THORLABS

High Power LED Controller

DC2200
Operation Manual

2018

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Contents

We aim to develop and produce the best solution for your application in the field of optical measurement technique. To help us to live up to your expectations and improve our products permanently we need your ideas and suggestions. Therefore, please let us know about possible criticism or ideas. We and our international partners are looking forward to hearing from you.

Thorlabs GmbH

Warning

Sections marked by this symbol explain dangers that might result in personal injury or death. Always read the associated information carefully, before performing the indicated procedure.

Attention

Paragraphs preceded by this symbol explain hazards that could damage the instrument and the connected equipment or may cause loss of data.

Note

This manual also contains "NOTES" and "HINTS" written in this form.

Please read these advices carefully!

1 General Information

The Thorlabs DC2200 High-Power LED controller features:

- Color Touch-Panel Display
- Two output terminals
  - LED1 (12 pin connector) for Thorlabs SOLIS High-Power LED Series
  - LED2 (4 pin connector) for Thorlabs Mounted (MxxxLx) or Fiber-Coupled (MxxxFx) LEDs.

  Using the supplied CAB-DC2200 and CAB-LEDD1 cables, custom LEDs can be connected as well, see Appendix in the full manual, section Connecting Custom LED 69.
- Constant Current Mode
- Brightness Mode
- Internal PWM (Pulse-Width Modulation) Mode with adjustable frequency, duty cycle and pulse count
- Internal Pulse Mode with adjustable On- /Off-Time and pulse count
- Internal Modulation (sine, square and triangle waveforms, 20 Hz to 100 kHz)
- External Modulation Mode
- External TTL Modulation Mode
- Remote Control via USB interface (DC2200 Remote Application; USB Test & Measurement Device driver)
- Firmware Update Capability via USB Interface and Thorlabs DFU Wizard application.

Terminal LED1

Terminal LED1 is capable of driving an LED with a forward voltage of up to 50 V and a current of up to 10 A. Five "pairs" of max. voltage and max. current are given:

- Max. current 10 A @ max. forward voltage 5 V
- Max. current 5 A @ max. forward voltage 10 V
- Max. current 4 A @ max. forward voltage 15 V
- Max. current 2 A @ max. forward voltage 35 V
- Max. current 1 A @ max. forward voltage 50 V

Terminal LED2

Terminal LED2 is capable of driving an LED with a forward voltage of up to 50 V and a current of up to 2 A. Two "pairs" of max. voltage and max. current are given:

- Max. current 2 A @ max. forward voltage 35 V
- Max. current 1.5 A @ max. forward voltage 50 V

1.1 Safety

Attention

The safety of any system incorporating the equipment is the responsibility of the assembler of the system.

All statements regarding safety of operation and technical data in this instruction manual will only apply when the unit is operated correctly as it was designed for.

The DC2200 must not be operated in explosion endangered environments!

Do not obstruct the air ventilation slots in the housing!

Do not remove covers!

Do not open the cabinet.There are no parts serviceable by the operator inside!

Keep in mind, that High Power LEDs may get hot!

This precision device is only serviceable if properly packed into the complete original packaging including the plastic foam sleeves. If necessary, ask for replacement packaging.

Refer servicing to qualified personnel!

Only with written consent from Thorlabs GmbH may changes to single components be made or components not supplied by Thorlabs GmbH be used.

Attention

Prior to applying power to the DC2200, make sure that the protective conductor of the 3 conductor mains power cord is correctly connected to the protective earth ground contact of the socket outlet! Improper grounding can cause electric shock resulting in damage to your health or even death!

All modules must only be operated with duly shielded connection cables.

Attention

The following statement applies to the products covered in this manual, unless otherwise specified herein. The statement for other products will appear in the respective accompanying documentation.

Note **This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules and meets all requirements of the Canadian Interference-Causing Equipment Standard ICES-003 for digital apparatus. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.**

Users that change or modify the product described in this manual in a way not expressly approved by Thorlabs GmbH (party responsible for compliance) could void the user's authority to operate the equipment.

Thorlabs GmbH is not responsible for any radio television interference caused by modifications of this equipment or the substitution or attachment of connecting cables and equipment other than those specified by Thorlabs GmbH. The correction of interference caused by such unauthorized modification, substitution or attachment will be the responsibility of the user.

The use of shielded I/O cables is required when connecting this equipment to any and all optional peripheral or host devices. Failure to do so may violate FCC and ICES rules.

Attention

Mobile telephones, cellular phones or other radio transmitters are not to be used within the range of three meters of this unit since the electromagnetic field intensity may then exceed the maximum allowed disturbance values according to IEC 61326-1.

This product has been tested and found to comply with the limits according to IEC 61326-1 for using connection cables shorter than 3 meters (9.8 feet).

1.2 Ordering Codes and Accessories

DC2200	High-Power LED Current Controller
CAB-DC2200	Connection Cable for custom LED - terminal LED1 (one end open wires, included)
CAB-LEDD1	Connection Cable for custom LED - terminal LED2 (one end open wires, included)

Compatible LEDs

SOLIS Series	Thorlabs High Power LED
MxxxLx	Thorlabs Mounted LED
MxxxFx	Thorlabs Fiber Coupled LED

1.3 Requirements

These are the requirements for the PC intended to be used for remote operation of the DC2200.

Hardware Requirements

CPU:	1 GHz or higher
RAM:	256 MB
Graphic card	Min. 32 MB memory
Hard disc	Min 100 MB free storage space
Interface	free USB2.0 port, USB cable according the USB 2.0 specification

Software Requirements

The DC2200 software is compatible with the following operating systems:

- Windows® XP (32-bit) SP3
- Windows® Vista (32-bit, 64-bit)
- Windows® 7 (32-bit, 64-bit)
- Windows® 8 / 8.1 (32-bit, 64-bit)

For operation of the DC2200, the NI-VISA™ Runtime (V 5.1.1 or later) is required as well. This NI-VISA™ software is included with the Thorlabs GmbH DC2200 installation package, but can be downloaded also from National Instruments' website www.ni.com.

2 Getting Started

2.1 Parts List

Inspect the shipping container for damage.

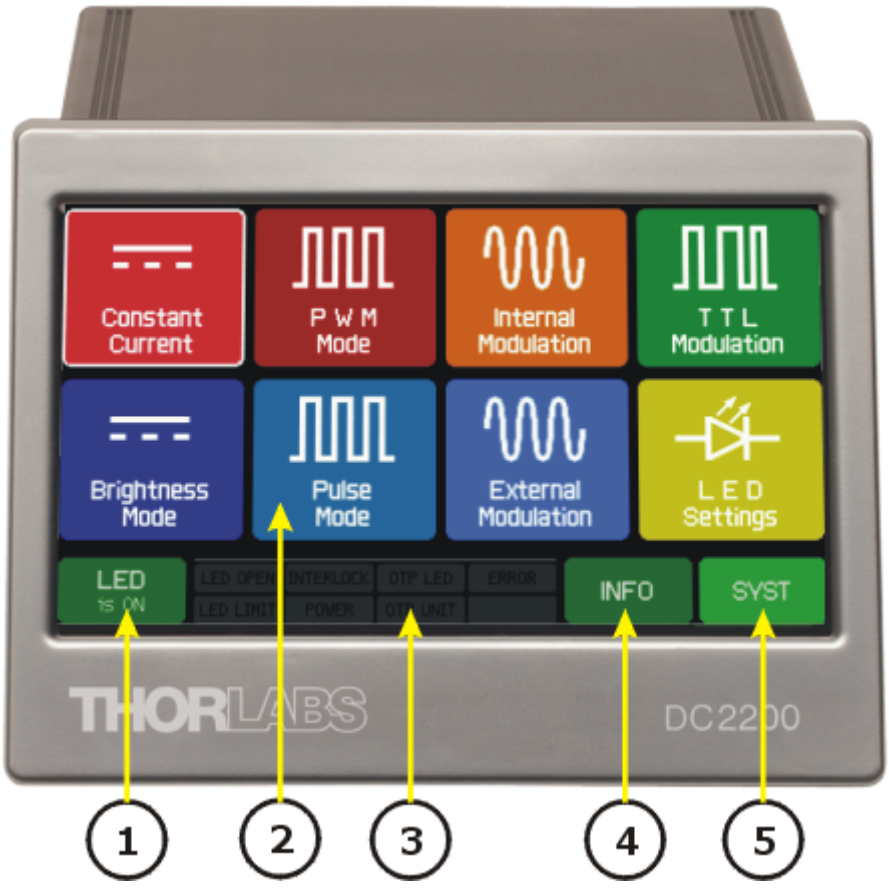
If the shipping container seems to be damaged, keep it until you have inspected the contents and you have inspected the DC2200 mechanically and electrically.

Verify that you have received the following items within the package:

1. DC2200
2. Power Supply 100 - 240 V AC / 48 V 2.08 A DC
3. Custom Cable CAB-DC2200 for connecting a custom LED to terminal LED1
4. Custom Cable CAB-LEDD1 for connecting a custom LED to terminal LED2
5. USB2.0 Cable
6. Quick Start Manual

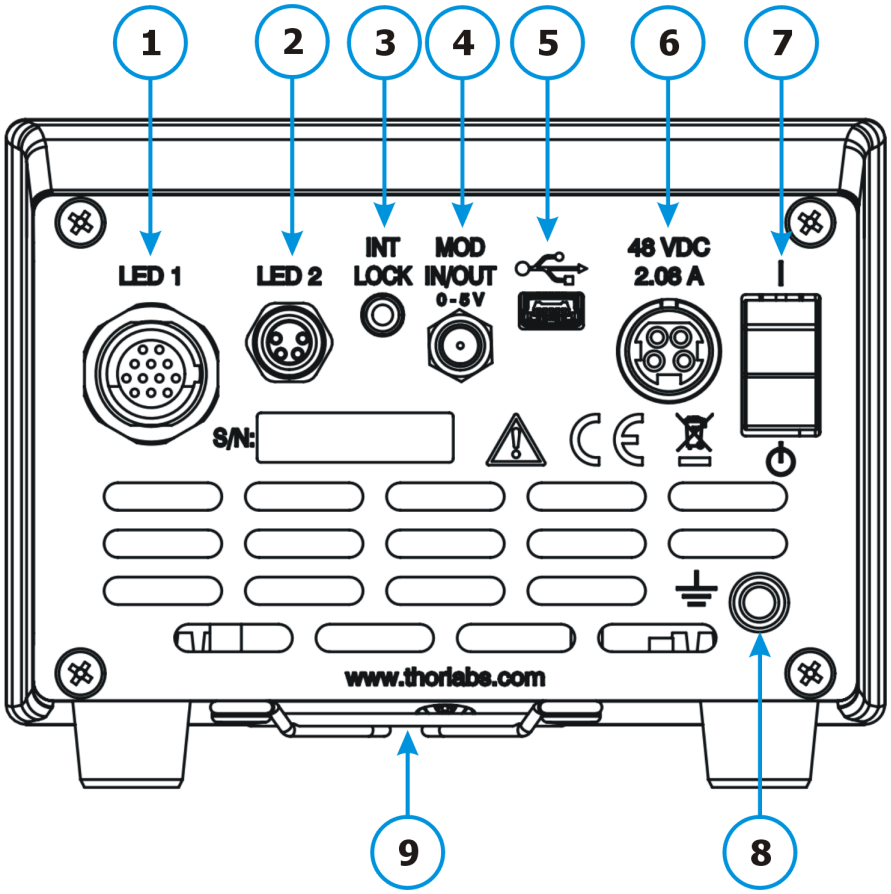
2.2 Operating Elements

Front Panel



1 LED On / Off Button
2 Main Menu
3 Status Bar
4 Device Information Button
5 System Settings Button

Rear Panel



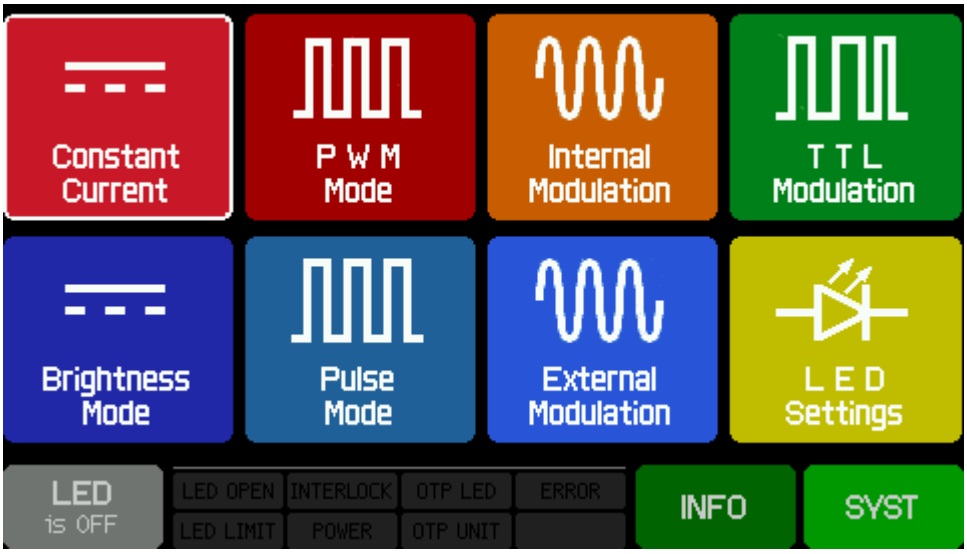
1 LED1 High-Power Terminal
2 LED2 Standard Terminal
3 Interlock Connector
4 SMA Connector: External Modulation Input / Internal Modulation Monitor
5 USB 2.0 Interface
6 DC Supply Input
7 Power-On Switch
8 Ground Jack
9 Ventilation Slots

2.3 First Steps

1. Connect the included power supply to the mains power and to the jack (6) 8 on the rear panel.
2. Connect your LED to the appropriate Terminal (LED1 (1) for SOLIS or custom high-power LED - or LED2 (2) for MxxxLx / MxxxFx or custom LED).
3. Make sure that the interlock pin (3) is inserted. Alternatively, if you use an external interlock 69, connect it to the 3.5 mm jack (3) 8.
4. Switch on your DC2200.

