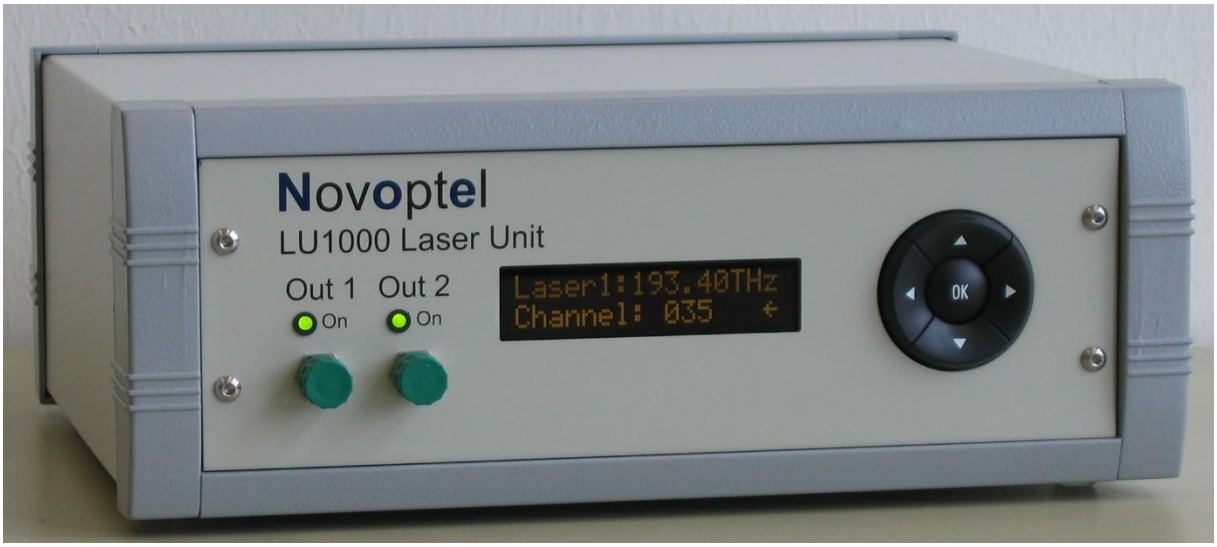
User Guide

Novoptel

LU1000 Laser Unit



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Revision history

Version	Date	Remarks	Author
0.1.0	28.02.2025	Draft version, referring to firmware 1.0.2.3	B. Koch

Table of contents

Operation of the instrument using the front control panel

Power the instrument with the provided power supply and switch it on. The instrument provides a cyclical menu, which is shown on the OLED display at the front of the instrument. The control buttons *UP* and *DOWN* let you navigate through the menu. The control buttons *LEFT* and *RIGHT* change a selected setting.

Menu structure and description

L1: 191.5000THz Sel. Laser: 1 ←	Select one of up to 4 lasers. The selected laser 1 is also indicated by 'L1' in the upper row.
L1: +10.0dBm Enabled ←	Enable or disable the laser.
L1: +10.0dBm Target:+10.0dBm←	Set the target power of the laser.
L1:StartFreq: 191.5000THz←	Set the start frequency of the laser. This refers to the frequency of channel 1.
L1:StartWLen: 1565.29nm←	Set the start wavelength of the laser. This refers to the wavelength of channel 1.
L1: 191.5000THz Channel: 001 ←	Select the laser channel. Increasing the channel number by 1 increases the laser frequency by one step on the grid.
L1: 191.5000THz Grid: 0.1000THz←	Set the grid spacing. Minimum grid spacing depends on laser properties.
L1: 191.5000THz FTune: 00000MHz←	Fine-tune the laser frequency in MHz-steps. Availability depends on laser properties.
L1: 191.5000THz Whispermode:OFF←	Disable the control loops of the laser to reduce AM and FM noise. Availability depends on laser properties.
Configure LAN ← Save Configur.	Enter LAN menu to set IP address, gateway address and subnet mask.
Configure LAN Save Configur. ←	Save the current configuration (including LAN settings) of the LU1000.

