustments within Lucid Generators. Tabor Electronics Ltd. recommends that the Lucid Generator is calibrated every 12 months or whenever a problem is suspected. The specific calibration interval depends upon the accuracy required. No periodic preventive maintenance is required.

1.6.2 Long Term Storage or Repackaging For Shipment

If the instrument is to be stored for an extended period or shipped immediately, proceed as directed below. If you have any questions, contact your local Tabor Electronics representative or the Tabor Electronics Customer Service Department.

1. Repack the instrument using the wrappings, packing material and accessories originally shipped with the unit. If the original container is not available, purchase replacement materials.
2. Be sure the carton is well sealed with strong tape or metal straps.
3. Mark the carton with the model and serial number. If it is to be shipped, show sending and return address on two sides of the box. If the instrument is to be shipped for service or repair, the following information must be included with the shipment:
    - Name and address of the owner.
    - Record the model and serial number of the instrument, options, and firmware version.
    - Note the problem and symptoms – detailed information will help in verifying the problem.
        - What was the instrument setup?
        - Did the unit work; then fail?
        - What other equipment was connected to the generator when the problem occurred?

- The name and telephone number of someone familiar with the problem that can be contacted by Tabor Electronics if any further information is required.
- Show the returned authorization order number (RMA) as well as the date and method of shipment.

Note

Always obtain a return authorization number from the factory before shipping the instrument to Tabor Electronics.

2 Introduction

The Lucid Series benchtop platform offers up to 4 phase coherent channels in a standalone compact unit. The series features 3, 6, and 12, GHz models in single, dual or four channel versions, all sharing the very same industry leading highlighted features. It provides extremely fast switching speed, superior signal integrity and purity, and a removable memory card for maximum security. It comes with all the necessary modulated signals for analog communication systems, and with built-in LAN and USB interfaces. The Lucid Series is designed to meet today's most demanding requirements that is needed from the R&D benches to the production lines.

2.1 Unpacking

Check that the packaging is undamaged. If packaging is damaged, notify the carrier immediately.

The Lucid benchtop model instrument is supplied with:

- Power cord with a plug according to customer country standard.
- USB cable for connecting a control PC to the instrument.
- Lucid software, user manual and instrument drivers can be downloaded from https://www.taborelec.com/Downloads

Caution!

The Lucid Series RF Signal Generator ships in an antistatic package to prevent damage from electrostatic discharge (ESD). When storing the unit, use the antistatic case.

2.2 Front Panel Controls

Figure 2.1 LS1294B Front Panel

- **Power Button** – Turn on or off the device.
- **5" Touch LCD Display** – 800x480 TFT display PCAP(Projected Capacitive Touch Panel) touch screen for controlling the device.

- **Numeric Keypad Program 1 - 4** – Select the channel, 1 up to 4, to show on the display.
- **Numeric Keypad** – Enter numeric values.
- **G/n Button** – Select GHz, ns or dBµV units depending on selected parameter.
- **M/µ Button** – Select MHz, µs or µV units depending on selected parameter.
- **k/m Button** – Select kHz, ms or mV units depending on selected parameter.
- **x1 Button** – Select x1 (default unit) or dBm units depending on selected parameter.
- **Back** – The backspace key deletes the last entered character.
- **Esc** – Has two functions:
    1. When in edit mode, cancels edit operation, restores last value and returns to the main function screen.
    2. When operating the device from a remote interface, none of the front panel buttons are active except the Local button. When pressed, it restores control to the front panel buttons.
- **Enter:**
    1. When multiple parameters are displayed on the screen, the cursor and the dial scroll through the parameters. Pressing Enter selects the parameter for edit. After the parameter has been modified, the Enter button locks in the new variable and releases the buttons for other operations.
    2. When a parameter is modified, Enter can be used to replace the x1 suffix key.
    3. When a discrete parameter is selected, Enter toggles between the values.
- **Man Trigger** – Manual trigger button, used instead of an external trigger signal.
- **Dial** – Turning the dial clockwise or counterclockwise works like the arrow UP and Down keys. Pushing the dial works like the Enter button.
- **Arrow Up, Down, Left, Right** – Has two functions:
    1. When multiple parameters are displayed on the screen, the arrow and the dial scroll through the parameters.
    2. When a parameter is selected for editing, arrow buttons right or left move the cursor accordingly. Arrow buttons up or down modify parameter value accordingly.
- **FREQ Button** – Select the frequency field in the CW (carrier wave) settings tab.
- **AMPT Button** – Select the power field in the CW (carrier wave) settings tab.
- **FM Button** – Select the frequency modulation screen.
- **Sweep Button** – Select the sweep screen tab.
- **Store Button** – Store current settings on selected memory device. Click the button to display a list of setting files, use the dial to scroll the list and push then the dial to store the settings in the file.
- **Recall Button** – Recall stored configuration.

- **AM Button** – Select the amplitude modulation screen.
- **List Button** – Select the list screen tab.
- **Preset Button** – Restore factory defaults.
- **System Button** – Select the system screen tab.
- **PM Button** – Select the phase modulation screen.
- **Run Mode** – Select the run mode screen tab.
- **Mod On/Off** – Set the selected modulation to on/off.
- **RF On/Off** – Set the selected output RF channel to on/off.

2.3 Front Panel Connectors

Figure 2.2 Front Panel with 4 Channels

- **CH1…CH4**
  - Up to four SMA type connectors for RF signal output.
- **USB** – Two USB 2 Type A interfaces for connecting a USB device (FAT32) such as a memory device for storing and recalling instrument setups, keyboard, or mouse.

