Artifex
Engineering

LIV 110

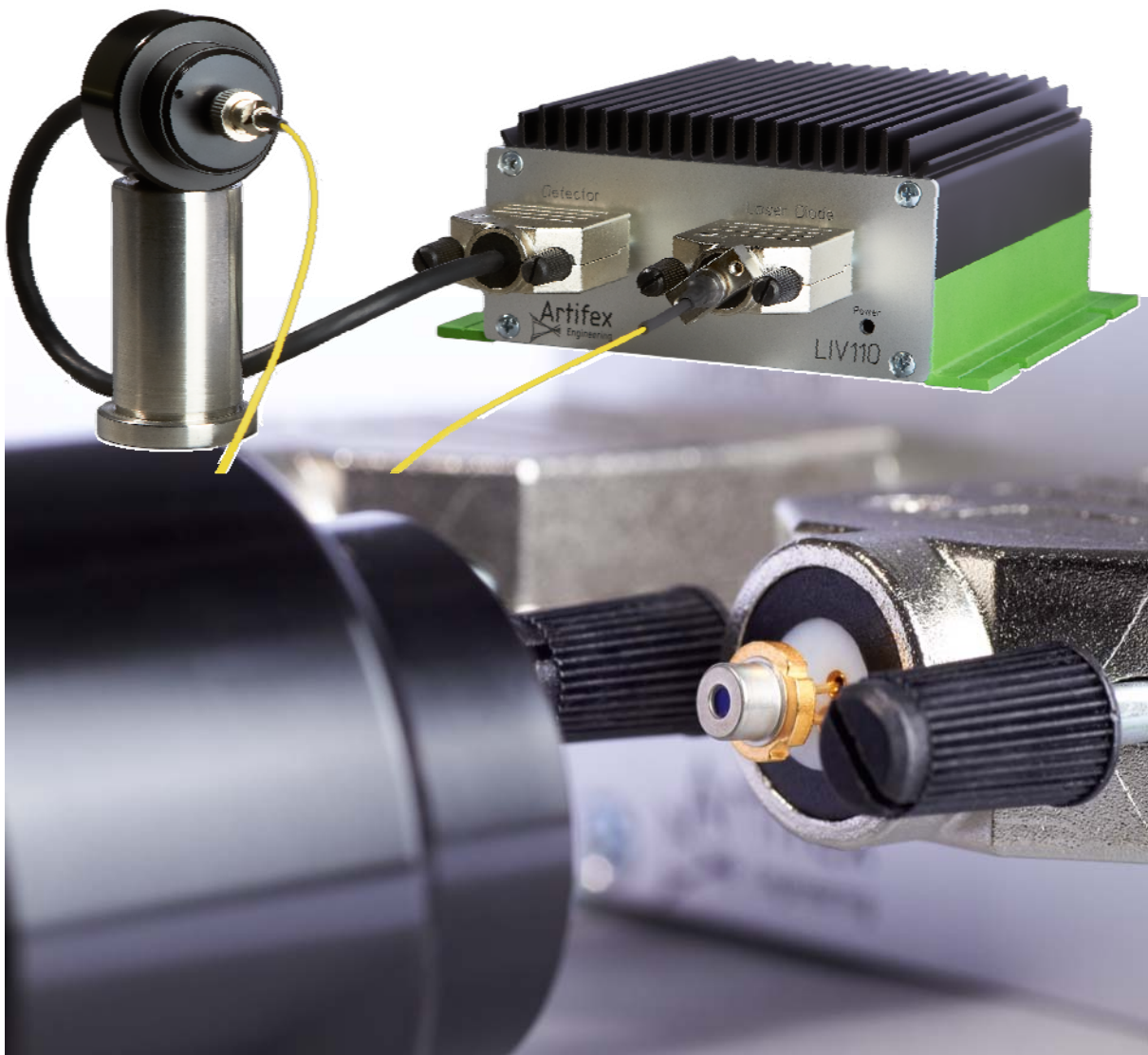# Laser Diode Characterization System

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1. General Information

The LIV110 is a powerful test instrument for use in the lab and in production environments. This instrument is ideal for laser diode characterization, quality control of incoming goods and for OEM applications. This compact unit comprises the current source as well as the data acquisition and communication hardware.

The LIV110 supplies a laser diode with well defined currents in the form of a staircase. During the current sweep, the instrument measures the optical power of the laser diode (L), the drive current (I) and the voltage drop across the laser diode (V). In addition, the LIV110 also measures the current from the laser diode's internal monitor photodiode. The standard LIV110 may be configured with any maximum current up to 250mA. Higher currents are available as custom solutions upon request.