The menu point *Configure LAN* is missing if the unit is not equipped with a LAN interface

Operation of the instrument via graphical user interface

The instrument communicates by a USB IC FT232R from FTDI (Future Technology Devices International Limited, http://www.ftdichip.com).

The Novoptel LU1000 Graphical User Interface (= GUI) is compiled on a Microsoft Windows 10 64 Bit system. It is recommended to set the DPI scaling to 100%.

Installing the USB driver

Normally this driver is already provided by the Windows system. If this is not the case, one can install the newest driver from https://ftdichip.com/drivers/d2xx-drivers/

Connecting the instrument

After the driver is installed successfully, connect PC and instrument using the provided USB cable. Power the instrument with the provided power supply and switch it on. Wait until Windows has recognized the USB device and shown an acknowledgement message.

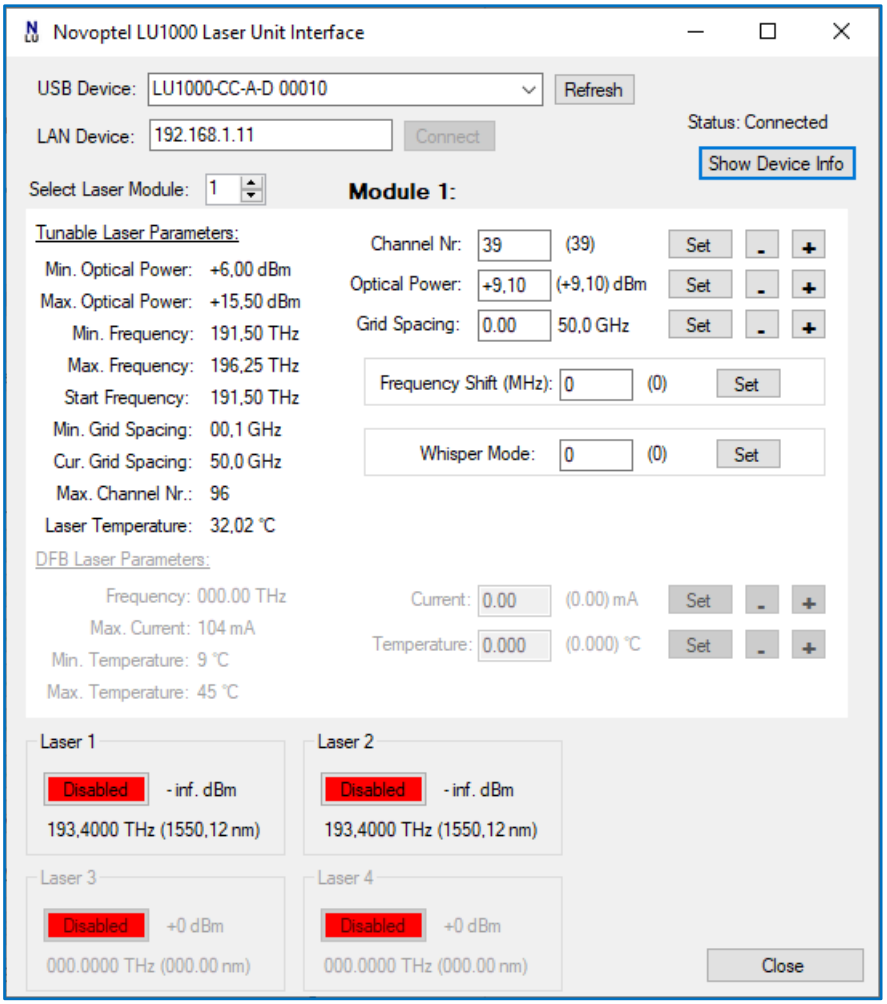
Installing the GUI

New GUI versions for LU1000 will be published here:

https://www.novoptel.de/Home/Downloads_en.php

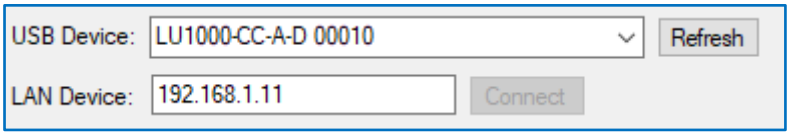
The LU1000_xxxx.exe can be executed without installation.