2.4 Rear Panel Connectors

Figure 2.3 Rear Panel for 4 Channels

- **10/100MHz IN** – BNC type connector for external 10 MHz or 100 MHz signal. This input is normally used for synchronizing system components to a single clock reference.
- **10 MHz OUT**
  - Lucid – BNC type connector for 10 MHz signal output. The output is used to synchronize other system devices to the Lucid Benchtop clock reference.
- **100 MHz OUT**
  - BNC type connector for 100 MHz signal output. The output is used to synchronize other system devices to the Lucid Benchtop clock reference.
- **MODULATION IN** – Up to four BNC type connectors, one for each channel, for an input from an external amplitude modulation source.
- **TRIGGER IN** – Up to four BNC type connectors, one for each channel, for an input from an external trigger source.
- **LAN + USB HOST** –
  - **RJ45** – 100BaseT Ethernet connector for connecting a control PC via the LAN.
  - **USB Type A** – USB 2 Type A interface for connecting a USB device (FAT32) such as a memory device for storing and recalling instrument setups, keyboard, or mouse.
- **USB DEVICE** – USB 2 Type B connector for connecting a control PC.
- **AC Power Socket**– 3 Pins IEC320 C14 Inlet Power Plug Socket.
- **SD CARD** – Removable SD card for instrument security. It is used for storing all data about used frequencies for PATTERN in the Modulation, the List, and System tabs.
  - Min capacity 4GB.
  - Max capacity 16GB.
  - Speed grade 10.

- Can be used with SD to micro-SD adapter.

- **POWER FUSE T6.3A/250V** – Fuse glass 6.3 A 250 VAC 5X20 mm Slo-Blo.

Note

The Lucid generator will automatically revert to external reference when a signal is detected at its input.

3 Benchtop GUI

3.1 CW Tab

The CW (Carrier Wave) tab becomes available on the front panel display after power-up of the generator. From here the user can set the basic output parameters of the generator.

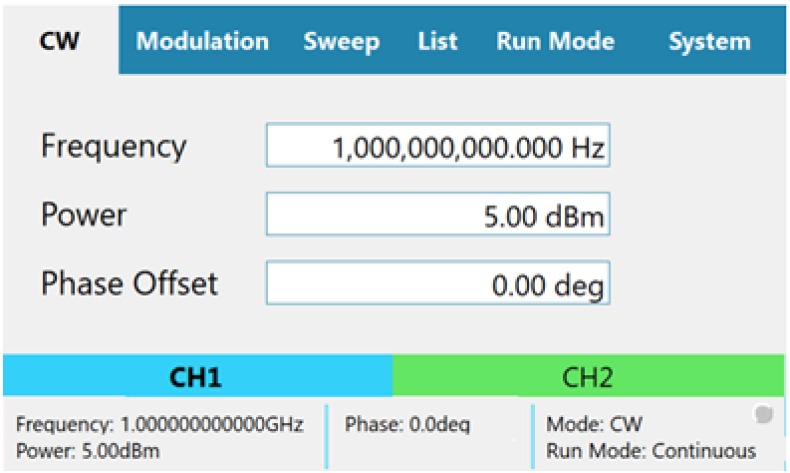

Figure 3.1 CW & Modulation Tab

- **Channel Bar** – The bar shows the available channels and which channel that is selected. Selected channel is denoted by a bold font.
- **Status Bar** – The bar at the bottom of the screen displays a summary of the system status and is shown in all tabs.
  - **Frequency** – The CW frequency.
  - **Power** – The power (amplitude) of the output signal (in dBm).
  - **Phase** – The phase offset of the signal (0 – 360 deg.).
  - **Mode** – Shows which modulation is on (press Mode ON/Off in the respective modulation window).
    - **CW** – Carrier wave (default)
    - **AM,ON** – Amplitude modulation
    - **FM, ON** – Frequency modulation
    - **PM, ON** – Phase modulation
    - **PULSE ON** – Pulse modulation
    - **PATT,ON** – Pattern modulation
    - **FRSW,ON** – Frequency sweep mode is selected.
    - **PRSW,ON** – Power sweep mode is selected.

- **LIST,ON** – List mode is selected.

- **Run Mode:**
  - **Continuous** – The device will generate a signal when the user clicks the RF OUT On button.
  - **Trigger** – The device waits for an external trigger event.

- **LED** –
  - **Gray** – The output RF channel is off.
  - **Green** – The output RF channel is on.

- **Frequency** – Sets the generator's basic frequency in Hz. You cannot enter a frequency smaller than the minimum frequency. Refer to 4 Lucid Benchtop Specifications for valid frequency range.
- **Power** – Sets the power (amplitude) of the generator's output signal (in dBm).

The default value is 5.00 dBm.

- **Phase Offset** – Sets the phase offset of the signal. Phase offset range is between **0 degrees** to **360 degrees**.

The default value is 0 degrees.

3.2 Modulation Tab

The user can set the basic output parameters of the generator in the Modulation tab. The modulation types that are available depend on the installed options.

3.2.1 AM – Amplitude Modulation

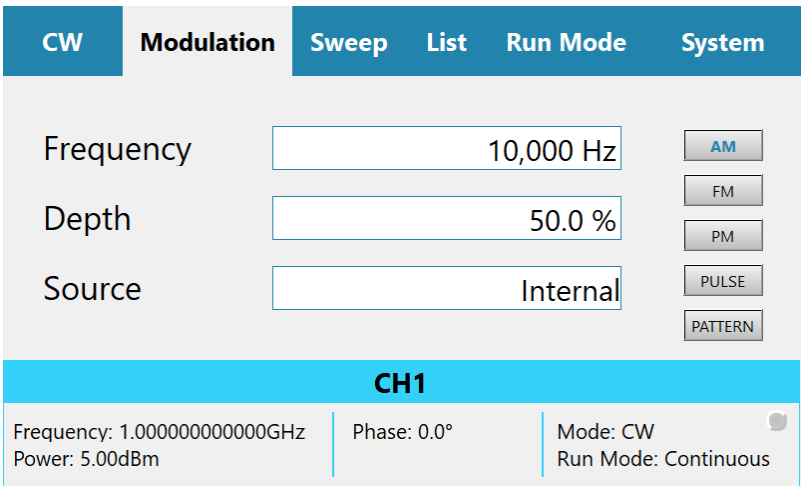

Figure 3.2 AM – Amplitude Modulation

- **Frequency** – Set the modulation frequency (Hz/kHz).
- **Depth** – Set the AM modulation in percent of the carrier wave amplitude.