The LIV110 is controlled via a set of commands and parameters which are uploaded from the controlling computer. This is followed by the command to begin measurement. The LIV110 then autonomously completes the full measurement sweep and sends the complete data set to the control computer. A graphical software package is provided to ease use of the instrument in a lab environment.

The software development kit allows for easy integration of the LIV110 into a custom software environment.

2. Specifications

Parameter	Conditions	Min	Typ	Max	Unit
INPUT					
Maximum measureable power	OD1, OD2 and OD3 refer to use with the respective attenuating filter				
Minimum measureable power					
Monitor Current	Gain 0 Gain 1 Gain 2	0.0025 0.00025 0.025		10 1 100	mA mA µA
OUTPUT					
Laser Diode Current		0.0625		250	mA
Current Resolution			0.0625		mA
Compliance		5.5	9		V
Accuracy				± 2	%
Offset			0.3	0.5	mA
Risetime / Falltime			25	30	µs
Number of Measure-ments per Channel		1		240	
Number of Measure-ment Channels			4		
GENERAL					
Power Supply		5.5	6	6.5	V
				1.5	A
Communication			USB 2.0		
Dimensions			130 x 120 x 44 mm (W x L x H)		mm

3. Connections

3.1 Power Supply

The power supply is 6V via a barrel socket. Please use only the power supply supplied with the unit.

3.2 Communication

The communication with the LIV110 is via USB 2.0 with a baud rate of 115200 kB/s. A Hardware – Handshake using RTS/CTS is employed to ensure secure communication.

3.3 Optical Power Measurement

The connector denoted „Detector" is compatible with the calibrated detector heads of the OPM150 series from Artifex Engineering. The calibration data are read out of the memory chip in the detector plug in order to calculate the optical power input.
Please use only detector heads which are compatible with this input. A generic input plug with a BNC socket is available for connecting bare photodiodes.

3.4 Laser Diode

The device under test is connected to the DB9 connector labeled "Laser Diode". The connections for the voltage measurement and monitor photodiode are integrated into this connector. The pinning is as follows:

Pin 1: Current output. Connect to the laser diode anode.
Pin 2: Current ground. Connect to the laser diode cathode.
Pin 3: Ground.
Pin 4: Voltage measurement (negative potential).
Pin 5: Voltage measurement (positive potential).
Pin 6: not connected.
Pin 7: not connected.
Pin 8: Ground. Connect the cathode of the monitor diode here if it is electrically isolated from the laser diode (see list of allowed laser / monitor configurations).
Pin 9: Monitor photodiode anode.

Fig. 1: Connecting the laser diode

4. Measurement Cycle

Before beginning the first measurement, the calibration factor for the wavelength of the laser to be measured should be called up (see "Miscellaneous", page 10).
A measurement begins by uploading the measurement parameters. These parameters are stored in the instrument but they are volatile – that is, the parameters are not stored after powering down the LIV110.

Command: U<Byte1><Byte2><Byte3><Byte4><Byte5><Byte6><Byte7><Byte8>
The definition and syntax of the bytes is defined in section 5.2 on page 8.

The measurement process is initiated by the command $G. The end of the measurement is signalized when the LIV110 sends either the byte "!" or "%". If "!" is sent, an error has occured during measurement and an error code is sent for diagnosis. If "%" is sent, the data are good. If the measurement is successful, the LIV110 begins downloading the data.
The initial string of data (header) comprises 5 bytes which indicate the number of data bytes to be sent as well as the gain factor for the optical channel. This information is required in order to calibrate the optical power measurement.

For example, the header may contain the following bytes:
1 (gain factor for the optical channel)
2 (gain factor for the laser diode monitor input channel)
67 (low byte of the number of data sets)
1 (high byte of the number of data sets)
4 (number of channels)

This information is to be interpreted as follows.
The amplifier for the optical input channel is in gain stage 1 corresponding to 1kV/A gain (gain stage 2 = 10kV/A, gain stage 3 = 100kV/A). From this information, the optical power may be calculated as follows:

$$P_{opt}[W] = \frac{1000 \bullet Measured\ value\ [mV]}{Wavelength\ calibration\ factor\ [A/W] \bullet Amplifier\ gain\ [V/A]}$$

The situation is correspondingly equivalent for the laser monitor photodiode input:

$$I_{MD}[A] = \frac{1000 \bullet Measured\ value\ [mV]}{Amplifier\ gain\ [V/A]}$$

The number of data bytes can be calculated as follows:

$$n = Number\_Channels \bullet Number\_Data\ sets$$

The measured laser diode voltage value is returned as a number in units of mV.
The measured drive current is calculated as follows:

$$I_{Laser\ diode}[A] = \frac{1000 \bullet Measured\ value\ [mV]}{12[V/A]}$$

4.1 CW Mode

The CW mode uses the current driver of the LIV110 without making any measurements. The upload parameters set the duration and current value. The duration is set in steps of 1ms from 1 to 60,000 – that is, durations of 1ms to 60s. The current which is generated is set via the parameter "upper current limit". The maximum current in this mode has been internally limited to 50mA in order to not overheat the end stage.
The instrument sends a "%" character when the "on" cycle has finished. No further data (eg data header) are communicated. The current can be interrupted by sending byte 27 (=ESC).