3 Operating Instruction

After the DC2200 is switched on, it will start up and show the main operating panel.



DC2200 Main Panel Menu
Click a menu topic or tab to get more information.

The image above is a screenshot of the main menu panel for the DC2200. Click on a button in the above image to skip to the section of this manual with detailed information on that button's function, or browse the appropriate sections in the Operation 14 chapter.

General Operations:

Menu Side Bar

	Select menu topic up
	Select menu topic down
	Edit menu topic (change value) (alternatively, push the highlighted topic a 2nd time). **Note:** Some menu items may be not editable in the actual menu or they might be read-out only parameters.
	Exit and return to Main Menu

Edit Side Bar

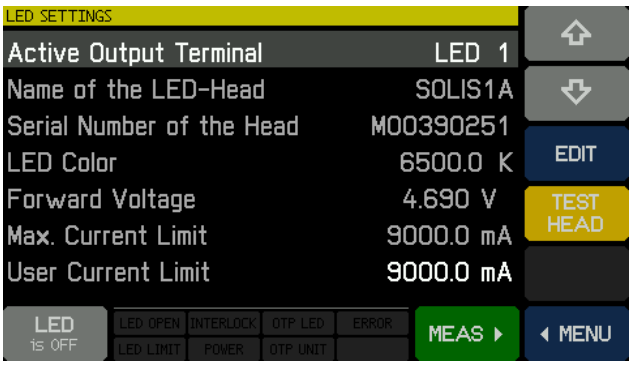
	Increase value
	Decrease value
	Shift cursor left
	Shift cursor right
	Save changes and return to previous menu
	Don't save changes and return to previous menu

3.1 LED Settings

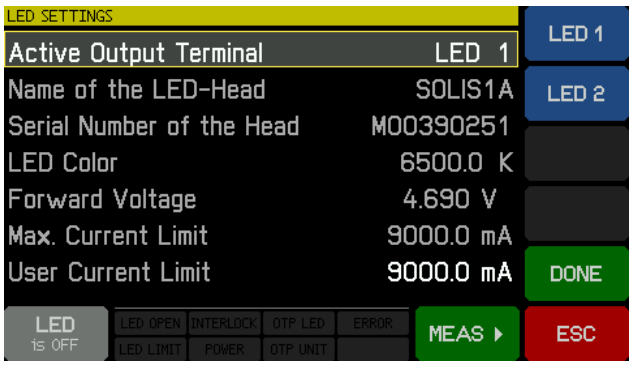
In this panel you can select the active output terminal, test (read out) and measure the connected head and change the user defined current limit for the connected LED(s).

Active Output Terminal

The selected terminal will be displayed.



DC2200 LED Settings Panel (LED1)



DC2200 LED Settings Panel (LED2)

To change the selection, tap the line "Active Output Terminal". A blinking yellow frame will appear to indicate that this field is being edited. Select the desired terminal from the options on the right sidebar and tap **DONE**.

The displayed values

- **Name of the LED-Head**
- **Serial Number of the Head**
- **LED Color**
- **Forward Voltage**
- **Max. Current Limit**

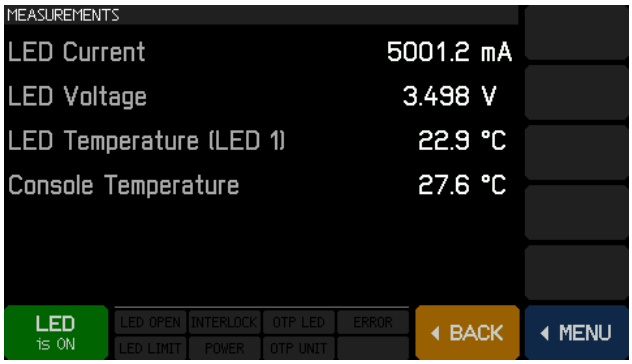
show the read-out from the internal LED memory (Thorlabs LEDs only). **LED Color** shows either the nominal LED wavelength (monochromatic LEDs) or the color temperature (only Thorlabs SOLIS series). If you have connected a custom LED, the above mentioned fields will show "n/a".

TEST HEAD

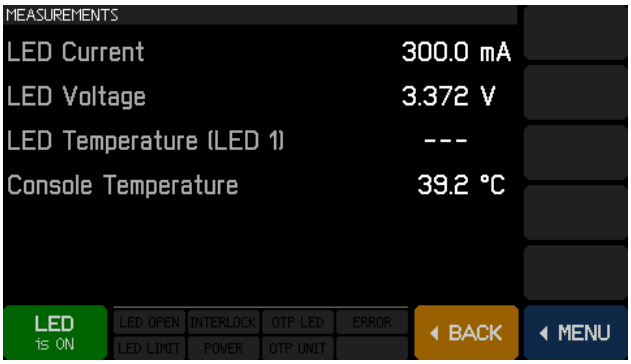
Tap this button to refresh information about the connected LED, particularly in case of a custom LED or when the LED was disconnected and replaced by another one.

MEAS

MEAS ▸ Tap this button to start the measurement of the current and forward voltage of the connected LED. By switching on the LED (lower left display button), the LED set current 14 is applied and in the display the values as below will be displayed.



DC2200 Measurement Panel (High Power LED)



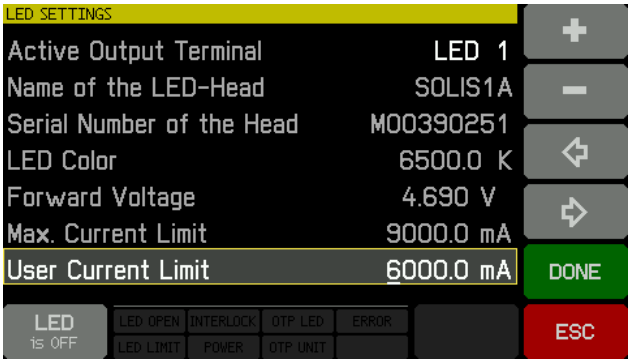
DC2200 Measurement Panel (Standard LED)

Notes

- The LED voltage is derived from a 2-wire measurement. Please be aware that the current through the LED cable will cause a voltage drop in addition to the forward voltage of the LED, resulting in a current-dependent inaccuracy in the forward voltage measurement.
- The LED Temperature will be displayed only for LEDs with an internal temperature sensor that is connected to the DC2200 via the LED1 high-power terminal.

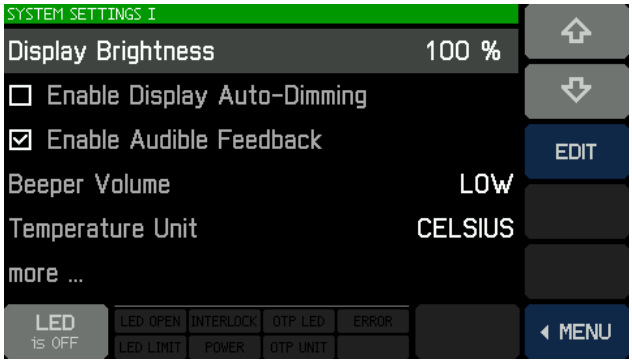
User Current Limit

Thorlabs LEDs come with an internal memory that saves the **Max. Current Limit** for the given type of LED. This value cannot be exceeded in order to avoid damage to the LED. Beside this limit, a user defined current limit can be set. Tap the menu item **User Current Limit** and adjust the desired value between 1 and the maximum. Then tap DONE to save changes.



3.2 System Settings

Tap the SYST button to display System Settings:



DC2200 System Settings Panel

DC2200 System Settings Panel

Display Brightness

Tap **EDIT**, set the desired brightness, then tap **DONE**. The brightness can be reduced down to 0% while the display will not become entirely dark to ensure operation.

Enable Display Auto-Dimming

If the remaining display brightness interferes with your application, check this option. The display illumination will shut off after about 30 seconds. When touching the display surface, the display brightness will return instantly to the set value.

Enable Audible Feedback

Enables a click sound each time the display was touched.

Beeper Volume

Adjust the volume of the alert beeper. The warning signal occurs when input values exceed valid range or a warning is sent by a connected device.

Temperature Unit

Select between °C, °F and °K to display the device temperature.

more...

Show more System Settings.

Enable LED Safety Mode

With the Safety Mode enabled, you cannot exit any of the LED operation panels (Constant Current, Brightness Mode, etc.) while the LED is switched on. The LED must be switched off prior to exiting the current operation panel.

Enable Firmware Update

Check this box if you want to update the DC2200's firmware 59.

Fan Voltage

An external fan for heat management can be connected to the DC2200. The fan power can be set between 6.0 V and 13.0 V. Please see the pin assignment 69 to use this feature.

Switch LED on when starting device

The connected LED will be activated when the DC2200 is switched on.

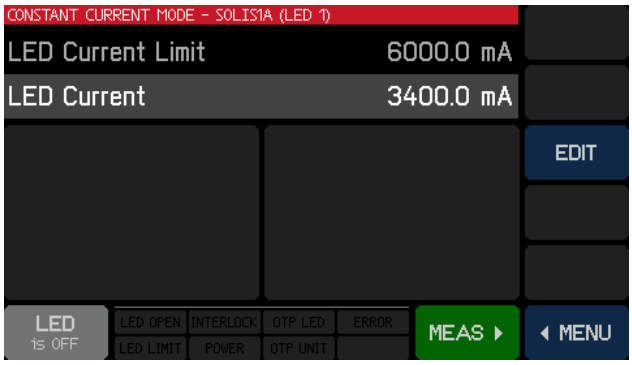
Select **...back** to switch to the previous System Settings panel.

3.3 Operation

This section is dedicated to the local operation of the DC2200. Thorlabs offers an application for remote operation 21 as well.

3.3.1 Constant Current Mode

In the Constant Current mode, you can set the LED current to a constant value. This panel shows the LED type, the allowed max. current (the indicated LED Current Limit is either the current limit of the detected LED or the user defined LED current limit - whichever is lower) and the set value of the LED current, that will be applied when switching on the LED.



DC2200 Constant Current Mode Panel

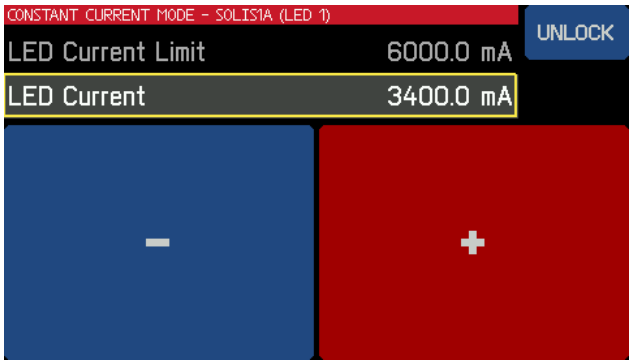
Set the LED Current

Tap the **LED Current** line or tap **EDIT**

Tap the large − / + or the − / + buttons to decrease / increase the LED current. Switch LED on in order to observe the illumination.

Press DONE to save your setting.

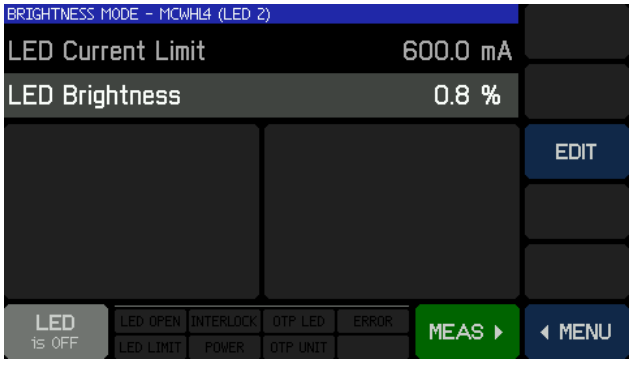
For more convenience, the area of the large − / + button can be increased by pressing the LOCK button - the side and the status bar will be hidden:



To return to normal display and make all operation buttons visible, press the UNLOCK button.

3.3.2 Brightness Mode

In this mode, you can set the brightness of the LED. This panel shows the LED type, the allowed max. current (the indicated LED Current Limit is either the current limit of the detected LED or the user defined LED current limit - whichever is lower) and the set brightness of the LED current, that will be applied when switching on the LED. The 100% brightness is always related to the displayed LED current limit.



DC2200 Brightness Mode Panel

Set the LED Brightness

Tap the **LED Brightness** line or tap **EDIT**

Tap the large − / + or the − / + buttons to decrease / increase the LED brightness. Switch LED on in order to observe the illumination.

Press DONE to save your setting.