- **Source** – The Enter key of the front panel will toggle the values.
  - **Internal** – Use the screen modulation parameters.
  - **External** – Use an AM source connected to the generator's MODULATION IN connector located on the rear panel. The Generator will accept modulating signals between DC and 100 kHz within ±1 V (2 V p-p) amplitude.
- Push the **Mod On/Off** button on the device front panel to start the modulation and then **RF On/Off** button to output the signal.

3.2.2 FM – Frequency Modulation

Select on the device display the Modulation tab, and then click the FM button to show the frequency modulation parameters. You can also push the FM button on the front panel to show the screen.

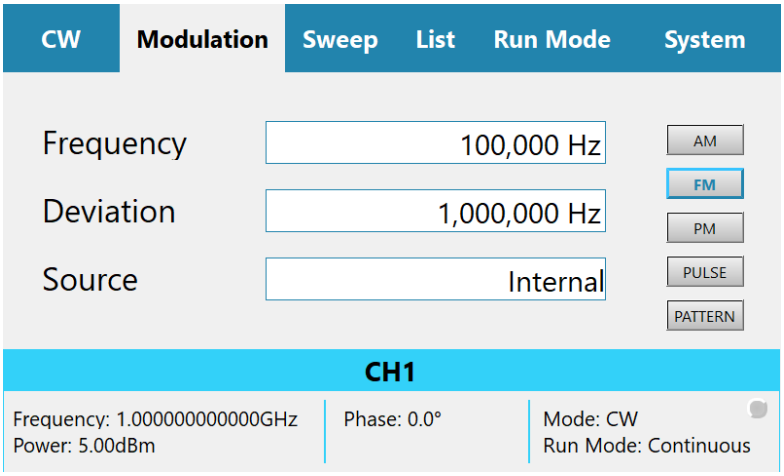

Figure 3.3 FM – Frequency Modulation

- **Frequency** – Set the modulation Frequency (Hz).
- **Deviation** – Set the frequency deviation of the carrier wave in (Hz).
- Source:
  - **Internal** – Use the screen modulation parameters.
  - **External** – Use an FM source connected to the generator's MODULATION IN connector located on the rear panel. The Generator will accept modulating signals between ±1 V (2 V p-p) amplitude.
- Push the **Mod On/Off** button on the device front panel to start the modulation and then **RF On/Off** button to output the signal.

3.2.3 PM – Phase Modulation

Select on the device display the Modulation tab, and then click the PM button to show the phase modulation parameters. You can also push the PM button on the front panel to show the screen.

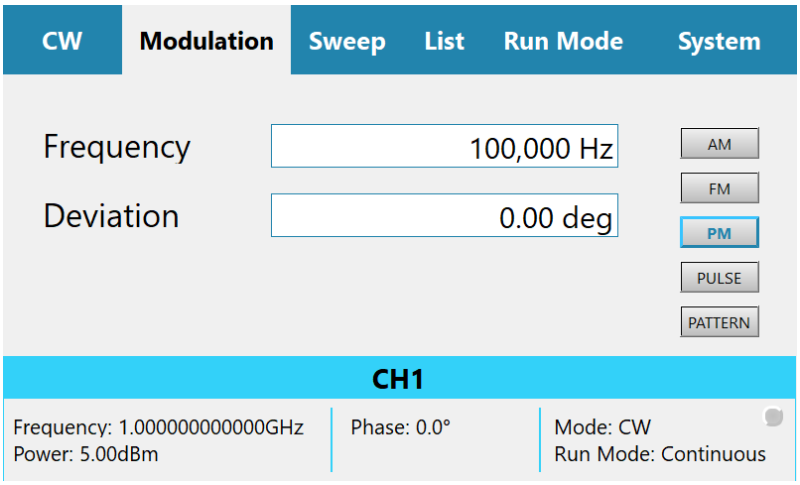

Figure 3.4 PM – Phase Modulation

- **Frequency** – Set the modulation Frequency (Hz).
- **Deviation** – Set the phase deviation degree of the modulation frequency.
- Push the **Mod On/Off** button on the device front panel to start the modulation and then **RF On/Off** button to output the signal.

3.2.4 Pulse Definition

Select on the device display the Modulation tab, and then click the PULSE button to show the pulse parameters.

Note

The **PULSE** button is only available if the device has the Pulse option installed.

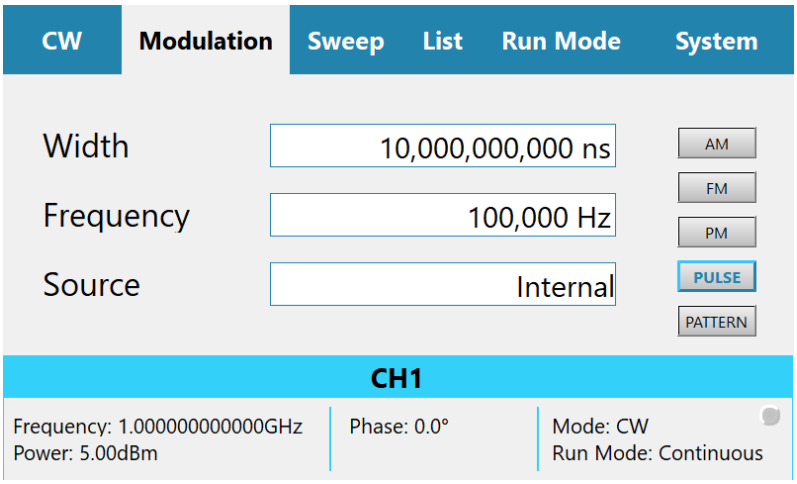

Figure 3.5 Pulse Definition

- **Width** – Set the pulse modulation width. Use the push buttons on the front panel to select units.
- **Frequency** – Set the pulse frequency in Hz.

- Source:
  - **Internal** – Use the screen modulation parameters.
  - **External** – Use a pulse source connected to the generator's MODULATION IN connector located on the rear panel. The Generator will accept modulating signals between ±1 V (2 V p-p) amplitude.
- Push the **Mod On/Off** button on the device front panel to start the modulation and then **RF On/Off** button to output the signal.