First steps with the GUI



Selecting one of the instruments attached via USB or LAN

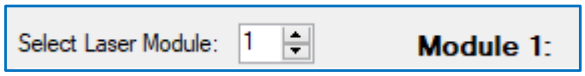
If you have attached only one Novoptel laser unit by USB, the GUI automatically selects this one. If you have attached more than one laser uint by USB, select the desired one from the drop-down list.



If a connected instrument does not appear in the list, click the *Refresh* button. Subsequently, you can launch further instances of the GUI and connect them to further instruments.
To connect to an instrument within the same LAN, type the instrument's IP address into the field next to *LAN Device* and click *Connect*. You can change the instruments network settings using the front buttons.

Selecting one of the laser modules

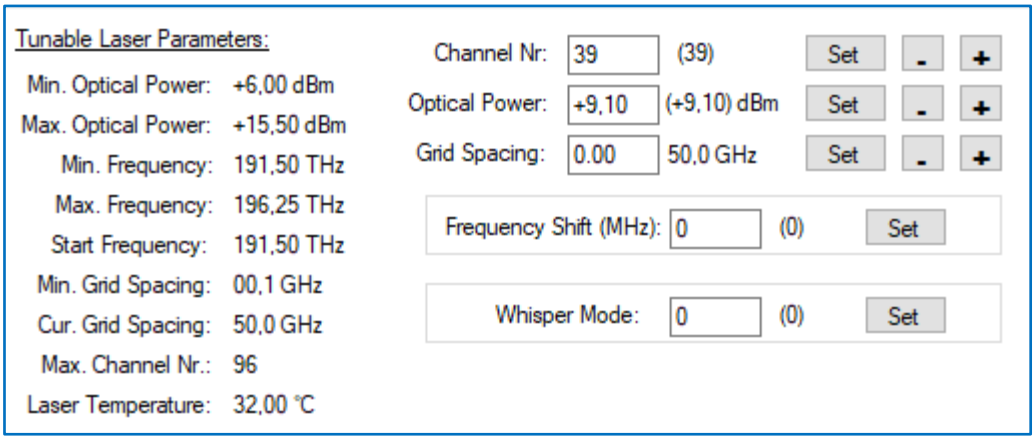
If the LU1000 is equipped with more than one laser module, you can select one of them by increasing or decreasing the number box:



The displayed properties will be updated according to the selected laser module.

Changing the settings of a tunable laser module

The laser module parameters are displayed on the left side. On the right side, the user can modify channel number, optical power and grid spacing. For changing the grid spacing, the laser must be disabled first.

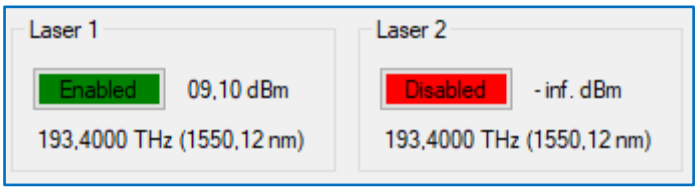


If the Start Frequency is changed using the front buttons, the GUI must be closed and opened again to recognize the new value.

The availability of *Frequency Shift* and *Whisper Mode* depends on the laser module properties. To enable or disable the whisper mode, write 1 or 0 into the field and click *Set*. To shift the laser frequency, enter a value in MHz into the field and click *Set*. The maximum frequency shift is ±30,000 MHz. Currently, negative values must be entered as 2^{16}-value, e.g. a frequency shift of -1,000 MHz must be entered as 64536.

Enabling and disabling a laser module

The current states of all up to 4 laser modules are shown at the bottom of the Gui window.



The laser module can be enabled/disabled by clicking into the red/green field.

