TABOR ELECTRONICS

LUCID SERIES

Lucid-X Series Microwave Signal Generator Desktop User Manual

Rev. 1.0

For more information or to schedule a demo contact info@tabor.co.il | www.taborelec.com

Warranty Statement

Products sold by Tabor Electronics Ltd. are warranted to be free from defects in workmanship or materials. Tabor Electronics Ltd. will, at its option, either repair or replace any hardware products which prove to be defective during the warranty period. You are a valued customer. Our mission is to make any necessary repairs in a reliable and timely manner.

Duration of Warranty

The warranty period for this Tabor Electronics Ltd. hardware is one year, except software and firmware products designed for use with Tabor Electronics Ltd. Hardware is warranted not to fail to execute its programming instructions due to defect in materials or workmanship for a period of ninety (90) days from the date of delivery to the initial end user.

Return of Product

Authorization is required from Tabor Electronics before you send us your product for service or calibration. Call your nearest Tabor Electronics support facility. A list is located on the last page of this manual. If you are unsure where to call, contact Tabor Electronics Ltd. Tel Hanan, Israel at 972-4-821-3393 or via fax at 972-4-821-3388. We can be reached at: support@tabor.co.il

Limitation of Warranty

Tabor Electronics Ltd. shall be released from all obligations under this warranty in the event repairs or modifications are made by persons other than authorized Tabor Electronics service personnel or without the written consent of Tabor Electronics.

Tabor Electronics Ltd. expressly disclaims any liability to its customers, dealers and representatives and to users of its product, and to any other person or persons, for special or consequential damages of any kind and from any cause whatsoever arising out of or in any way connected with the manufacture, sale, handling, repair, maintenance, replacement or use of said products. Representations and warranties made by any person including dealers and representatives of Tabor Electronics Ltd., which are inconsistent or in conflict with the terms of this warranty (including but not limited to the limitations of the liability of Tabor Electronics Ltd. as set forth above), shall not be binding upon Tabor Electronics Ltd. unless reduced to writing and approved by an officer of Tabor Electronics Ltd. This document may contain flaws, omissions, or typesetting errors. No warranty is granted nor liability assumed in relation thereto. The information contained herein is periodically updated and changes will be incorporated into subsequent editions. If you have encountered an error, please notify us at support@taborelec.com. All specifications are subject to change without prior notice. Except as stated above, Tabor Electronics Ltd. makes no warranty, express or implied (either in fact or by operation of law), statutory or otherwise; and except to the extent stated above, Tabor Electronics Ltd. shall have no liability under any warranty, express or implied (either in fact or by operation of law), statutory or otherwise.

Proprietary Notice

This document and the technical data herein disclosed, are proprietary to Tabor Electronics, and shall not, without express written permission of Tabor Electronics, be used, in whole or in part to solicit quotations from a competitive source or used for manufacture by anyone other than Tabor Electronics. The information herein has been developed at private expense and may only be used for operation and maintenance reference purposes or for purposes of engineering evaluation and incorporation into technical specifications and other documents, which specify procurement of products from Tabor Electronics.

Document Revision History

Revision	Date	Description	Author
1.0	15-Oct-2024	• Original release. • Release supporting Lucid Control Panel Ver. 1.3.500 and TE Update Tool Ver. 1.1.212, Lucid-X SCPI 1.011, and Lucid-X FPGA version 1.14 or higher.	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
ENoB	Effective Number of Bits
ESD	Electrostatic Discharge
EVM	Error Vector Magnitude
FPGA	Field-Programmable Gate Arrays
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
ns	Nanoseconds

Acronym	Description
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
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

Figures

Tables

1 General

1.1 Scope

The scope of this manual is to describe the setup and operating procedures of the Lucid-X desktop microwave signal generator. This covers the following models listed in section 5.1 Ordering Information Desktop and options listed in section 5.2 Lucid-X Series Options.