3.2.5 Pattern Sequence

Select on the device display the Modulation tab, and then click the PATTERN button to show the pattern sequence parameters. You can set a sequence of pulses according to the list of pulses where each step in the list defines a pulse Time On and Time Off time and the number of Loops.

Note

The **PATTERN** button is only available if the device has the PAT option installed.

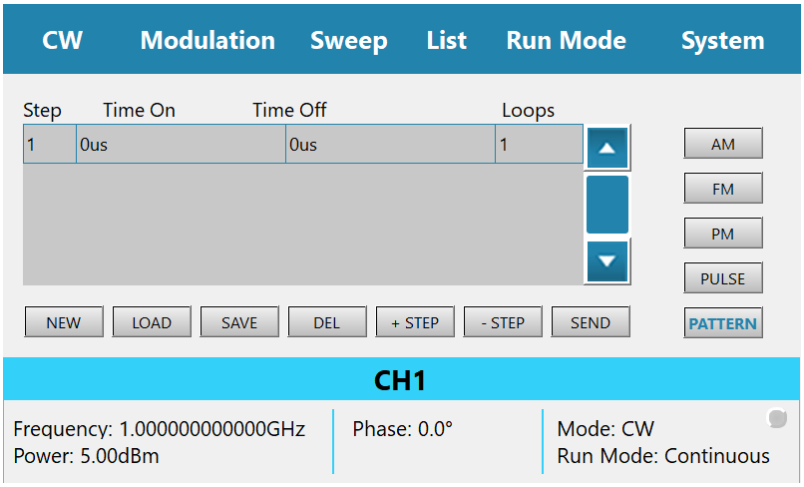

Figure 3.6 Pattern Sequence

Define a patter according to the steps below.

1. **NEW** – Click the button to create a new Pattern.
2. **LOAD** – Click the button to select a file to load.
3. **SAVE** – Click the button to save the Pattern in a JSON (JavaScript Object Notation) format. You can save to a new name (valid name is only numbers) or overwrite an old file. You can select to store the data on the SD card.
4. **DEL** – Click the button to select a file to delete.
5. **+STEP** – Click the button to add a new step.

6. Enter the duration of the pulse (Time On), the delay for next pulse (Time Off), and the number of repetitions (Loops) of this step.
7. **-STEP** – Click the button to delete the last step.
8. **SEND** – Click the button to upload the Pattern to the instrument.

3.3 Sweep Tab

The Sweep tab menu allows you to define a signal that sweeps over a frequency or power range. You can also push the Sweep button on the front panel to show the screen.

Two **Sweep Types** are available:

- **FREG** – Frequency based, where the signal sweeps from one frequency to the next, maintaining the same amplitude.
- **PWR** – Power based, where the signal sweeps from one amplitude to the next, maintaining the same frequency.

3.3.1 Frequency Sweep

Select the Sweep tab, and then click the FREQ button. You can now define a signal that sweeps from one frequency to the next, maintaining the same amplitude.

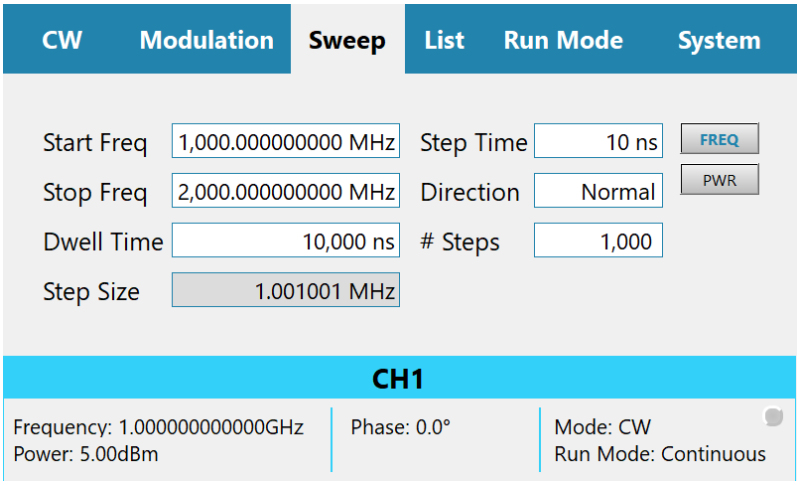

Figure 3.7 Frequency Sweep

Following are the details of the frequency-based Sweep menu:

- **Start Freq** – sets the sweep start frequency (in Hz).
- **Stop Freq** – sets the sweep stop frequency (in Hz).
- **Dwell Time** – sets the sweep dwell time that is the duration of the entire sweep.
- **Step Size** – sets the size of each step (in Hz) in the sweep. The value displayed in **# Steps** changes accordingly.
- **Step Time** – sets the step dwell time. The value displayed in **Dwell Time** changes accordingly.
- **Direction** – sets the sweeping direction:
  - **UpDown** – to sweep from start frequency to stop frequency; then, from stop frequency to start frequency .
  - **Normal** – to sweep from start frequency to stop frequency.

- **# Steps** – sets the number of steps in one sweep (including **Start** and **Stop**). The value displayed in **Step Size** changes accordingly.

3.3.2 Power Sweep

Select the Sweep tab, and then click the PWR button. You can now define a signal that sweeps from one amplitude to the next, maintaining the same frequency.