Operation of the instrument using register access

The instrument is controlled by reading from and writing to internal control registers. The register address line is 12 bits wide, while each register stores 16 bits. The connection host, e.g. the program running on the connected PC, initiates all communication.

Access the USB driver

The USB driver (FTDI D2XX) must be installed on your system and the laser unit needs to be connected using a USB cable.

Support for Matlab

Novoptel provides a Matlab class (LU1000.m) with functions for LU1000 as well as precompiled MEX files for register operations via USB or LAN. The archive Matlab_Support_Files.zip is available at the top of page https://www.novoptel.de/Home/Downloads_en.php.

Support for Python

Novoptel provides a Python class (PyEps.py or EPS.py) with functions for EPS1000 via USB or LAN. The functions can be modified for LU1000 by reading and writing to the registers known from the Matlab examples.
The archive EPS_Python_Example.zip is available at the top of page https://www.novoptel.de/Home/Downloads_en.php.

Operation of the instrument using other programs

The USB vendor FTDI provides examples for USB access using other programs, for example LabVIEW® here:
https://ftdichip.com/software-examples/code-examples/

USB Settings

The following settings must be applied to enable USB communication:

Baud Rate	230400 baud
Word Length	8 Bits
Stop Bits	0 Bit
Parity	0 Bit

To speed up sequential read and write operations, we recommend setting:

USB Latency Timer	2 ms

USB Transfer protocol

Writing to a register requires a 9 byte data packet. Each byte represents an ASCII-coded character. The packet starts with the ASCII-code 0x57 (for “W”) and ends with the ASCII-code 0x0D for *carriage return*.

Send *write data* packet

„W“	A(2)	A(1)	A(0)	D(3)	D(2)	D(1)	D(0)	^CR

The 12 bit register address A is sent using 3 bytes, each containing the ASCII-character of the hexadecimal numbers 0 to F which represents the 4 bit nibble. The character of the most significant nibble is sent first. The 16 bit data, which should be written into the register, is sent with 4 bytes using the same coding as the register address.

Reading data from a register requires the host to send a *request data* packet to the instrument. The packet starts with the ASCII-code 0x52 (for “R”), followed by the register address coded the same way as in *write data* packets.

Send *request data* packet

„R“	A(2)	A(1)	A(0)	„0“	„0“	„0“	„0“	^CR

After receiving the *request data* packet, the instrument sends the requested data packet to the host:

D(3)	D(2)	D(1)	D(0)	CR

TCP/IP (LAN) Communication

The user can set the IP address, gateway and subnet mask via the front buttons. After the next power-up, the LU1000 will open a TCP/IP socket using the entered settings and wait for a connection.

TCP/IP Settings

Port	5025
Input buffer	8192 Bytes

TCP/IP Transfer protocol

***write data* packet**

In contrast to USB communication, writing to a register via TCP/IP requires only a 5 byte data packet. The packet starts with the ASCII-code 0x57 (for “W”).

„W“	A(11..8)	A(7..0)	D(15..8)	D(7..0)

The 12 bit register address is sent first in two bytes, followed by the 16 bit register data in another two bytes.

Reading data over TCP/IP requires the program to send a *request data* packet of 3 bytes to the instrument. The packet starts with the ASCII-code 0x52 (for “R”), followed by the register address coded the same way as in *write data* packets.

Send *request data* packet

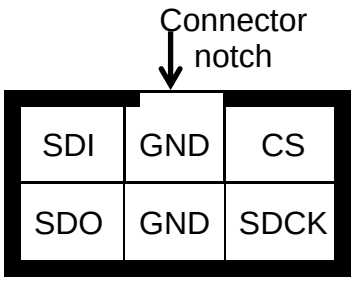
„R“	A(11..8)	A(7..0)

After receiving the *request data* packet, the instrument sends the requested data packet to the host:

D(1)	D(0)

Operation of the instrument using SPI

The SPI allows communication with a simpler protocol and shorter delays than USB. The SPI connector at the backside of the device provides the following connection:



Transmission starts with falling edge of CS and ends with rising edge of CS. After falling edge of CS, the command is transmitted. SDI is sampled with rising edge of SCK. Maximum SCK frequency is 500 kHz. Command and data word length is 16 bit each. MSB of command and data word is sent first, LSB last. If a valid *register read* (RDREG) command is received, the SDO output register shifts with falling edge of SCK to transmit the requested data word. Otherwise SDO remains in high impedance state. Data transfer to the device continues directly after transmitting a *register write* (WRREG) command.