For more convenience, the area of the large − / + button can be increased by pressing the LOCK button - the side and the status bar will be hidden:

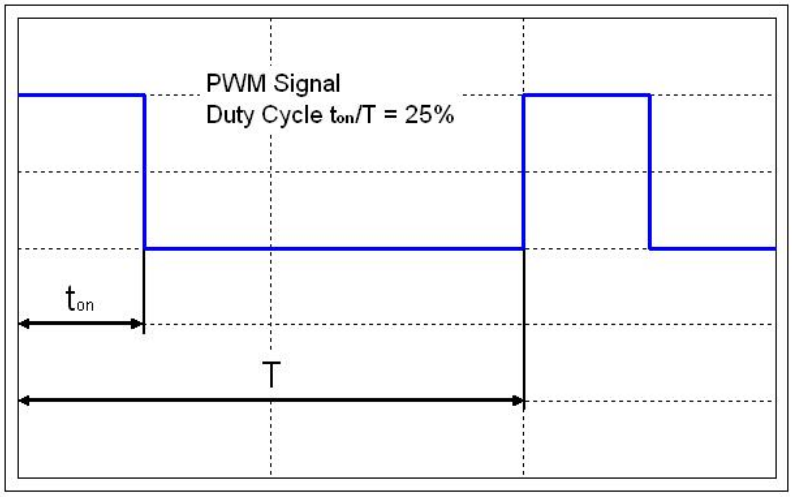
To return to normal display and make all operation buttons visible, press the UNLOCK button.

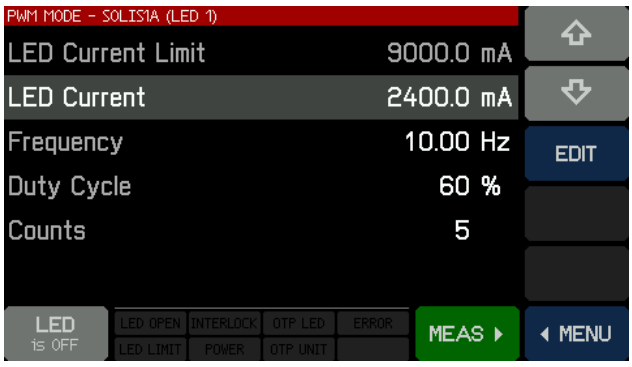
3.3.3 PWM Mode

PWM stands for **P**ulse **W**idth **M**odulation. In PWM mode the DC2200 generates rectangular pulses with

- adjustable frequency (0.1 Hz to 20 kHz)
- adjustable duty cycle (0.1 % to 99.9 %)
- adjustable pulse count (1 to 1000; infinite)

The pulse amplitude is given by the set value of the LED current, in other words, the LED current is modulated by a train of rectangular pulses. The graphics below illustrates the **Duty Cycle** parameter:





DC2200 PWM Panel

- Set the LED Current: This will be the current supplied to the LED while it is switched on. It can be adjusted between 0 and the indicated above LED Current Limit 12.
- Set the Frequency.
- Set the Duty Cycle.
- Set the number of counts. "Infinite" is set by decreasing below 1.

Note

In PWM Mode, at the SMA MOD IN/OUT connector (4) 8 at the rear panel the internal modulation signal is reproduced as a TTL signal.

3.3.4 Pulse Mode

The Pulse Mode is comparable to the PWM Mode 16. Here, the DC2200 generates also rectangular pulses with

- adjustable ON time (0.001 ms to 10 s)
- adjustable OFF time (0.001 ms to 10 s)
- adjustable pulse count (1 to 1000; infinite)

The pulse amplitude is given by the set value of the LED brightness from 0 to 100 %. As in Brightness Mode 15, 100 % brightness are related to the maximum LED current.

If needed, the pulse frequency can be calculated from

$$f = \frac{1}{t_{ON} + t_{OFF}}$$

The achievable frequency range reaches from 0.05 to 500 Hz.

DC2200 Pulse Mode Panel

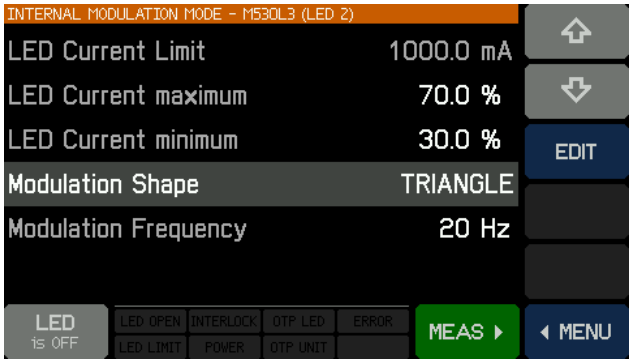
- Set the LED brightness: This will be the brightness during "LED ON". It can be adjusted between 0 and 100 %, with the max brightness corresponding to the LED being driven at the LED Current Limit 12.
- Set the ON and OFF time.
- Set the number of counts. "Infinite" is set by decreasing below 1.

Note

In Pulse Mode, at the SMA MOD IN/OUT connector (4) 8 at the rear panel the internal modulation signal is reproduced as a TTL signal.

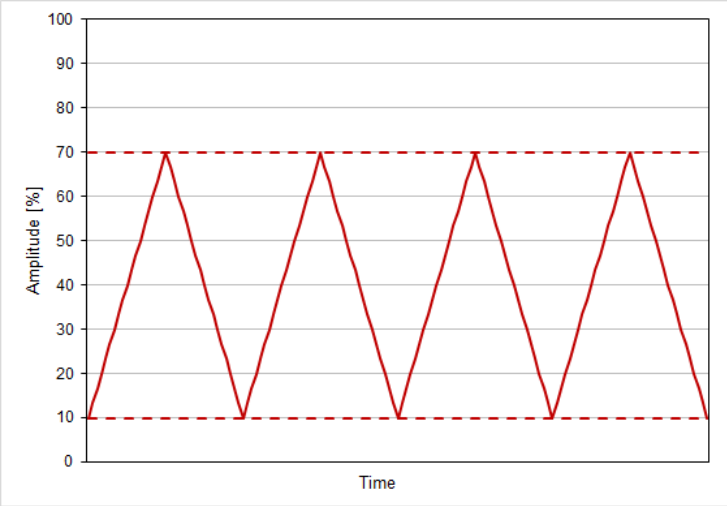
3.3.5 Internal Modulation Mode

In this mode the DC2200 generates a signal that modulates the LED current.

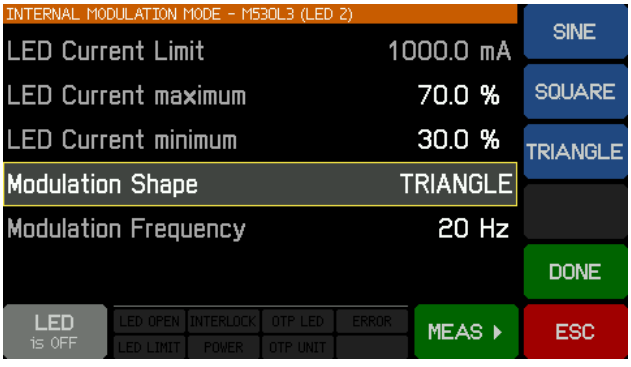


- waveforms: sine, square and triangle
- modulation frequency range: 20 Hz to 100 kHz
- adjustable LED current maximum (0 % to 100 %)
- adjustable LED current minimum (0 % to 100 %)

The amplitude results from the difference between the LED current maximum and minimum. The following time diagram illustrates that for the above shown settings:



- Set the LED max and min current in % of the LED current limit stated at the top of the panel.
- Select the waveform:



- Select the modulation frequency.

Note

In Internal Modulation Mode, at the SMA MOD IN/OUT connector (4) 8 at the rear panel a TTL signal is available that is synchronized with the zero-crossings of the internal modulation signal.

In above example, the monitor signal is triggered each time the LED current crosses the 40% amplitude line.

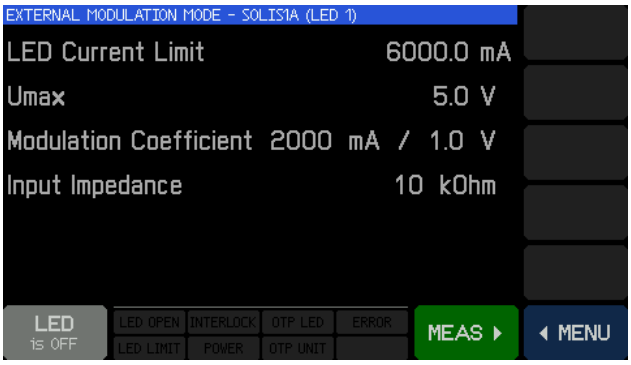
3.3.6 External Modulation Mode

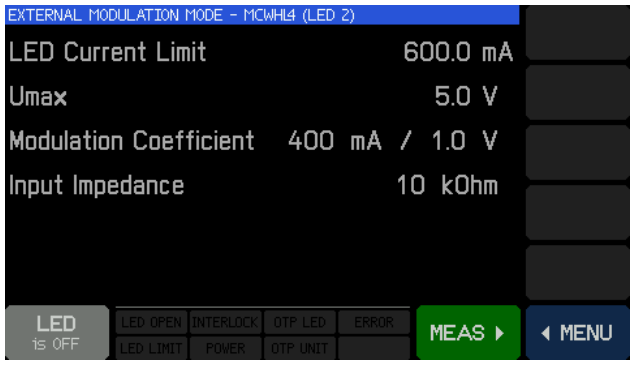
The external modulation signal (voltage) is applied to the SMA connector on the rear panel 8 and modulates the LED current. The allowed input voltage range is 0 to 5 V.

The applied voltage is converted into the LED current, the conversion coefficient (AKA modulation coefficient) depends on the terminal and the value of LED current limit 12:

Terminal	LED Current Limit	Modulation Coefficient
LED1	0.0 to 4.0 A	800 mA/V
	> 4.0 to 10.0 A	2000 mA/V
LED2	0.0 to 2.0 A	400 mA/V

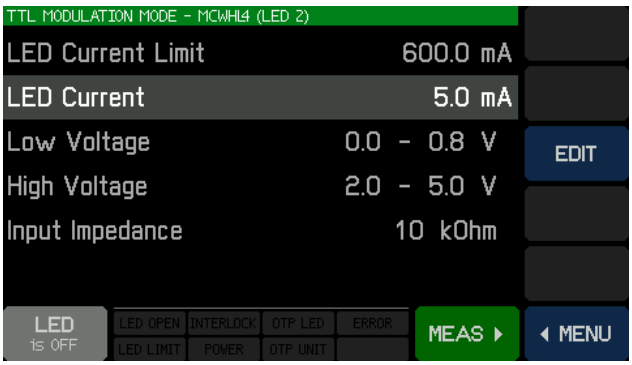
The External Modulation panel shows above parameters:





3.3.7 TTL Modulation Mode

The SMA connector on the rear panel 8 is used for TTL modulation input as well. The input works with standard TTL level signals, the Low and High Level voltage ranges are displayed in the panel:



TTL Low Level corresponds to LED OFF, TTL High Level - LED ON.

LED Current is the value that is applied to the LED when the TTL input is on H level; it can be adjusted between 0 and the value of **LED Current Limit** 12 (see upper line in the panel).

Note

The frequency range of the modulating TTL signal is measured under the following definitions and conditions:

- Resistive load
- The "Maximum Modulation Frequency" f_{max} is defined as the frequency, when the sum of rise time t_{rise} and fall time t_{fall} equals 10 % of the TTL signal period:

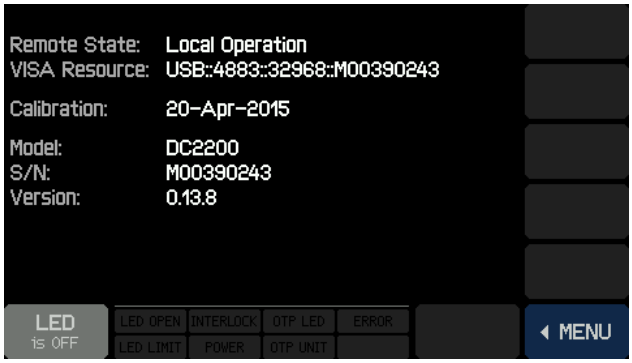
$$f_{max} = \frac{1}{T_{min}} = \frac{1}{10\ (t_{rise} + t_{fall})}$$

- Rise and fall time are defined as the time between 10% and 90% of the current at TTL HIGH level

Current Range	Measurement Current	Load	Max. Modulation Frequency
Terminal LED1			
0.0 - 4.0 A	500 mA	1.0 Ω	23 kHz
4.0 - 10.0 A	1000 mA	0.5 Ω	18 kHz
Terminal LED1			
0.0 - 2.0 A	250 mA	2.0 Ω	27 kHz

3.3.8 Info

Tap the INFO button to display information about the DC2200 hardware and firmware:



3.4 Remote Operation

The DC2200 can be operated remotely via the USB 2.0 interface

- by Thorlabs communication tools available for download here: Thorlabs Instrument Communicator
- by Thorlabs DC2200 Remote Application 31
- by your own application 37

When the DC2200 is in remote mode, some additional information appears in the status bar of the display:

TMC-ID	Blinking when a remote identification request is received.
REMOTE	Device switched to Remote state after receipt of 1st remote command.
LOCAL	The **LOCAL** button was pressed during remote operation. The unit is operable locally but returns to remote mode with the first received remote command.
LOCK	From the remote computer a **Local Lock-Out** command was sent. The unit is locked and cannot be set to local mode.

Note

While the DC2200 is controlled by the DC2200 Remote GUI, the instrument is in continuous communication with the PC, preventing local operation. The LOCAL button does not return the instrument into local mode - therefore please disconnect the GUI from the instrument.

3.4.1 Installing Software

Note

Do not connect the DC2200 to the PC prior to software installation!