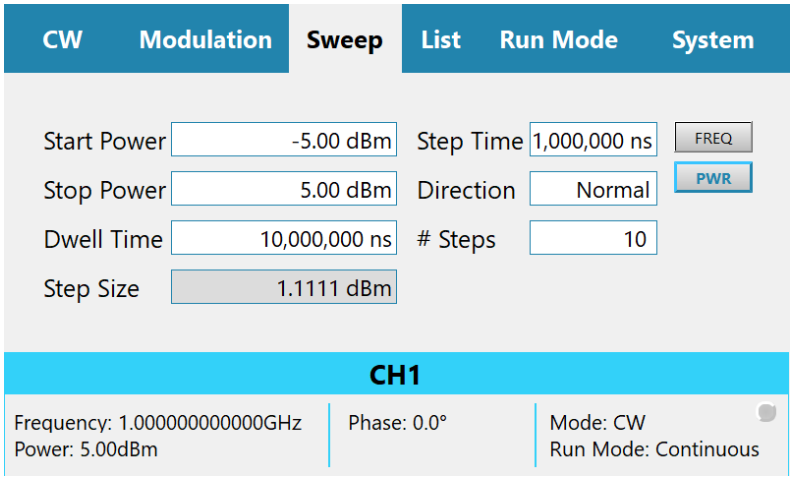

Figure 3.8 Power Sweep

- **Start Power** – start power sets the start sweep amplitude (in dBm).
- **Stop Power** – stop power sets the stop sweep amplitude (in dBm).
- **Dwell Time** – sets the sweep dwell time that is the duration of the entire sweep.
- **Step Size** – sets the size of each step (in dBm) in the sweep. The value displayed in **# Steps** changes accordingly.
- **Step Time** – sets the step dwell time. The value displayed in **Dwell Time** changes accordingly.
- **Direction** – sets the sweeping direction:
  - **UPDOWN** – to sweep from start frequency to stop frequency; then, from stop frequency to start frequency .
  - **NORMAL** – to sweep from start frequency to stop frequency.
- **# Steps** – sets the number of steps in one sweep (including **Start** and **Stop**). The value displayed in **Step Size** changes accordingly.

3.4 List Tab

The List tab enables you to create and generate a sequence of signals that can vary in frequency, power, and dwell time. You can also push the List button on the front panel to show the screen.

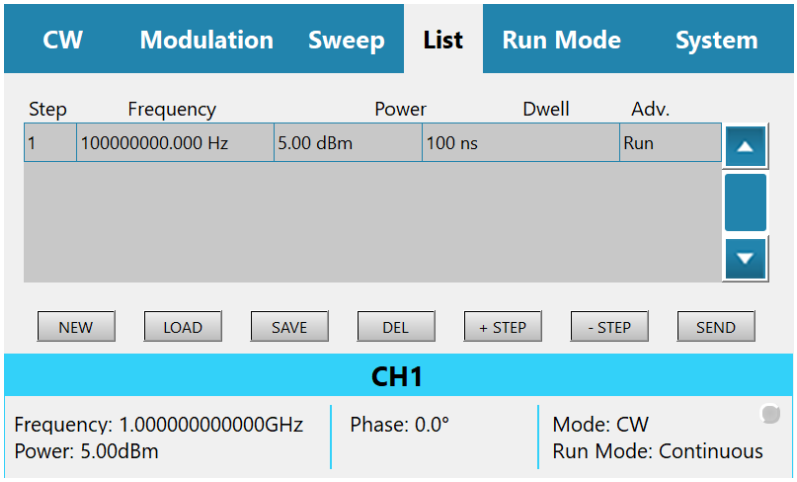

Figure 3.9 List

Define a patter according to the steps below.

1. **NEW** – Click the button to create a new list.
2. **LOAD** – Click the button to load a previously saved list.
3. **SAVE** – Click the button to save the list in a JSON (JavaScript Object Notation) format. You can select to store the data on the SD card or on the internal.
4. **DEL** – Click the button to delete selected step.
5. **+STEP** – Click the button to add a new step. Enter the following parameters:
   a. Frequency (in Hz, kHz, MHz, or GHz) - sets the step frequency.
   b. Power (in dBm) – sets the step power.
   c. Dwell – sets the duration of the step (in µs, ms, or s).
   d. Adv. – Advance, toggle the values by pushing the Enter button:
      i. Run – the Dwell Time is followed by a Run to the next step.
      ii. Wait – the Dwell Time is followed by a Wait for a Trigger that advances it to the next step.
6. **-STEP** – Click the button to delete selected line.
7. **SEND** – Click the button to upload the list to the instrument.

3.5 Run Mode Tab

The Run Mode Tab sets the mode by which the unit will run. E.g., if the sweep starts generating the signals when the user clicks the **Run** button, or it will wait for an external trigger event. You can also push the Run Mode button on the front panel to show the screen.

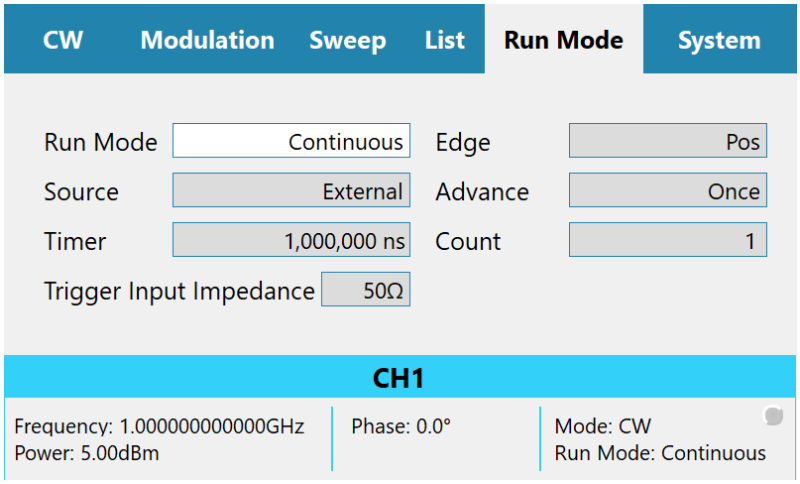

Figure 3.10 Run Mode

- **Run Mode** – sets the way in which the signals are generated. The Enter key of the front panel will toggle the values.
  - **Continuous** – enables running the signal continuously, as defined in the other tabs, and regardless of the trigger events. All Trigger oriented parameters are hidden.
  - **Trigger** – enables running the signal when a trigger event is detected.
- **Source** – sets the source of the trigger. The Enter key of the front panel will toggle the values.
  - **Timer** – sets the rate for clocked triggers (in ns, µs, ms, or s).
  - **External** – an external source, connected to the Pulse/Trig-In port, issues the triggers.
  - **Bus** – a trigger is issued when the user clicks the **Man Trigger** button.
- **Timer** – sets the rate for clocked triggers (in ns, µs, ms, or s).
- **Trigger Input Impedance** – Sets the trigger input impedance value, selectable between 50 Ω and high Z (10 kΩ).
  Note: An input voltage exceeding 5 V may damage the instrument.
- **Count** – sets the number of triggers that will be issued.
- Edge:
  - **Pos** – trig on the trigger positive rising edge.
  - **Neg** – trig on the trigger negative (falling) edge.
- **Advance** – sets the trigger advance either in steps or as a one-time event.