Serial interface (SPI) commands

Each SPI register has 16 bit. Upon power-on, all registers are reset to default. The upper 4 bit can be 0h (read) or 1h (write). The lower 12 bits are the control register address.

Command	Code	Data	Function
RDREG	0XXXh	OUT	Read control register XXXh (for definition see below)
WRREG	1XXXh	IN	Write control register XXXh (for definition see below)

Serial interface (SPI) timing

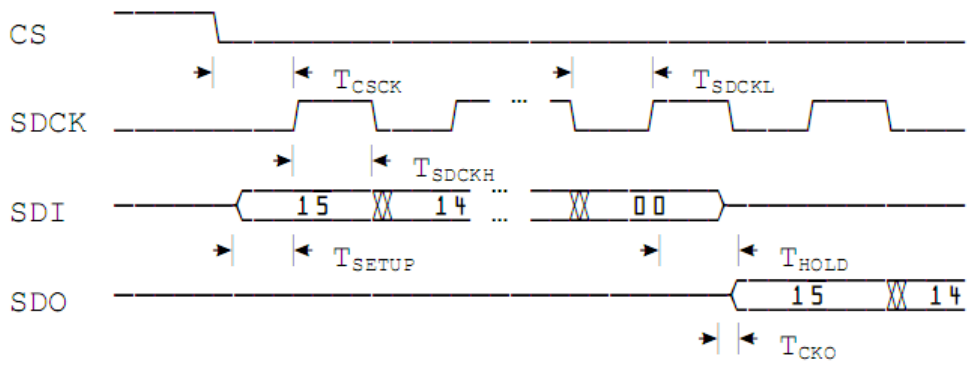


Fig. 1: Timing of SPI port.

Symbol	Description	Min	Max	Units
T_{CSCK}	CS low to SDCK high	120	–	ns
T_{CKCS}	SDCK low to CS high	120	–	ns
T_{SDCKL}	SDCKL low time	1	–	µs
T_{SDCKH}	SDCKL high time	1	–	µs
T_{SETUP}	SDI egde to SDCK high (setup time)	30	–	ns
T_{HOLD}	SDCK to SDI edge (hold time)	30	–	ns
T_{CKO}	SDCK edge to stable SDO	–	100	ns

Register address coding

Bits	Function
11..10	Reserved. Leave “00”.
9..7	“000”: Common registers “001”: Laser 1 registers “010”: Laser 2 registers (optional) “011”: Laser 3 registers (optional) “100”: Laser 4 registers (optional)
6..0	Register address 0..127