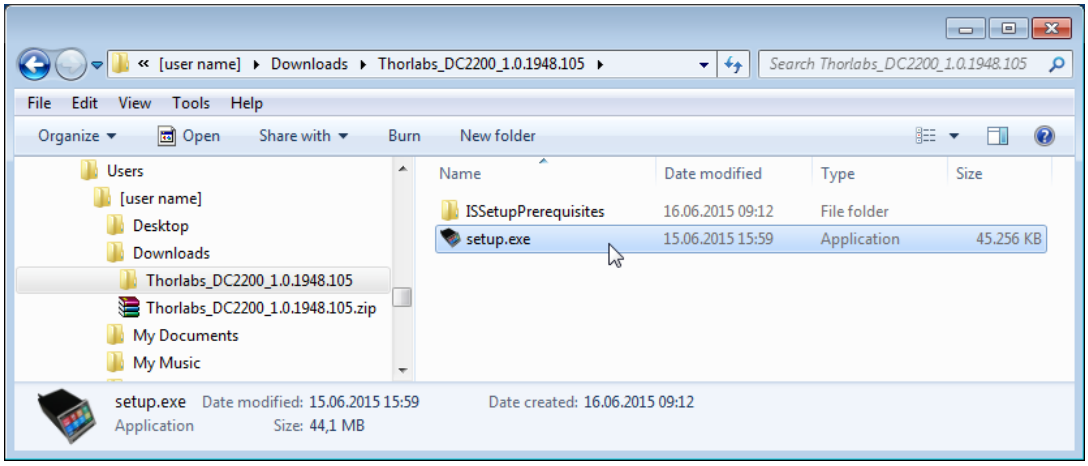
Attention

Exit all running applications on your PC as the installer may require a reboot of your PC during installation!

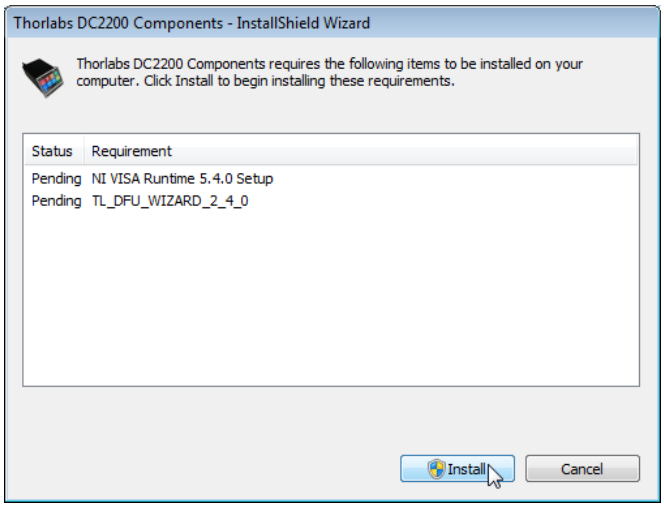
Thorlabs is breaking new ground in saving our environment. We decided to refrain from shipping an installation CD ROM and to offer a download of the software from our website instead. As an additional advantage to this distribution method, the most recent version of the software will always be available online.

The DC2200 software package can be found easily on the website. Download it and unzip the archive, making sure to note the target location.

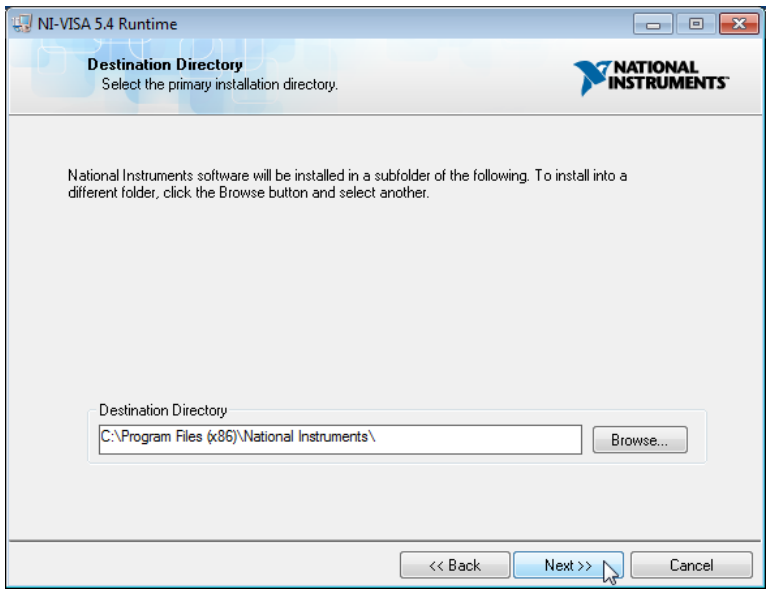
Start the installation by double clicking the setup.exe file:

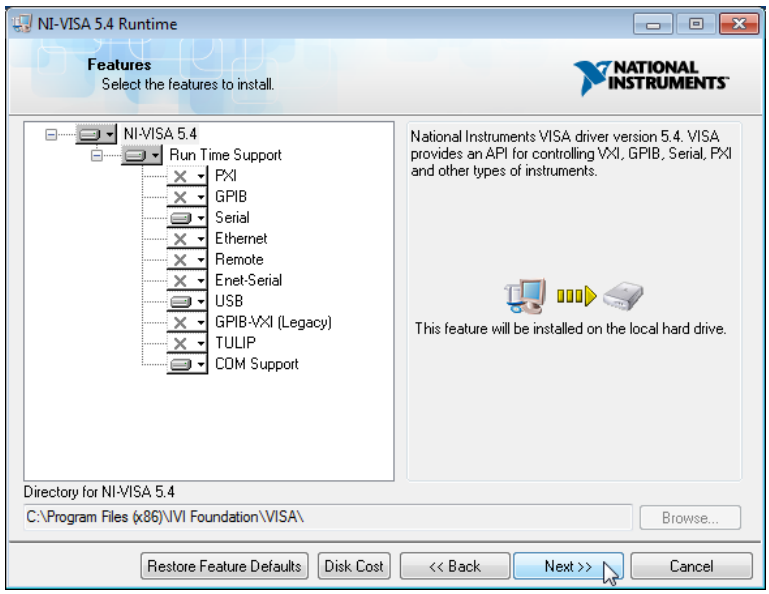


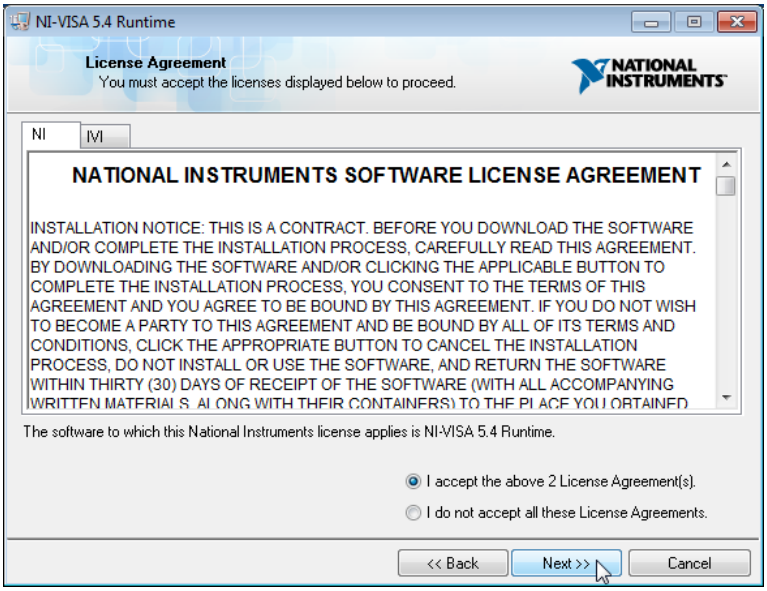
The installer verifies if NI-VISA™ Runtime V 5.1.1 or later software is installed on your computer. If so, the installer skips the NI Software installation and continues with the DC2200 software installation 25. For completeness, below the NI software installation steps are listed.



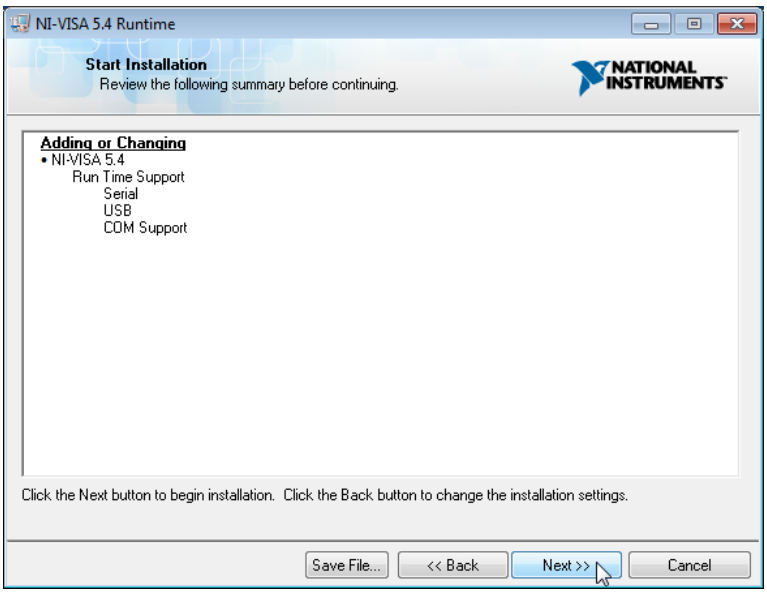
Click '**Next >>**' to continue installation. Please do so in the subsequent dialogs.



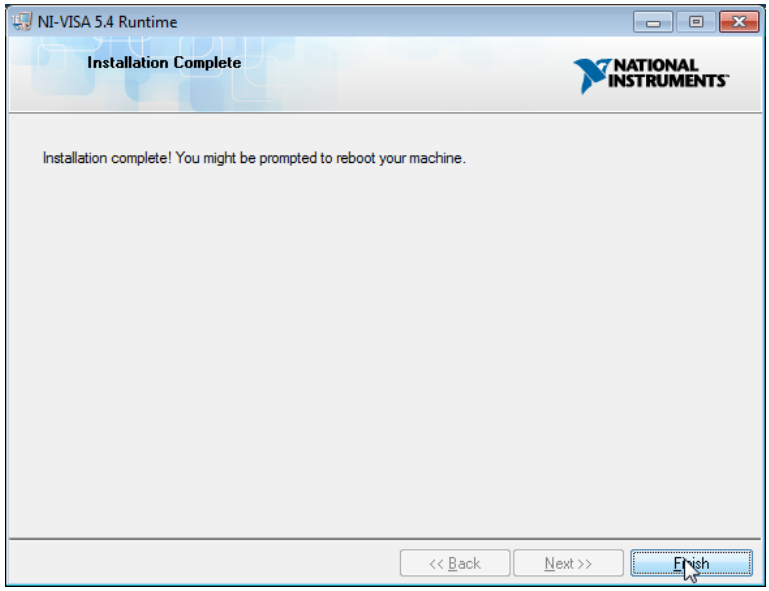




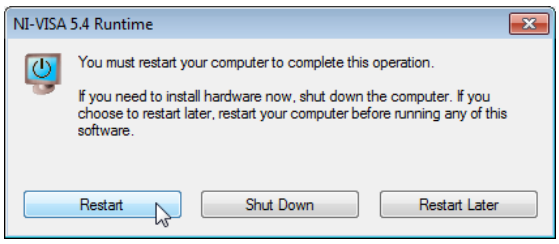
Click '**I accept...**' if you do so, then '**Next >>**' to continue.



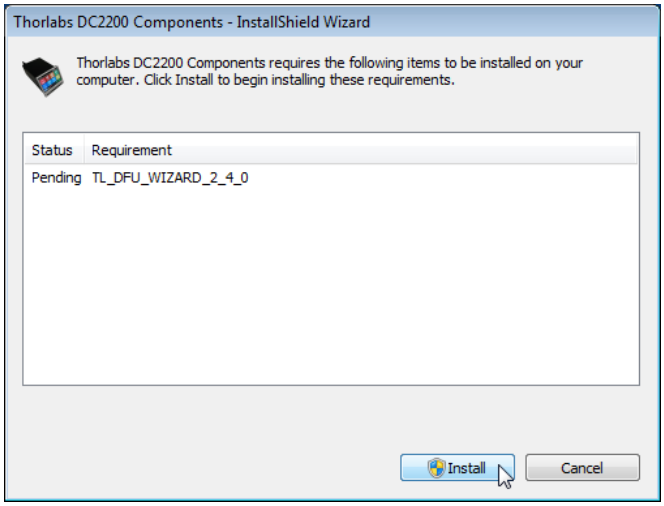
Click '**Next >>**' to continue.