Figure 1.1 LSX2091D – 20 GHz 1 Channel, Desktop Microwave Signal Generator

1.2 Related Documentation

- Lucid Control Panel User Manual
- TE Update Tool User Manual
- Lucid-X 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 comes on a CD supplied with the device. It 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-X 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 specified for this manual 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 the 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 a long period of time 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.
4. 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 who 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-X series desktop models feature 20 and 40 GHz single channel generator versions, all sharing the very same industry leading highlighted features, in a compact, small footprint module. Featuring extremely fast switching speed, superior signal integrity and purity, all the necessary modulated signals for analog communication systems, with built in SPI and micro-USB interface. 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 Documentation & Software

Lucid software, user manual and instrument drivers can be downloaded from https://www.taborelec.com/Downloads

2.2 Unpacking

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

Your new Lucid-X desktop model package contains:

1. Power supply. Input 100 – 240 V AC, 1.5 A, 47-63 Hz. Output 12.0 V DC, 8.34 A, 100.0 W, Outside ⊖—●—⊕ Inside
2. Desktop microwave signal generator.
3. Two stands with assembly screws.
4. USB Type-A to USB Type-C cable for connecting a control PC to the instrument.
5. Power cord with country specific plug.

Caution!

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

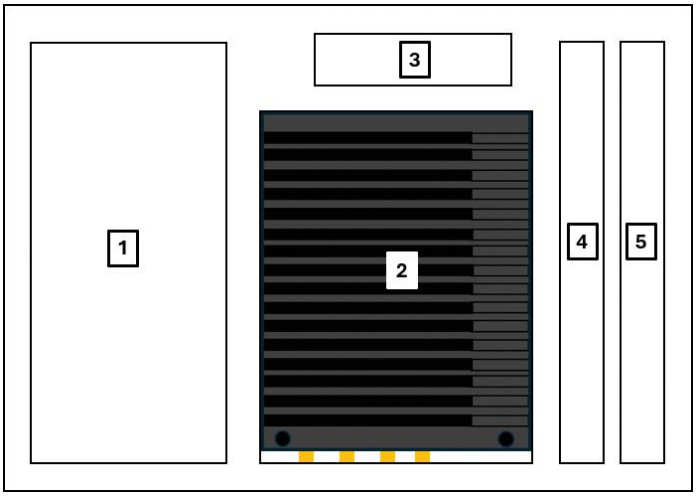

Figure 2.1 Package and Contents of Lucid-X Desktop Model

2.3 Assembly

The Lucid-X desktop can be operated either with or without its leg stands as per your preference. Use a screw driver with the supplied screws to attach the two stands to the bottom of the instrument. Always remove the legs for storing in the original package.

Caution!
Avoid overheating. Keep the fans on the top of the unit and the vents on the bottom of the unit free of obstructions.

2.4 Rear Panel Connector

Figure 2.2 Rear Panel Lucid-X

- Power 12VDC – 12V power supply connector
- SPI connector – SPI interface for remote connection to PC. Tabor internal use only.
- SYNC X – MMCX type connector for Tabor Electronics factory use only
- SYNC I/O – MMCX type connector for Tabor Electronics factory use only
- USB Device/Host – USB Type-C interface for remote connection to PC

2.5 Front Panel Connectors

Figure 2.3 Front Panel Lucid-X

- CLK OUT 3GHz – SMA type connector for 3 GHz signal output
- PULSE/TRIG – SMP type connector for pulse modulation or for trigger input
- CLK IN – SMA type connector for 3 GHz signal input
- AM – SMP type connector for amplitude modulation input
- REF IN 10/100MHz – SMA type connector for 10 MHz or 100 MHz signal input
- FM – SMP type connector for frequency modulation input
- REF OUT 10/100MHz – SMA type connector for 10/100 MHz signal output
- Status – LED
  - On – RF OUT port is active
  - Off – RF OUT port is not active
- RF OUT – RF signal output
  - LSX2091D - 2.92 mm type connector
  - LSX4091D - 2.4 mm type connector

Note

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

3 Getting Started

Refer to the “Lucid Control Panel User Manual” for a detailed description of operating the instrument. Here follows a short description how to get started.

1. You can download the latest Lucid Control Panel (LCP) from the Tabor Electronics website at http://www.taborelec.com/downloads to your control PC.
2. Double-click the “te_lucid_control_panel_x.y.zzz” installation file to install LCP.
3. Follow the instructions.
4. Connect your control PC to Lucid-X using the supplied USB Cable.
5. Double click the LCP icon on your desktop.
6. The Communications tab will be displayed.