5. Communication

The communication with the LIV110 is via USB 2.0.
The most recent USB driver for the MS Windows® operating system is included on the storage medium shipped with the device.

Following installation there will be two drivers in the device manager under "System Properties". One is in the communication ports (COM und LPT), the other is in the list of USB controllers.
The first driver generates a virtual COM port for ease of control. The communication can be realized via a terminal programme.
The second driver can be adressed directly without a port number for integration in custom software. An example programme with direct adressing is also included on the storage medium provided (folder "SDK").

5.1 Communication Protocol

Baud rate: 115200 Bits/s
Data bits: 8
Parity: none
Stop bits: 1
Flow control: Hardware

5.2 Command List

Receipt of all commands will be recognized by an echo from the microcontroller. This echo should be read and checked. The flow control ensures error free communication.
If a command or upload is not recognized properly by the microcontroller, a time-out after 1.5 s will reset the internal parameter.
The upload parameter storage is non-volatile – the values remain valid following a restart of the unit. For safety reasons, the driver starts in a current off state.

The following commands are available:

Upload

Parameter upload:
Command: U   <operating mode>
                        <lower current limit - High Byte> <lower current limit - Low Byte>
                        <upper current limit - High Byte> <upper current limit - Low Byte>
                        <step size - High Byte> <step size - Low Byte>
                        <number of averages (1 – 255)>
                        <pulse duration cw mode – High Byte>
                        <pulse duration cw mode – Low Byte>

Echo: <13> (= Carriage Return)

The numbers for the parameters can be separated in a High- Byte and a Low – Byte by a bit shift operation (language C) or via bit masking.

Operating modi:
0 – including meaurement of monitor photodiode
1 – excluding measurement of monitor photodiode
2 – CW mode

Current limits and step size:
The current limits are given in multiples of the resolution of the instrument.
For example, the LIV110-250 has a current resolution of 62.5µA (=250mA/4000).
If the current sweep is to be set from 1mA to 146mA in 2.5mA steps, then the following parameters must be set:
a.) 1/0.0625 = 16 (lower current limit)
b.) 146/0.0625 = 2336 (upper current limit)
c.) 2.5/0.0625= 40 (step size)

Number of averages:
At each current step, a number of measurements can be made for each channel which are immediately averaged before storing. Increasing the number of averages increases the signal-to-noise ratio but also increases the duration of the measurement. In general, between 10 and 50 averages should be chosen for good accuracy.

Measurement

Start measurement:
Command: $G

Response if the measurement is erroneous: „!"
followed by the error code:
E1 : no detector connected
E5 : power on the monitor diode is too low

Response following a successful measurement: „%" (indicating end of measurement).
followed by header data:
1): gain factor for the optical channel
2): gain factor for the laser diode monitor input channel
3): low byte of the number of data sets
4): high byte of the number of data sets
5): number of channels

and subsequently followed by the measurement data (the number of measurement cycles is given in the header data):
1): voltage measurement – Low Byte
2): voltage measurement – High Byte
3): current measurement – Low Byte
4): current measurement – High Byte
5): optical power measurement – Low Byte
6): optical power measurement – High Byte
7) monitor diode measurement – Low Byte
8) monitor diode measurement – High Byte

Information about the instrument:
Command: $I
This command calls up information about the instrument and the detector attached to the „Detector" input. Each line is terminated with Byte 13 (= Carriage Return).
Line 1: Model (LIV110)
Line 2: Serial number
Line 3: Date of manufacture
Line 4: Serial number of the detector
Line 5: Lower calibration wavelength of the detector
Line 6: Upper calibration wavelength of the detector

If no detector is connected, line 4 will contain the error code "E4" and the data tranfer is terminated with the carriage return.

Calibration factor:
Command: L <wavelength – High Byte><wavelength – Low Byte>

The desired wavelength in nm is to be separated into two bytes via a bit shift operation (language C) or through byte masking.

The instrument responds as follows: <calibration factor - High Byte><calibration factor - Low Byte>
The calibration factor is the 1000x the sensitivity of the detector in [A/W]

Possible error codes:
E2 : no detector connected
E3: the desired wavelength is outside the range of calibration of the detector