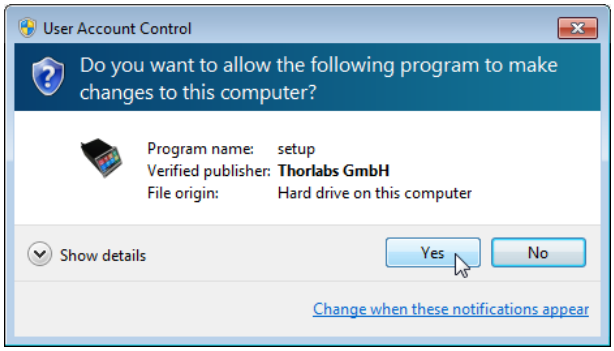


Click '**Finish**' to complete installation. You might be prompted to reboot your computer:

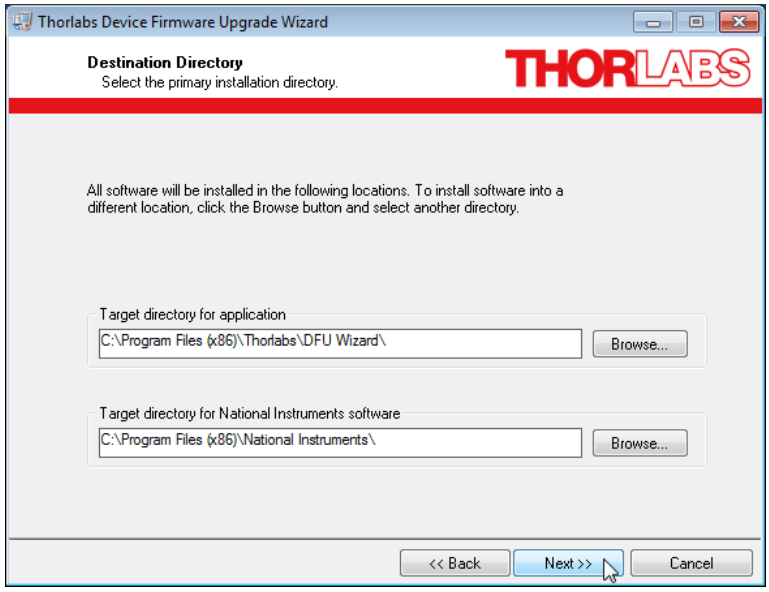


Click '**Restart**'. After the restart, the computer continues the Thorlabs GmbH software installation. If the installer does not continue automatically, please call the setup.exe 22 again.

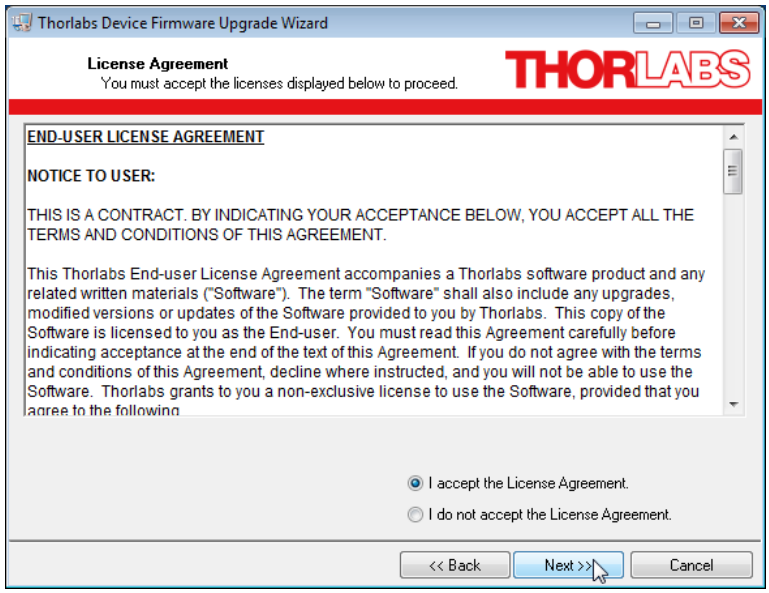




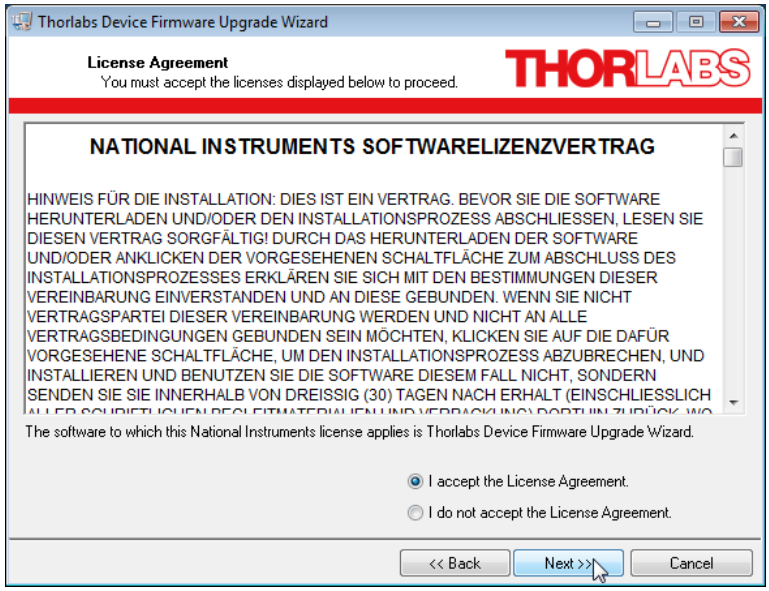
Confirm ("**Yes**") to continue.



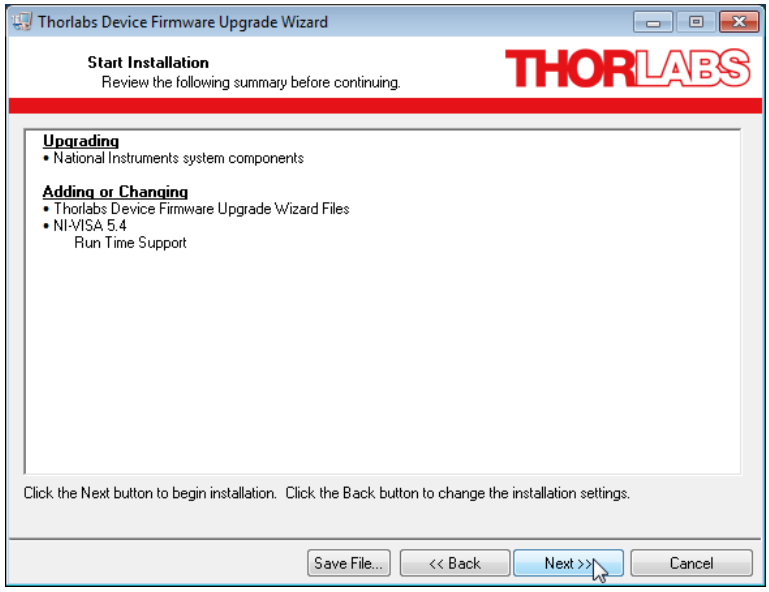
Click '**Next >>**' to continue.

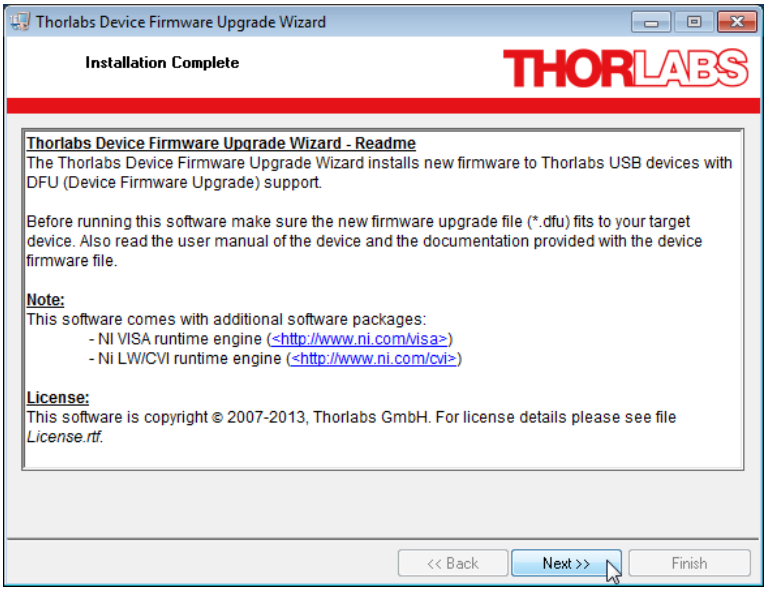


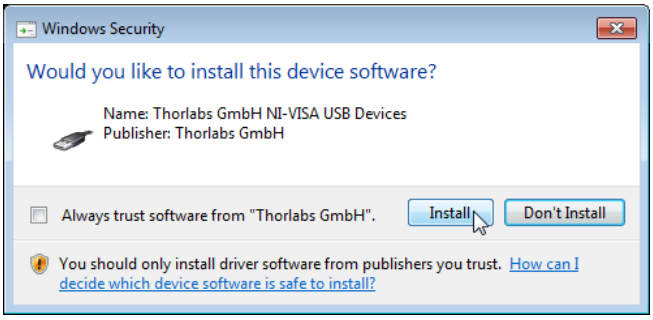
Click '**I accept...**' if you do so, then '**Next >>**' to continue.



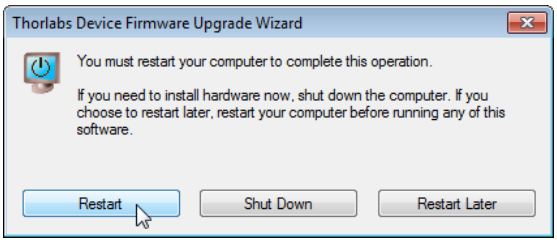
Click '**I accept...**' if you do so, then '**Next >>**' to continue. Please do so in the subsequent dialogs.



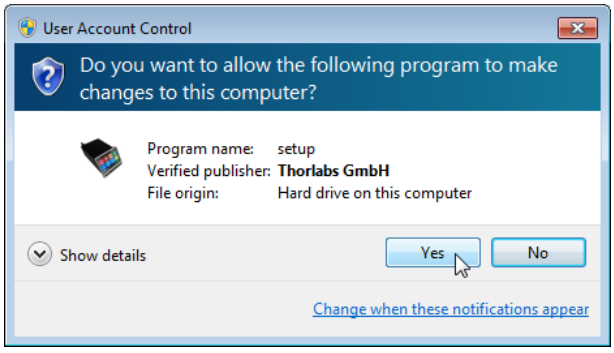




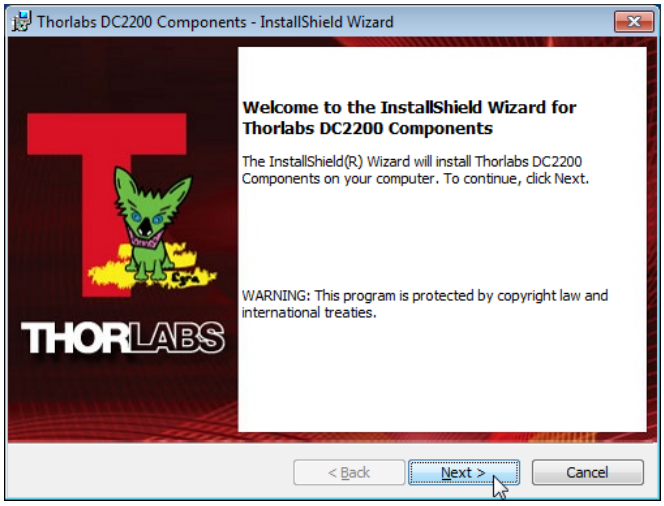
Confirm ("**Yes**") to continue.



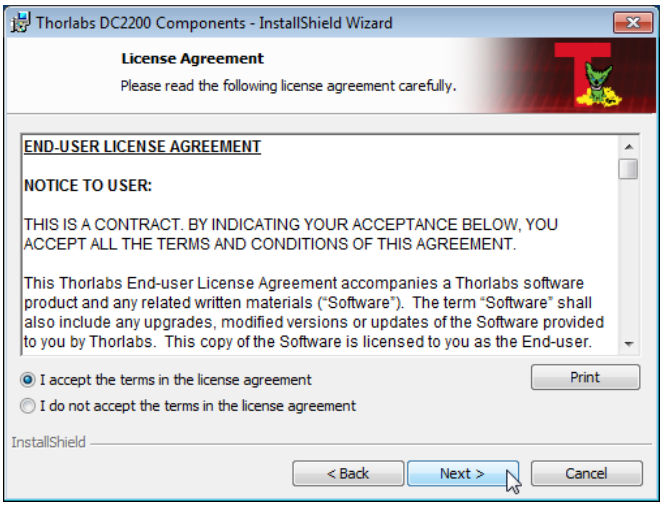
Click '**Restart**'. After the restart, the computer continues the Thorlabs GmbH software installation. If the installer does not continue automatically, please call the setup.exe 22 again.

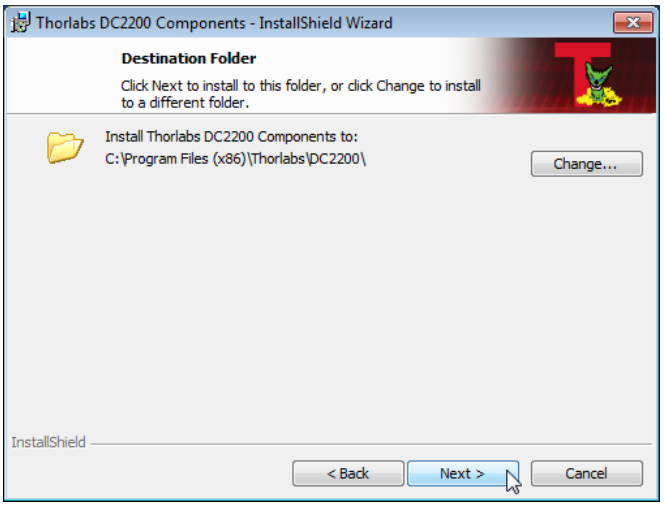


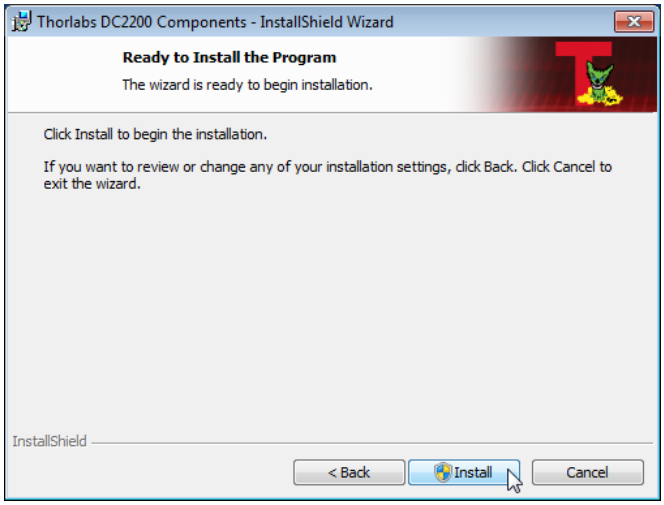
Confirm ("**Yes**") to continue.