Common registers

Register address	Name	Bit(s)	Read/ Write	Function
0	ALM			Internal alarm code. The alarm can be cleared by writing “0” to this register. This is successful only if the alarm condition is no longer present.
		0	R/W	tbd.
		1	R/W	tbd.
		2	R/W	tbd.
		4	R/W	Critical temperature.
1	BUSY	0	R	“1”: Controller module is busy
2	NLAS	15..0	R	Number of installed laser modules
19	UPDIS	0	R/W	“1” (default) : Enable internal register update
20	WRADDR	7..0	W	Write address for external register access
21	WRDATA	15..0	W	Data word for external register access
22	WRTRIG	0	W	“1”: External write operation on registers of laser 1.
		1	W	“1”: External write operation on registers of laser 2.
23	RDADDR	7..0	W	Read address for external register access
24	RDTRIG	0	W	“1” triggers read operation on all installed lasers.
25	DOUT1	15..0	R	Data word read from laser 1
26	DOUT2	15..0	R	Data word read from laser 2
27	RES			Reserved
28	DOUT3	15..0	R	Data word read from laser 3
29	DOUT4	15..0	R	Data word read from laser 4
51	TMPR	15..0	R	Controller board temperature in Celsiusx16
64	FW	15..0	R	Firmware version as 4 digit BCD
65	SN	15..0	R	Controller board serial number
68 … 83	MODTYP	15..0	R	Module Type as 32 character string. Beginning at 512+144, each Register contains two bytes, representing two ASCII-coded characters.
85	DDNA1	15..0	R	Device DNA word 3 (DNA bits 63...48) (same as read via JTAG)
86	DDNA2	15..0	R	Device DNA word 2 (DNA bits 47...32) (same as read via JTAG)
87	DDNA3	15..0	R	Device DNA word 1 (DNA bits 31...16) (same as read via JTAG)
88	DDNA4	15..0	R	Device DNA word 0 (DNA bits 15...0) (same as read via JTAG)

Laser control registers (ITLA)

Register address	Name	Bit(s)	Read/ Write	Function
0	NOP	15..8	R	Pending Operation Flags. 0 indicates that there are no currently pending operations
		4	R	"1" indicates that the module is ready for its output to be enabled
		3..0	R	Error condition according to OIF-ITLA-MSA-01.0
1	LBUS	1	R	"1": Serial interface of laser is busy.
		0	R	"1": Serial interface of laser is has a timeout exception.
48	Channel	15..0	R/W	Sets or returns the laser module's current channel.
49	PWR	15..0	R/W	Sets or returns the laser module's current optical power in dBm*100
50	ResEna	15..0	R/W	Sets or returns the laser module's current status. Supported commands: 0x00: Laser output disabled 0x08: Laser output enabled
52	GRID	15..0	R	Grid spacing in GHz*10
53	FCF1	15..0	R	First channel's frequency, THz
54	FCF2	15..0	R	First channel's frequency, GHz*10
64	LF1	15..0	R	Returns channel's frequency as THz
65	LF2	15..0	R	Returns channel's frequency as GHZ*10
66	OOP	15..0	R	Returns the optical power encoded as dBm*100
67	CTemp	15..0	R	Returns the current temperature encoded as °C*100.
80	OPSL	15..0	R	Minimum possible optical power setting
81	OPSH	15..0	R	Maximum possible optical power setting
82	LFL1	15..0	R	Laser's first frequency, THz
83	LFL2	15..0	R	Laser's first frequency, GHz*10
84	LFH1	15..0	R	Laser's last frequency, THz
85	LFH2	15..0	R	Laser's last frequency, GHz*10
86	LGrid	15..0	R	Laser's minimum supported grid spacing, GHz*10
98	FTune	15..0	R/W	Fine tuning of laser frequency in MHz steps*) ("FTune" on display; "Frequency Shift" in GUI)
108	Whisper	15..0	R/W	0x0000: disable, 0x0002: enable whisper mode*)

*) only applicable if supported by laser module

Laser control registers (DFB modules)

Register address	Name	Bit(s)	Read/ Write	Function
23		15..0	R/W	Laser temperature in Celsius*1000.
24		15..0	R/W	Laser current in mA*100
25		15	R	Error flag of laser temperature controller
		15	W	"1" resets error flag
		14..12	R	Reserved
		11..0	R	Value of ADC1 (temperature)
26		15..0	R	Value of ADC2 (photocurrent)
27		13..0	R	Value of DAC1 (temperature)
28		13..0	R	Value of DAC2 (laser current)
29		15..0	R	Optical power in mW*1000
30		15..0	R	Optical Frequency in THz*100
31		15..0	R	Optical power in dBm*1000

Firmware upgrade

Via the JTAG port the user can upgrade the firmware, if ever needed. Note that the upgrading firmware must be obtained from Novoptel to avoid incompatibilities. An application note for firmware upgrading is available at the bottom of page https://www.novoptel.de/Home/Downloads_en.php.