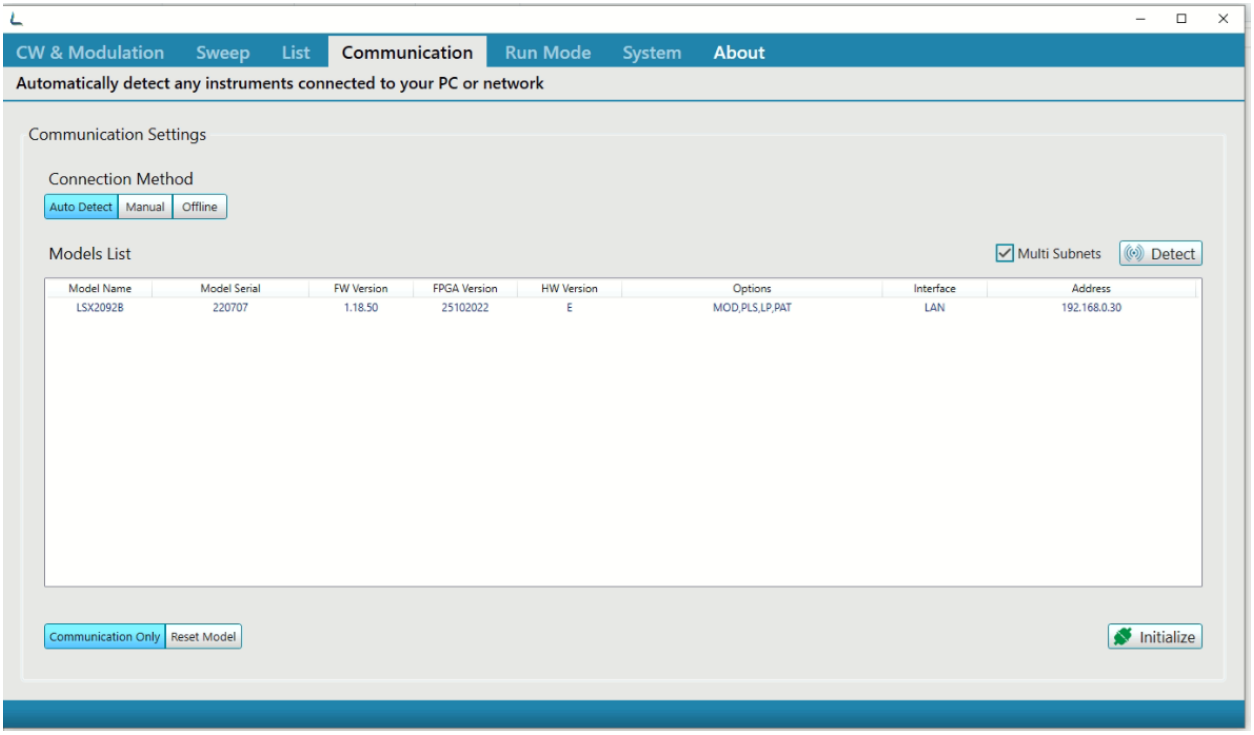

Figure 3.1 Lucid Control Panel CW & Communication Tab

7. LCP will detect your instrument, click on it and then press "Initialize".
8. The “CW & Modulation” tab will be displayed.