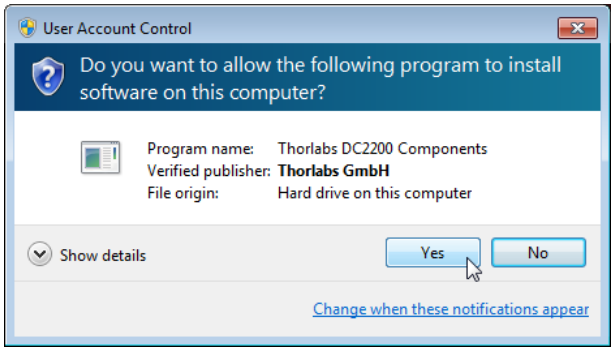


Click "**Next >**" and then "**Install**" to continue:

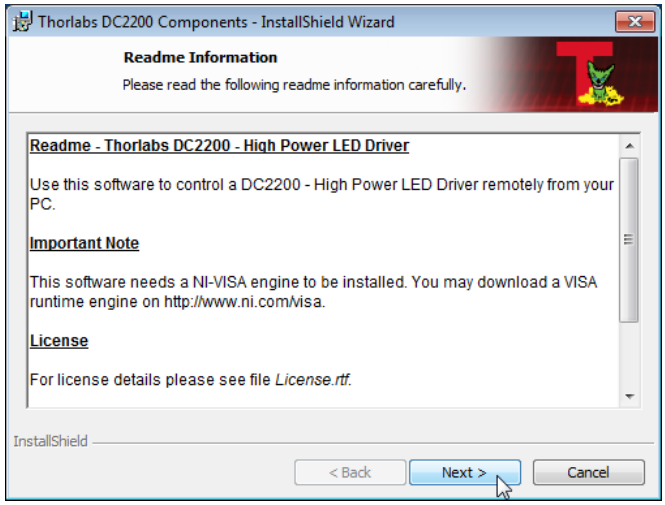




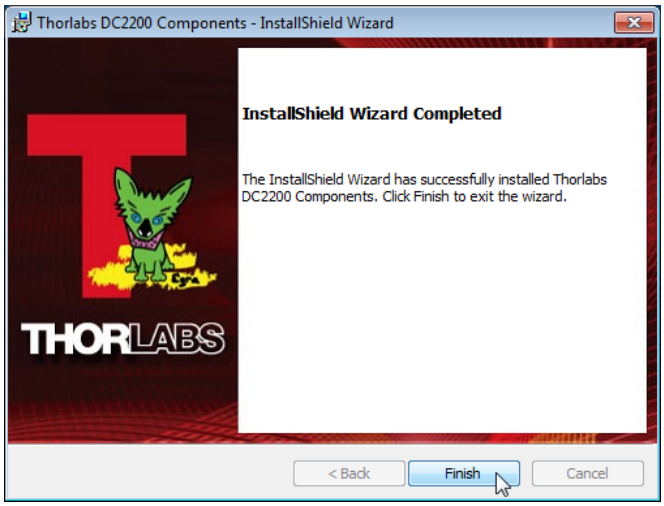




Confirm ("**Yes**") to continue:



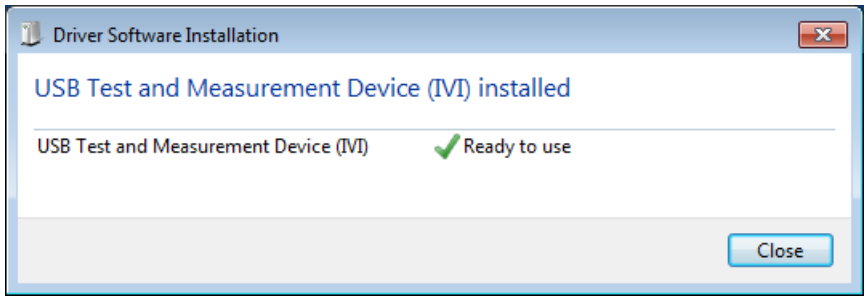
Click "**Next >**".



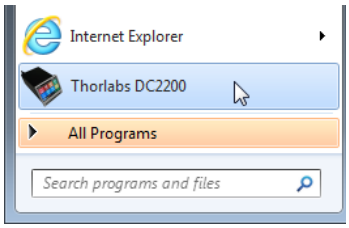
Click "Finish". Now the DC2200 software is installed to your computer.

3.4.2 Remote Operation GUI

Connect your DC2200 to the computer using the supplied USB 2.0 cable. The PC recognizes the DC2200 and automatically installs the required driver software:

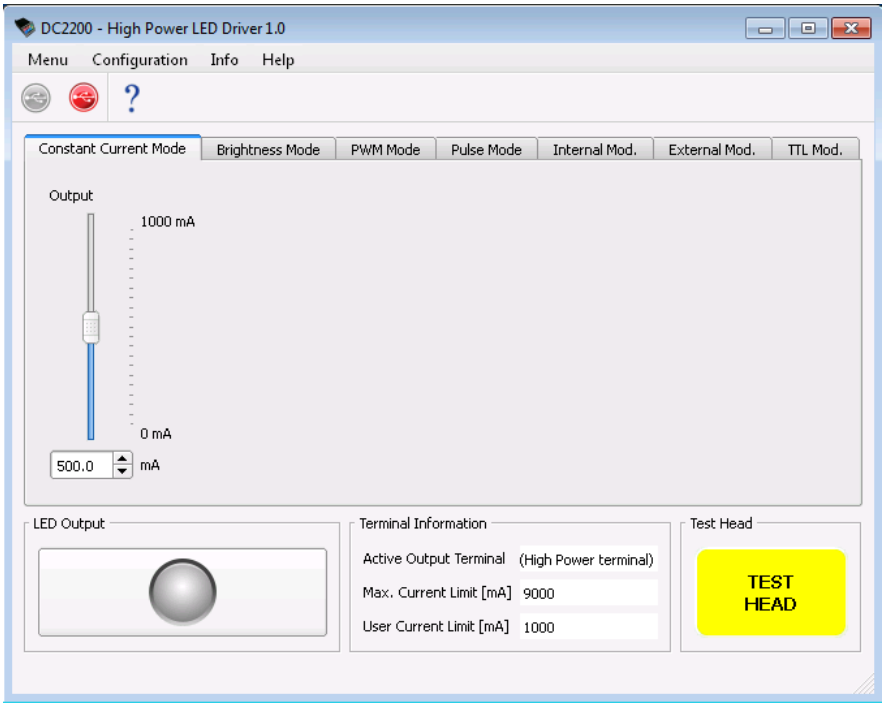


Now you can start the remote application it either from the desktop icon or from the start menu:

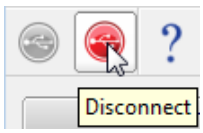


The GUI (Graphic User Interface) comes up and the software connects automatically to the detected DC2200.

Note If you forgot to connect the DC2200 first, the GUI waits for the DC2200 to be connected, and then establishes communication automatically.



DC2200 GUI. Click a menu topic or tab for more detailed information.

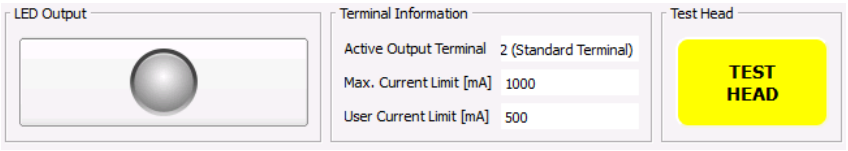


If you want disconnect your DC2200 temporarily, click the red **Disconnect** button from the toolbar or select the appropriate **Menu** item.

In order to reconnect the DC2200, click the green **Connect** button.

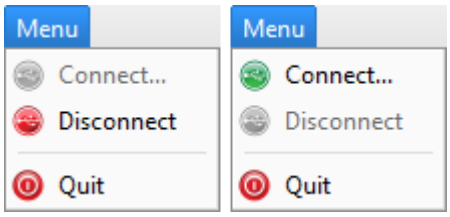
The "?" icon opens the online help to the Remote Operation software.

Status Bar



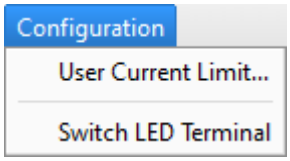
The **LED Output** button, used to switch the LED on and off, is located on the bottom of the GUI. To the right, the **Terminal Information** box displays the active terminal, the maximum current of the recognized LED and the user current limit set value. The button **Test Head** in the lower right corner proceeds a test of the LED that is connected to the active terminal, and displays the results in the **Active Terminal Information** 33 dialog.

Menu

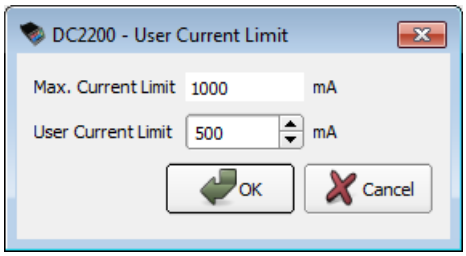


The **Menu** has only 3 entries - Disconnect or Connect (whichever is active) and Quit.

Configuration



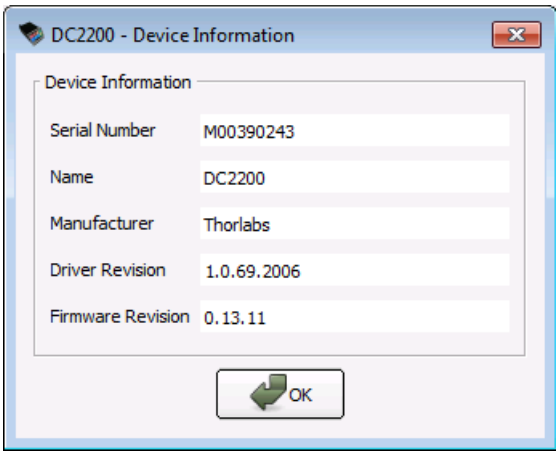
The **Configuration** menu allows the User Current Limit to be changed and the active output terminal to be switched between LED1 and LED2.

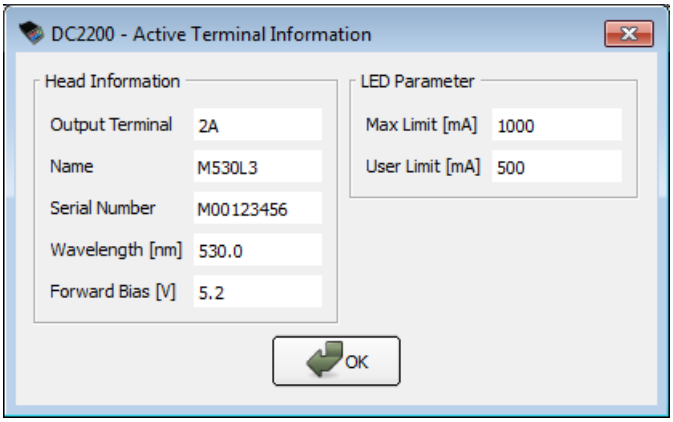


Here you can set a user current limit in the range between 1 and the displayed **Max. Current Limit** value that is read out from the memory of the connected LED (Not available for a custom LED!)

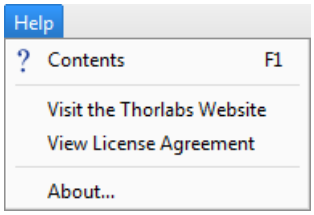
Info

The **Info** menu provides information about the DC2200 and the LED connected to the active terminal.



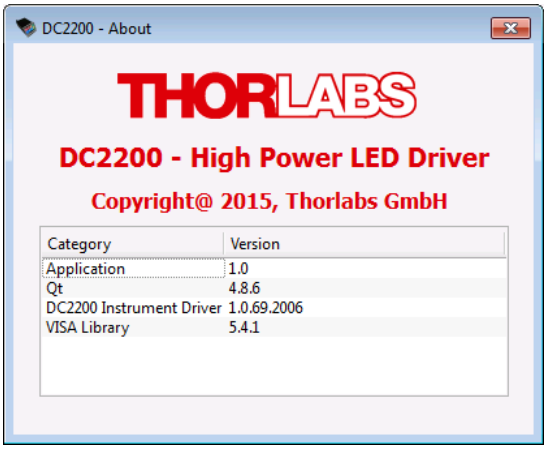


Help



From the **Help** menu you can

- access the online help of the Remote Operation application,
- open the DC2200 product page on Thorlabs' web site,
- view the software agreement and
- get the version information about the Remote software and the device driver (**About** topic):

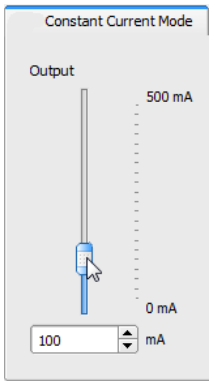


Adjusting Values in the Remote Operation Software

All values can be adjusted by

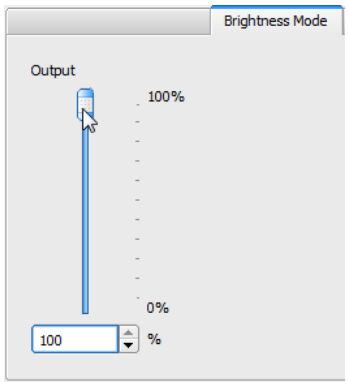
- dragging the slider using the mouse
- scrolling the mouse wheel while the mouse cursor is located in the slider area
- clicking the  arrows next to the numeric input box
- entering the desired value numerically into the box.