- **Once** – sets the number of times a sweep or list will be generated. When the count is set to 0, unit outputs signal continuously once a trigger is accepted.
- **Step** – for every trigger that is accepted the sweep or list is advanced by 1 step. While the step is being generated, any incoming trigger is ignored until the step is completed.

3.6 System Tab

The System Tab manages the setup parameters of the entire system. You can load a system file to use a previously used system configuration.

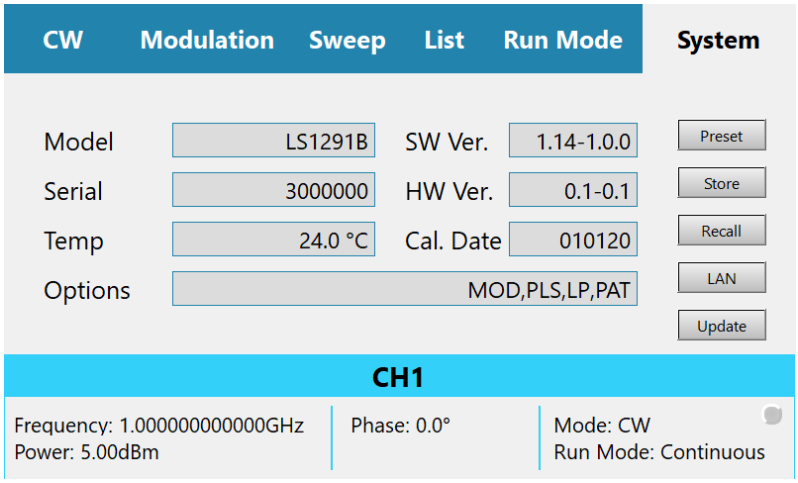

Figure 3.11 System Tab

Following are the details of the System menu:

- **Model** – The ordering model name.
- **Serial** – The serial number of the generator.
- **Temp** – The temperature of the generator (℃).
- **Option**s – The options available in the generator.
  - **MOD** – Modulation package (AM, FM, PM).
  - **PUS** – Pulse generator.
  - **FS** – Fast switching.
  - **LP** – Low Power (-90 dBc).
  - **EMU** – Emulation, includes emulators for Keysight, Anapico, and Holzworth
  - **PAT** – Pattern generator.
- **SW Ver.** – The device software version x.xx-y.y.z.
  - **x.xx** – GUI version.
  - **y.y** – SCPI version.
  - **z** – Driver build version.
- **HW Ver.** – The FPGA FW and board version x.x-y.y.
  - **x.x** – FPGA firmware version.
  - **y.y** – D, E F or other is HW board version.

- **Cal. Date** – The time stamp of the last calibration.

3.6.1 Preset

Select on the device display the System tab, and then click the **Preset** button to set the system settings to factory defaults.

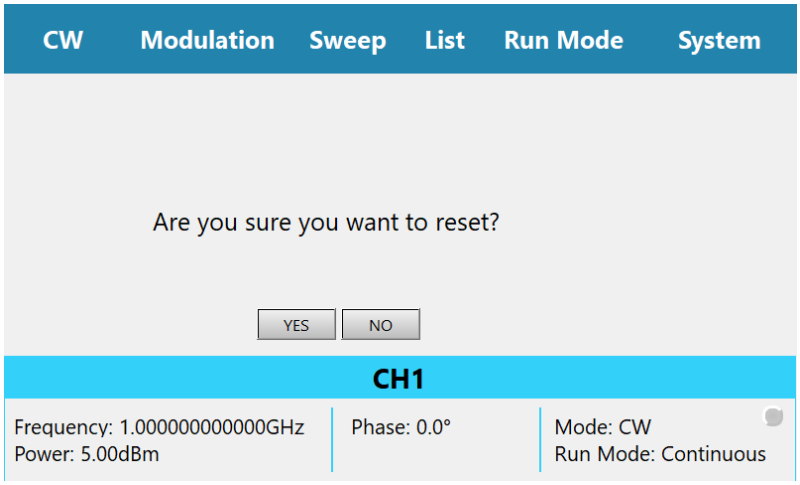

Figure 3.12 Preset Confirmation Pop-up

3.6.2 Store

Select on the device display the System tab, and then click the Store button to save the current settings of the entire system in a JSON (JavaScript Object Notation) format. You can select to store the data on the SD card.

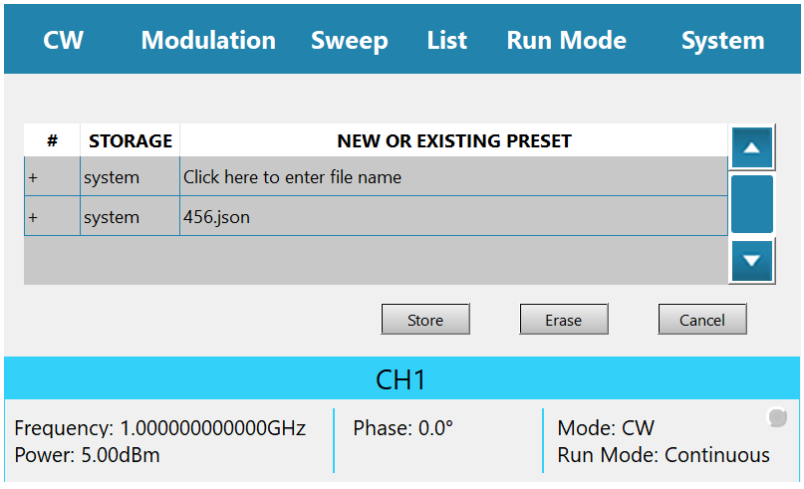

Figure 3.13 Store Settings

- **Store** – Click the button to store the system setting in selected file and storage device.
- **Erase** – Click the button to erase the selected file.
- **Cancel** – Click the button to cancel any changes.