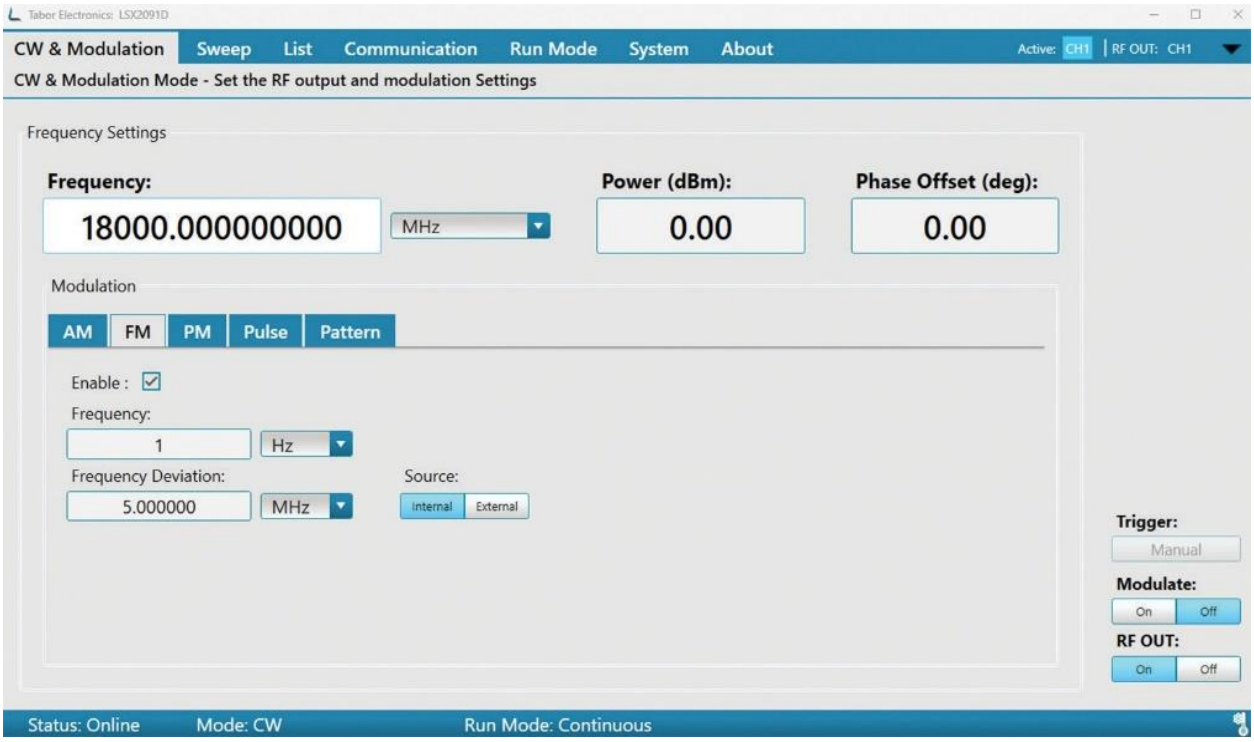

Figure 3.2 Lucid Control Panel CW & Modulation Tab

9. Enter the desired Frequency and Power (dBm) and switch "RF OUT" to "On".
10. Verify with an oscilloscope or a spectrum analyzer the generated RF signal.

4 Lucid-X Series Specifications

4.1 Frequency

Table 4.1 Frequency Specifications

Frequency	
Range	
LSX8081X(1)	50 kHz to 8 GHz
LSX209xy(1)	50 kHz to 20 GHz
LSX409xy(1)	50 kHz to 40 GHz
Resolution	0.001 Hz
Phase offset	0.01 deg
Switching speed	
Standard	500 µs
FS Option	100 µs

(1) x = Number of channels, y=X/R/B/D/P=PXIe/Rackmount/Benchtop/Desktop/Portable.

4.2 Frequency Reference

Table 4.2 Frequency Reference Specifications

Frequency Reference	
Temperature Stability	±10 ppb max (0-50°C)
Aging	±0.3 ppm 1st year, ±3 ppm 20 years
Warm up Time	15 min
Frequency Accuracy	±0.5 ppm

4.3 Amplitude

Table 4.3 Amplitude Specifications

Amplitude		
Max Output Power		
Settable	+12 dBm	
Calibrated	+10 dBm	
Min Output Power	Base	LP Opt.
Settable	-30 dBm	-75 dBm
Calibrated	-20 dBm	-70 dBm
Resolution	0.01 dB	
Power Mute	-80 dBm	
Output Return Loss	-10 dBm	
Accuracy (dB)	-70 dBm to +10 dBm	
Up to 100 MHz	±0.3 (typ.) dBm	
100 MHz to 3 GHz	±0.4 (typ.) dBm	
3 GHz to 9 GHz	±0.7 (typ.) dBm	
Above 9 GHz	±1 (typ.) dBm	

4.4 Phase Noise and Harmonics

Table 4.4 Phase Noise and Harmonics Specifications

Phase Noise (dBc/Hz		
Measured @ 10 kHz Offset		
100 MHz	-153 (typ.)	
250 MHz	-147 (typ.)	
500 MHz	-141 (typ.)	
1 GHz	-134 (typ.)	
2 GHz	-128 (typ.)	
4 GHz	-122 (typ.)	
8 GHz	-116 (typ.)	
10 GHz	-114 (typ.)	
20 GHz	-108 (typ.)	
40 GHz	-102 (typ.)	
Harmonics (typ.)		
Range	0 dBm	+10 dBm
Up to 8 GHz	-50 dBc	-40 dBc
8 GHz to 20 GHz	-40 dBc	-30 dBc
20 GHz to 40 GHz	-35 dBc	-28 dBc
Sub-Harmonics (typ.)		
Up to 20 GHz	-70 dBc	
20 GHz to 40 GHz	-35 dBc	
Non-harmonics (dBc)		
Up to 20 GHz	-90 dBc (typ.), 60 dBc max. [(2)]	
20 GHz to 40 GHz	-60 dBc max	