Constant Current Mode



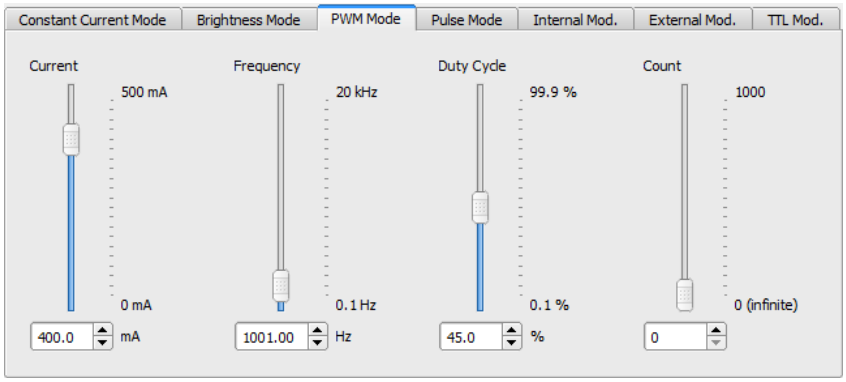
The LED current can be adjusted between 0 and the LED Max. Current Limit or the User Current Limit, whichever is lower.

Brightness Mode



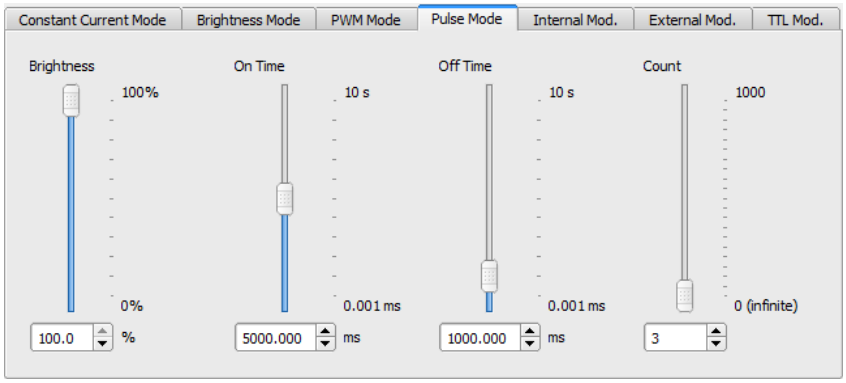
The LED brightness can be adjusted between 0 and 100%, whereas 100% refer to the LED Max. Current Limit or the User Current Limit, whichever is lower.

PWM Mode



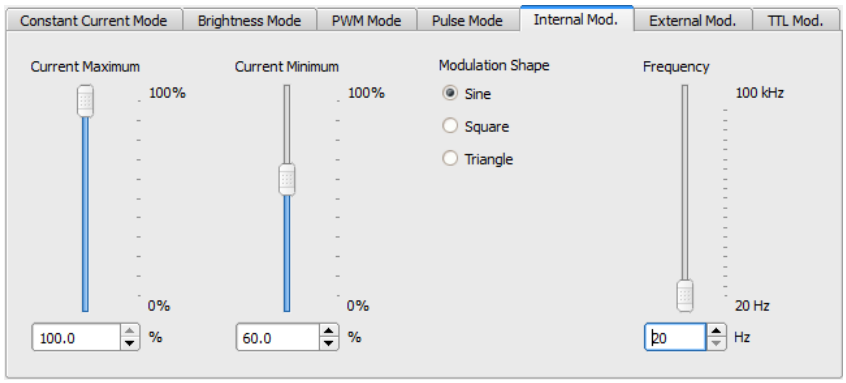
Here, the LED current, the pulse frequency, the duty cycle and the pulse count can be set. For details about the parameters, please see section PWM Mode 16.

Pulse Modulation Mode



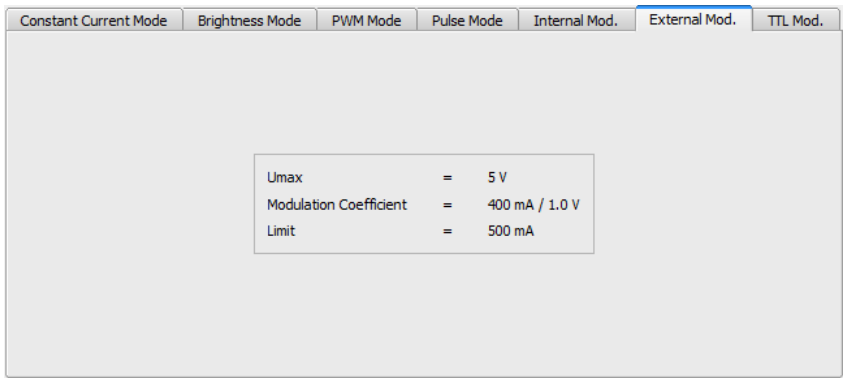
Here, the LED brightness, the LED ON- and OFF-Time and the pulse count can be set. For details about the parameters, please see section Pulse Mode 17.

Internal Modulation Mode



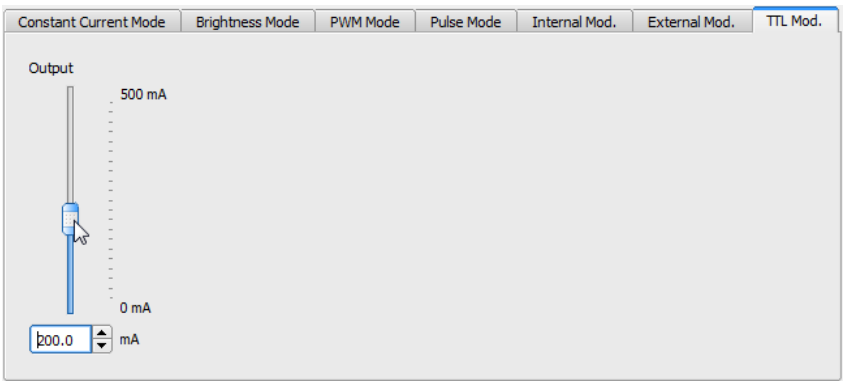
Here, the LED maximum and minimum current, the modulation waveform and frequency can be set. For details about the parameters, please see section Internal Modulation Mode 18.

External Mode



In External Modulation Mode, only the DC2200 set parameters are displayed, similar to the display shown in External Modulation Mode 19.

TTL Mode



The only parameter that can be adjusted in TTL Mode is the LED current when TTL = H. The LED current can be adjusted between 0 and the LED Max. Current Limit or the User Current Limit, whichever is lower. Please see TTL Modulation Mode 19 for more details.

4 Write Your Own Application

In order to write your own application, you need a specific instrument driver and some tools for use in different programming environments. The driver and tools are included in the installer package that can be downloaded from the website.

In this section the location of drivers and files, required for programming in different environments, are given for installation under Windows 7 (32 and 64 bit).

Note

DC2200 software and drivers contains 32 bit and 64 bit applications.

In 32 bit systems, only the 32 bit components are installed to

```
C:\Program Files\...
```

In 64 bit systems the 64 bit components are being installed to

```
C:\Program Files\...
```

while 32 bit components can be found at

```
C:\Program Files (x86)\...
```

In the table below you will find a summary of what files you need for particular programming environments.

Programming environment	Necessary files
C, C++, CVI	*.fp (function panel file; CVI IDE only) *.h (header file) *.lib (static library) *.dll (dynamic linked library)
C#	.net wrapper dll
Visual Studio	*.h (header file) *.lib (static library) or .net wrapper dll
LabVIEW™	*.fp (function panel) and NI-VISA™ instrument driver Beside that, LabVIEW™ driver vi's are provided with the *.llb container file

Note

All above environments require also the NI-VISA™ instrument driver .dll !

During NI-VISA™ Runtime installation, a system environment variable `VXIPNPPATH` for including files is created. It contains the information where the drivers are installed to, usually to `C:\Program Files\IVI Foundation\VISA\WinNT\`.

This is the reason, why after installation of a NI-VISA™ Runtime a system reboot is required: This environment variable is necessary for installation of the instrument driver software components.

In the next sections the location of above files is described in detail.

4.1 32 bit Systems

NI-VISA™ instrument driver

```
C:\Program Files\IVI Foundation\VISA\WinNT\Bin\TLDC2200_32.dll
```

Online help for NI-VISA™ instrument driver

```
C:\Program Files\IVI Foundation\VISA\WinNT\TLDC2200\Manual...
...\TLDC2200.html
```

NI LabVIEW™ driver

The LabVIEW™ Driver is a 32 bit driver and compatible with 32 bit NI LabVIEW™ versions 8.5 and higher only.

```
C:\Program Files\National Instruments\LabVIEW <version>\instr.lib...
...\TLDC2200\TLDC2200.llb
```

(LabVIEW™ container file with driver vi's. "LabVIEW™ <version>" stands for actual LabVIEW™ installation folder.)

Header file

```
C:\Program Files\IVI Foundation\VISA\WinNT\include\TLDC2200.h
C:\Program Files\IVI Foundation\VISA\WinNT\include...
...\TLDC2200_defines.h
```

Static library

```
C:\Program Files\IVI Foundation\VISA\WinNT\lib\msc\TLDC2200_32.lib
```

Function panel

```
C:\Program Files\IVI Foundation\VISA\WinNT\TLDC2200\TLDC2200.fp
```

.net wrapper dll

```
C:\Program Files\IVI Foundation\VISA\VisaCom...
...\Primary Interop Assemblies\Thorlabs.TLDC2200_32.Interop.dll
```

Example LabWindows CVI

```
C:\Program Files\IVI Foundation\VISA\WinNT\TLDC2200\Examples...
...\CSample\TLDC2200Sample.prj
```

Basic C Sample to get one measurement

Example Visual Studio .Net 2010

```
C:\Program Files\IVI Foundation\VISA\WinNT\TLDC2200\Examples...
...\DotNet\Thorlabs DC2200 DotNet Sample.csproj
```

C Sharp sample to get one measurement

4.2 64 bit Systems

Note

According to the VPP6 (Rev 6.1) Standard the installation of the 64 bit VXIpnp driver includes the WINNT, WIN64, GWINNT and GWIN64 frameworks. That means, that the 64 bit driver includes the 32 bit driver as well.

On a 64 bit operating system, 64 bit drivers and applications are installed to

"C:\Program Files"

while the 32 bit files - to

"C:\Program Files (x86)"

Below are listed both installation locations, so far applicable.

NI-VISA™ instrument driver

C:\Program Files (x86)\IVI Foundation\VISA\WinNT\Bin\TLDC2200_32.dll
C:\Program Files\IVI Foundation\VISA\Win64\Bin\TLDC2200_64.dll

Online help for NI-VISA™ instrument driver

C:\Program Files (x86)\IVI Foundation\VISA\WinNT\TLDC2200\Manual...
...\TLDC2200.html

NI LabVIEW™ Driver

The LabVIEW™ Driver supports both 32 bit and 64 bit NI LabVIEW™ 2009 and higher.

C:\Program Files\National Instruments\LabVIEW <version>\instr.lib...
...\TLDC2200\TLDC2200.llb

(LabVIEW™ container file with driver vi's. "LabVIEW™ <version>" stands for actual LabVIEW™ installation folder.)

Header file

C:\Program Files (x86)\IVI Foundation\VISA\WinNT\include\TLDC2200.h
C:\Program Files (x86)\IVI Foundation\VISA\WinNT\include...
...\TLDC2200_defines.h
C:\Program Files\IVI Foundation\VISA\Win64\Include\TLDC2200.h
C:\Program Files\IVI Foundation\VISA\Win64\Include...
...\TLDC2200_defines.h

Static library

C:\Program Files (x86)\IVI Foundation\VISA\WinNT\lib\msc...
...\TLDC2200_32.lib
C:\Program Files\IVI Foundation\VISA\Win64\Lib_x64\msc...
...\TLDC2200_64.lib

Function panel

C:\Program Files (x86)\IVI Foundation\VISA\WinNT\TLDC2200...
...\TLDC2200.fp

.net wrapper dll

```
C:\Program Files (x86)\IVI Foundation\VISA\VisaCom...
...\Primary Interop Assemblies\Thorlabs.TLDC2200_32.Interop.dll
C:\Program Files\IVI Foundation\VISA\VisaCom64\Primary Interop Assem-
blies\Thorlabs.TLDC2200_64.Interop.dll
```

Example LabWindows CVI

```
C:\Program Files (x86)\IVI Foundation\VISA\WinNT\TLDC2200...
...\Examples\CSample\TLDC2200Sample.prj
```

Basic C Sample to get one measurement

Example Visual Studio .Net 2010

```
C:\Program Files (x86)\IVI Foundation\VISA\WinNT\TLDC2200...
...\Example\DotNet\Thorlabs DC2200 DotNet Sample.csproj
```

C Sharp sample to get one measurement

4.3 Command Reference

4.3.1 IEEE488.2 Common Commands

Common commands are device commands that are common to all devices according to the IEEE488.2 standard. These commands are designed and defined by this standard. Most of the commands are described in detail in this section. The following common commands associated with the status structure are covered in the “Status Structure” section: *CLS, *ESE, *ESE?, *ESR?, *SRE, *SRE?, *STB?