3.6.3 Recall

Select on the device display the System tab, and then click the **Recall** button to restore the stored settings of the entire system in a JSON (JavaScript Object Notation) format. You can select to restore the data from an SD card.

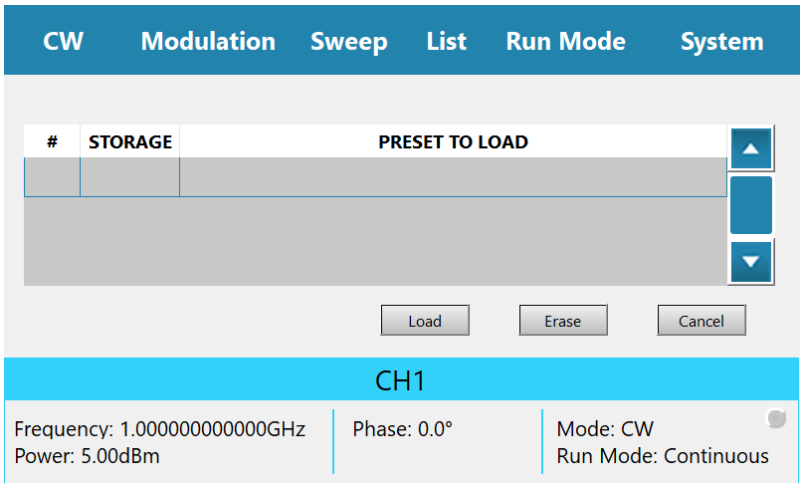

Figure 3.14 Recall Settings

- **Load** – Click the button to load the system setting from the selected file and storage device.
- **Erase** – Click the button to erase the selected file.
- **Cancel** – Click the button to cancel any changes.

3.6.4 LAN

Select on the device display the System tab, and then click the LAN button to show or modify the IP parameters.

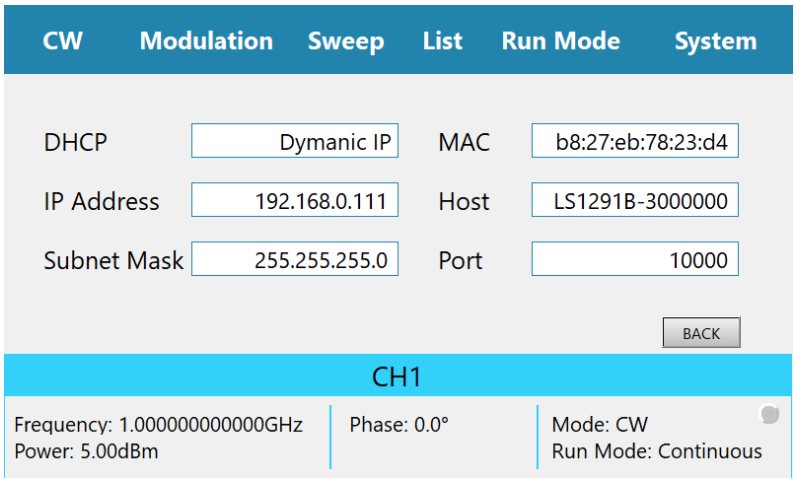

Figure 3.15 System Tab LAN

- **DHCP** – Dynamic Host Configuration Protocol.

- **Fixed** – Define a static IP Address. Verify that the PC running Lucid software is on the same network (default).
- **Dynamic** – Get an IP address from the DHCP server. The IP Address, Port and Subnet Mask fields are not accessible.

- **IP Address** – Define a static IP address.
- **Subnet Mask** – Verify that the PC running Lucid software is on the same network.
- **MAC** – The device MAC address.
- **Host** – The device computer name.
- **Port** – Define the SCPI port for communication. Users should use a free port in the range 1 to 65535.
- **BACK** – Click the button to return to the System dialog box.

3.6.5 Update

Select on the device display the System tab, and then click the Update button to update the device software. Refer to "Lucid Control Panel User Manual" section "Appendix FPGA Firmware Update" for how to update the FPGA firmware.

Device SW Update Sequence

1. Prepare on a PC a USB flash memory that is formatted to exFAT file system.
2. Download the "Lucid Benchtop FW - x.y.z.zip" file from the Tabor Electronics website at http://www.taborelec.com/downloads to the USB flash memory.
3. Unzip the file. The new directory x.y.z contains two files:
   a. benchtop_fw.tar.gz
   b. Manifest
4. Insert the flash memory in a free USB connector on the device.
5. Select on the device display the System tab, and then click the Update button to select the firmware for updating the device.

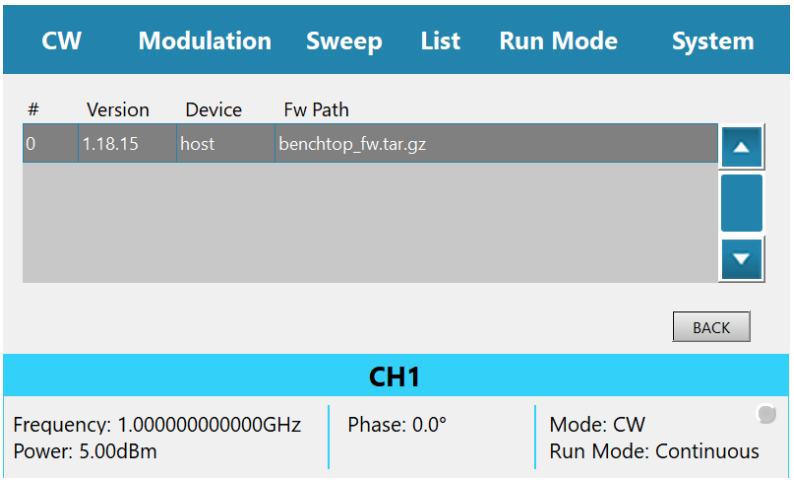

Figure 3.16 System Update

6. Wait for the operation to be completed.
7. The device will reboot automatically.

- **BACK** – Click the button to return to the System dialog box.