[(2)] 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	
AM Depth	
Type	Linear
Maximum Settable	1
Resolution	0.1% of depth
Modulation Rate	DC to 100 kHz

Modulation	
Phase Modulation	
Peak Deviation	360 deg
Modulation Rate	DC to 100 kHz
Sweep	
Range	Same as frequency range
Modes	Frequency step, Amplitude step, List
Dwell Time	10 µs to 562,499 s
Resolution	1 µs
Number of Points	2 to 4,096
Step Change	Linear
Trigger	Free run, External, Bus, Timer
Pattern Modulation (PAT Option)	
Number of Steps	1 to 2048
Step Repetition	1 to 65535
On/Off Time	32 ns to 20 days
Pulse Modulation (PLS Option)	
On/Off Ratio	80 dB
Rise/Fall Time	15 ns, 10%-90% (typ.)
Resolution	8 ns
Minimum Width	32 ns
Repetition Frequency	DC to 10 MHz

4.6 Inputs/Outputs

Table 4.6 Inputs/Outputs Specifications

Inputs / Outputs	
RF Out	
Impedance	50 Ω
Connector Type	
LSX8081X	2.92 mm
LSX209xy	2.92 mm
LSX409xy	2.4 mm
VSWR	1:2.1
Reverse Power	0.5 W, 16 VDC
Reference Out	
Impedance	50 Ω
Connector Type	SMA
Frequency	10 MHz or 100 MHz
Shape	Sine
Power	3 to 7 dBm

Inputs / Outputs	
Modulation Input	
Connector Type	SMP
Input Impedance	50 Ω
Max. Input Voltage	±1 V
Input Damage Level	±3.5 V
Pulse / Trigger Input	
Connector Type	SMP
Input Impedance	50 Ω
Input Voltage	TTL, CMOS compatible
Threshold	1.5 V
Damage Level	-0.42 V or 5.42 V
Reference Input	
Connector Type	SMA
Input Impedance	50 Ω
Waveform	Sine or Square
Frequency	10/100 MHz
Power	-3 dBm to +10 dBm
Absolute Max. Level	+15 dBm
Clock Input/Output	
Number of Ports	2, (1 Input & 1 Output)
Connector Type	SMA
Input Impedance	50 Ω
Waveform	Sine
Frequency	2.7 GHz - 3.3 GHz
Power	+10 dBm
Absolute Max. Level	+12 dBm

4.7 General

Table 4.7 General Specifications

General	
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

4.8 General Desktop

Table 4.8 General Desktop

General Desktop	
Power Supply	Input: 100 – 240 V AC, 1.5 A, 47-63 Hz. Output 12.0 V DC, 8.34 A, 100.0 W
Power Consumption	
LSX2091D	30 W typ., 45 W max.
LSX4091D	35 W typ., 55 W max.
Interface	USB TYPE C, SPI
Dimensions	14.5 x 9.5 x 3 cm
Weight	
Without Package	1.0 kg
Shipping Weight	1.5 kg

5 Lucid-X Series Ordering Information

5.1 Ordering Information Desktop

Table 5.1 Ordering Information Desktop

Model	Description
LSX2091D	20 GHz, 1 channel, desktop microwave signal generator
LSX4091D	40 GHz, 1 channel, desktop microwave signal generator

5.2 Lucid-X Series Options

Table 5.2 Lucid-X Series Options

Options	Description	Models[1]
LP	Low power option -70 dBm. Included for B/R/X.	D/P
ELP	Extended low power range -150 dBm. Not available for 4 channels.	B/R
EPR	Extended power range -130dBm to +20dBm. Not available for 4 channels.	B/R
PLS	Pulse modulation	X/R/B/D/P
PAT	Pattern modulation	X/R/B/D/P
FS	Fast switching 100 µs	X/R/B/D
EMU	Emulator pack for Keysight, R&S, Anapico & Holzworth	X/R/B/D/P
BAT	4-cell, replaceable extra battery	P
CHA	External charger	P
W-Rack	Rack-mount kit	B/R
SD	Removable SD memory card	R
Accessories		
PXE21100	21 slot PXIe chassis	X

[1] X/R/B/D/P=PXIe/Rackmount/Benchtop/Desktop/Portable.