4 Lucid Benchtop Specifications

4.1 Frequency

Table 4.1 Frequency Specifications

Frequency	
Range	
LS3081B, LS3082B. LS3084B	9 kHz to 3 GHz
LS6081B, LS6082B, LS6084B	9 kHz to 6 GHz
LS1291B, LS1292B, LS1294B	9 kHz to 12 GHz
Resolution	0.001 Hz
Phase Offset	0.01 deg
Switching Speed	
Standard	500 µs
FS Option	100 µs

4.2 Frequency Reference

Table 4.2 Frequency Reference Specifications

Frequency Reference	
Temperature Stability	±25 ppb max
Aging	±3 ppm max for 20 years
Warm Up time	30 min

4.3 Amplitude

Table 4.3 Amplitude Specifications

Amplitude		
Max Output Power		
Settable	+20 dBm	
Calibrated	+15 dBm[1]	
Min Output Power	Base	LP Opt.
Settable	-100 dBm	
Calibrated	-80 dBm	
Resolution	0.01 dB	
Power Mute	-95 dBm	

Amplitude		
Output Return Loss	-10 dBm	
Accuracy (dB)	-50 dBm to +15 dBm	-90 dBm to -50 dBm
Up to 100 MHz	±0.3 (typ.)	±0.5 (typ.)
100 MHz to 3 GHz	±0.4 (typ.)	±0.6 (typ.)
3 GHz to 9 GHz	±0.7 (typ.)	±0.9 (typ.)
Above 9 GHz	±1 (typ.)	±1.5 (typ.)

[1] Above 25 kHz.

4.4 Phase Noise and Harmonics

Table 4.4 Phase Noise and Harmonics Specifications

Phase Noise (dBc/Hz	
Measured @ 10 kHz Offset)	
1 GHz	-138 (typ.)
2 GHz	-133 (typ.)
3 GHz	-130 (typ.)
4 GHz	
6 GHz	-124 (typ.)
12 GHz	-118 (typ.)
Harmonics (dBc)	
Range	
Up to 100 MHz	-30 dBc
Up to 8 GHz:	-50 dBc
100 MHz to 12 GHz	-50 dBc[2]
Sub-harmonics (dBc)	
6 to 12 GHz:	-55 dBm
Non-harmonics (dBc)	
Up to 12 GHz	-90 dBc (typ.)[3,4], -60 dBc (max.)[5]

[2] 750 MHz to 900 MHz -35dBc (typ.).

[3] -60 dBm max. @ 1 GHz, 1.5 GHz, 2.5 GHz, and 3 GHz.

[4] -75 dBm max. @ -15 dBm to +15 dBm and f> 6 GHz.

[5] Boundary spurs which may appear @ -100 MHz to +100 MHz offset from CW.

4.5 Modulation

Table 4.5 Modulation Specifications

Modulation	
Frequency Modulation	
Maximum Deviation	10 MHz
Resolution	0.1 % or 1 Hz (the greater)
Modulation Rate	1 MHz
Resolution	1 Hz
Amplitude Modulation[6]	
AM Depth	
Type	Linear
Maximum Settable	90 %
Resolution	0.1 % of depth
Modulation Rate	DC to 100 kHz
Phase Modulation	
Peak Deviation	360 deg
Modulation Rate	DC to 100 kHz
Pulse Modulation (PLS Option)	
On/off Ratio	60 dB
Rise/fall Time (10%-90%)	15 ns (typ.)
Resolution	6.4 ns
Minimum Width	32 ns
Repetition Frequency	DC to 10 MHz
Pattern Modulation (PAT Option)	
Number of Steps	1 to 2,048
Step Repetitions	1 to 65,535
ON/Off Time	32 ns to 20 days
Sweep	
Range	Same as frequency range
Modes	Frequency and amplitude step, list
Dwell Time	100 µs to 1,000 s

Modulation	
Resolution	1 µs
Number of Points	
List	2 to 4, 096
Step	2 to 65,535
Step Change	Linear
Trigger	Free run, External, Bus, Timer

[6] Specified for CW>100MHz

4.6 Inputs

Table 4.6 Inputs Specifications

Inputs	
10/100 MHz Input	
Connector Type	BNC
Input Impedance	50 Ω
Waveform	Sine or Square
Frequency	10 MHz/100 MHz
Power	-3 dBm to +10 dBm
Absolute Maximum Level	+15 dBm
Modulation Input	
Connector Type	BNC (per channel)
Input Impedance	50 Ω
Maximum Input Voltage	±1 V
Input Damage Level	±3.5 V
Trigger Input	
Connector Type	BNC (per channel)
Input Impedance	50 Ω
Input Voltage	TTL, CMOS compatible
Threshold	1.5 V
Damage Level	-0.42 V or +5.42 V

4.7 Outputs

Table 4.7 Outputs Specifications

Outputs	Lucid
CH1/CH2/CH3/CH4 RF Out	
Impedance	50 Ω
Connector Type	SMA
Number of Outputs	
LS3081B/LS6081B/LS1291B	1
LS3082B/LS6082B/LS1292B	2
LS3084B/LS6084B/LS1294B	4
10/100 MHz Output	
Impedance	50 Ω
Connector Type	2 x BNC
Frequency	10 MHz, 100 MHz
Shape	Sine
Power	3 to 7 dBm

4.8 General

Table 4.8 General Specifications

General	
Voltage Range	90 VAC to 264 VAC
Frequency Range	47 Hz to 63 Hz
Power Consumption	100 W
Display Type	5", TFT capacitive touch screen
Interface	
Host	2 x front panel USB type A 1 x rear panel USB type A
Device	1 x rear panel USB type B
LAN	1 x 1000/100/10 BASE-T
Storage	32 GB removable SD card
Dimensions (WxHxD)	
With Feet	315 X 102 x 425 mm
Without Feet	315 X 88 x 425 mm

General	
Weight	
Without Package	6 kg
Shipping Weight	6.5 kg
Temperature	
Operating	0°C to +40°C
Storage	-40°C to +70°C
Warm up time	15 minutes
Humidity:	85% RH, non-condensing
Safety	CE Marked, IEC61010-1:2010
EMC	IEC 61326-1:2013
Calibration	2 years
Warranty	3-years