Command summary

Mnemonic	Name	Description
***CLS**	Clear status	Clears all event registers and Error Queue
***ESE <NRf>**	Event enable command	Sets the Standard Event Enable Register
***ESE?**	Event enable query	Returns the Standard Event Enable Register
***ESR?**	Event status register query	Returns and clears the Standard Event Register
***IDN?**	Identification query	Returns the unit’s identification string
***OPC**	Operation complete command	Sets the Operation Complete bit in the Standard Event Register
***OPC?**	Operation complete query	Places a “1” into the output queue when all device operations have been completed
***RST**	Reset command	Returns the unit to the *RST default condition
***SRE <NRf>**	Service request enable command	Sets the Service Request Enable Register
***SRE?**	Service request enable query	Returns the Service Request Enable Register
***STB?**	Status byte query	Returns the Status Byte Register
***TST?**	Self-test query	Performs the unit’s self-test and returns the result.
***WAI**	Wait-to-continue command	Waits until all previous commands are executed

Command reference

1. *IDN? – identification query - read identification code

The identification code includes the manufacturer, model code, serial number, and firmware revision levels and is sent in the following format: `Thorlabs GmbH,MMM,SSS,X.X.X,` where

`MMM`	is the model code
`SSS`	is the serial number
`X.X.X`	is the instrument firmware revision level

Example: `THORLABS,DC2200,M00123456,1.0.1`

2. *OPC – operation complete - set OPC bit

3. *OPC? – operation complete query – places a “1” in output queue

When `*OPC` is sent, the OPC bit in the Standard Event Register will set after all pending command operations are complete. When `*OPC?` is sent, an ASCII “1” is placed in the Output Queue after all pending command operations are complete.

Typically, either one of these commands is sent after the `INITiate` command. The `INITiate` command is used to take the instrument out of idle in order to perform measurements. While operating within the trigger model layers, many sent commands will not execute. After all programmed operations are completed, the instrument returns to the idle state at which time all pending commands (including `*OPC` and/or `*OPC?`) are executed. After the last pending command is executed, the OPC bit and/or an ASCII “1” is placed in the Output Queue.

4. *RST – reset – return instrument to defaults

When the `*RST` command is sent, the instrument performs the following operations:

- Returns the instrument to default conditions.
- Cancels all pending commands.
- Cancels response to any previously received `*OPC` and `*OPC?` commands.

5. *TST? – self-test query – run self test and read result

Use this query command to perform the instrument self-test routine. The command places the coded result in the Output Queue. A returned value of zero (0) indicates that the test passed, other values indicate that the test failed and an error code is placed into the error queue.

6. *WAI – wait-to-continue – wait until previous commands are completed

The *WAI command is a no operation command for the instrument and thus, does not need to be used. It is there for conformance to IEEE488.2.

4.3.2 SCPI Command Reference

SYSTem subsystem commands

Command	Description	SCPI
SYSTem	Path to SYSTem subsystem	Vol.2 §21
:BEEPer		Vol.2 §21.2
[:IMMediate]	Issues an audible signal	Vol.2 §21.2.2
:STATe {ON|1|OFF|0}	Activates/deactivates the beeper	Vol.2 §21.2.3
:STATe?	Returns the state of the beeper	Vol.2 §21.2.3
:VOLume <value>	Sets the beeper volume in a range from 0.0 to 1.0	Vol.2 §21.2.5
:VOLume?	Returns the beeper volume	Vol.2 §21.2.5
:ERRor		Vol.2 §21.8
[:NEXT]?	Returns the latest error code and message	Vol.2 §21.8.8
:VERSion?	Returns level of SCPI standard (1999.0)	Vol.2 §21.21
:TERMinal{[1]|2}	Information about the LED heads connected to the LED terminals LED1 or LED2	
[:HTYPe]?	LED head type identification query. The query response is in the format "<vendor_name_string>,<led_head_model_name_string>,<led_head_serial_no_string>,<fw_version_major_num>,<fw_version_minor_num>,<fw_version_submin or_num>". The firmware version indicates the head's onboard memory mapping version. A major version number -1 indicates a custom head without onboard head info memory. A major version number – 2 indicates that there is no head connected on the terminal Sample of a LED with onboard head info memory: Thorlabs,M365F1,M00123456,1.0.0 Sample of a LED without onboard head info memory: Thorlabs,custom,n/a,-1.0.0 Sample of no LED head connected: Thorlabs,no head,no head,-2.0.0	
:HEAD		
:TEMPerature		
[:COUNt]?	Get the number of temperature sensor available in the LED head currently connected to the specified terminal.	
:LABel? [{0|<sensidx>}]	Query LED head temperature sensor label. This is a query with parameter. The optional numeric parameter is the index of the LED head temperature sensor to query. Parameter value range is 0 <= sensidx < senscnt with default parameter value is 0.	
:VOLTage?	Query maximum LED forward voltage specified by the head's onboard info memory	
:CURRent?	Query maximum LED forward current specified by the head's onboard info memory	
:SPECtrum?	Query the spectrum information of the LED head. Positive values describe the nominal LED center wavelength in nm. Negative values describe the color temperature in K. The value 0.0 describes "information not available"	

DISPlay subsystem commands

Command	Description	SCPI
DISPlay	Path to DISPlay subsystem.	Vol.2 §8
:BRIGhtness <value>	Sets the display brightness in a range from 0.0 to 1.0	Vol.2 §8.2
:BRIGhtness?	Returns the display brightness value	Vol.2 §8.2
:CALibration[:TOUCh][:INITiate]	Initiates Touchscreen calibration	
:FADeout		
[:STATe] {ON|1|OFF|0}	Activates/deactivates automatic dimming	
[:STATe]?	Returns the state of automatic dimming	

STATus subsystem commands

Command	Description	SCPI
STATus	Path to STATus subsystem.	Vol.2 §20
:MEASurement	Path to control measurement event registers	
[:EVENt]?	Returns the event register	
:CONDition?	Returns the condition register	
:PTRansition <value>	Sets the positive transition filter	
:PTRansition?	Returns the positive transition filter	
:NTRansition <value>	Sets the negative transition filter	
:NTRansition?	Returns the negative transition filter	
:ENABle <value>	Sets the enable register	
:ENABle?	Returns the enable register	
:OPERation	Path to control operation event registers	Vol.2 §20.1
[:EVENt]?	Returns the event register	Vol.2 §20.1.4
:CONDition?	Returns the condition register	Vol.2 §20.1.2
:PTRansition <value>	Sets the positive transition filter	Vol.2 §20.1.7
:PTRansition?	Returns the positive transition filter	Vol.2 §20.1.7
:NTRansition <value>	Sets the negative transition filter	Vol.2 §20.1.6
:NTRansition?	Returns the negative transition filter	Vol.2 §20.1.6
:ENABle <value>	Sets the enable register	Vol.2 §20.1.3
:ENABle?	Returns the enable register	Vol.2 §20.1.3
:QUEStionable	Path to control questionable event registers	Vol.2 §20.3
[:EVENt]?	Returns the event register	Vol.2 §20.3.4
:CONDition?	Returns the condition register	Vol.2 §20.3.2
:PTRansition <value>	Sets the positive transition filter	Vol.2 §20.3.7
:PTRansition?	Returns the positive transition filter	Vol.2 §20.3.7
:NTRansition <value>	Sets the negative transition filter	Vol.2 §20.3.6
:NTRansition?	Returns the negative transition filter	Vol.2 §20.3.6
:ENABle <value>	Sets the enable register	Vol.2 §20.3.3
:ENABle?	Returns the enable register	Vol.2 §20.3.3
:AUXiliary	Path to control auxiliary event registers	
[:EVENt]?	Returns the event register	
:CONDition?	Returns the condition register	
:PTRansition <value>	Sets the positive transition filter	
:PTRansition?	Returns the positive transition filter	
:NTRansition <value>	Sets the negative transition filter	
:NTRansition?	Returns the negative transition filter	
:ENABle <value>	Sets the enable register	
:ENABle?	Returns the enable register	
:PRESet	Return status registers to default states.	Vol.2 §20.2

OUTPut subsystem commands

Command	Description	SCPI
OUTPut[1]	Path to OUTPut subsystem	Vol.2 §15
[:STATe] {ON|1|OFF|0}	Enables (ON) or disables (OFF) LED output	Vol.2 §15.12
[:STATe]?	Returns output state	Vol.2 §15.12
:TERMinal {1|2}	Select output terminal: 1 = 10A/12Pin connector (LED1); 2 = 2A/4Pin connector (LED2);	
:TERMinal?	Returns selected output terminal	
:TERMinal:ABORt	Abort any running LED head presence test	
:TERMinal{[1]|2}		
:TEST	Testing presence and properties of LEDs	
[:INITiate]	Initiate presence test procedure on the specified terminal	
:STATus?	Query status of the presence test procedure as an <NF1> value: 0 = The presence test procedure is running 1 = The latest presence test detected no LED 2 = The latest presence test detected a custom LED without onboard head info memory 3 = The latest presence test detected a LED head with onboard head info memory	
:PROTection		
:INTLock[:TRIPped]?	Returns interlock circuit protection tripped (1) or untripped (0)	
:TEMPerature		
[:DRIVer][:TRIPped]?	Returns driver (console) over temperature protection tripped tripped (1) or untripped (0)	
:HEAD[:TRIPped]?	Returns head over temperature protection tripped tripped (1) or untripped (0)	

SENSe3 LED current sensing subsystem commands

Command	Description	SCPI
SENSe3	Path to LED current sensing	
[:CURRent][:DC]		
[:DATA]? [{MIN|MAX}]	Returns the measured LED current. Parameters MIN and MAX return the measurement value range possible in the currently active driver configuration (depends on the compliance voltage required by the LED head)	

SENSe4 LED voltage sensing subsystem commands

Command	Description	SCPI
SENSe4	Path to LED voltage sensing	
[:VOLTage][:DC]		
[:DATA]? [{MIN|MAX}]	Returns the measured LED voltage. Parameters MIN and MAX return the measurement value range possible.	

SENSe5 LED temperature sensing subsystem commands

Command	Description	SCPI
SENSe5	Path to LED temperature sensing	
[:TEMPerature]? [{MIN|MAX}]	Returns the measured LED temperature. Parameters MIN and MAX return the measurement value range possible.	

SOURce1 LED source subsystem commands

Command	Description	SCPI
SOURce[1]		Vol.2 §19
:MODe {CC*|1|CB|2|PWM|3|PULS|4| IMOD|5|EMOD|6|TTL|7}	Set the LED operating mode: 1 = CC = Constant Current 2 = CB = Constant Brightness 3 = PWM = Pulse Width Modulation 4 = PULS = Pulse Modulation 5 = IMOD = Internal Modulation 6 = EMOD = External Modulation 7 = TTL = TTL Input Controlled	
:MODe?	Query the LED operation mode	
[:CURRent]		Vol.2 §19.5
:LIMit		Vol.2 §19.5.5
[:AMPLitude] {MIN|MAX|<amps>}	Sets the limit current value	Vol.2 §19.5.5.1
[:AMPLitude]? [{MIN|MAX}]	Query the limit current value	Vol.2 §19.5.5.1
:TRIPped?	Returns limit detection tripped (1) or un-tripped (0)	
[:AMPLitude] {MIN|MAX|<amps>}	Set the constant current mode forward current value	
[:AMPLitude]? [{MIN|MAX}]	Query the constant current mode forward current value	
:CCURent	LED operating mode “Constant Current” specific settings. These settings only have an effect while in “Constant Current” mode	
[:CURRent][:LEVel]		
[:AMPLitude] {MIN|MAX|<amps>}	Set the constant current mode forward current value	
[:AMPLitude]? [{MIN|MAX}]	Query the constant current mode forward current value	
:CBRightness	LED operating mode “Constant Brightness” specific settings. These settings only have an effect while in “Constant Brightness” mode	
[:BRIGhtness][:LEVel]		
[:AMPLitude] {MIN|MAX|<perc>}	Sets LED brightness set value in percent of currently set limit current	
[:AMPLitude]? [{MIN|MAX}]	Query LED brightness set value in percent of currently set limit current	
:PWM	LED operating mode “Pulse Width Modulation” specific settings. These settings only have an effect while in PWM mode	
[:CURRent][:LEVel]		
[:AMPLitude] {MIN|MAX|<amps>}	Set the PWM mode forward current value	
[:AMPLitude]? [{MIN|MAX}]	Query the PWM mode forward current value	
:FREQency		
[:CW|:FIXed] {MIN|MAX|<hertz>}	Set PWM mode modulation frequency	
[:CW|:FIXed]? [{MIN|MAX}]	Query PWM mode modulation frequency	
:DCYCle {MIN|MAX|<perc>}	Set the duty cycle in percent	
:DCYCle? [{MIN|MAX}]	Query the duty cycle in percent	
:COUNt {MIN|MAX|<numeric_value>}	Set the number of pulses. 0 = infinite pulses	
:COUNt? [{MIN|MAX}]	Query the number of pulses	
:PULSe	LED operating mode “Pulse Modulation” specific settings. These settings only have an effect while in Pulse mode	
[:BRIGhtness][:LEVel]		
[:AMPLitude] {MIN|MAX|<perc>}	Sets LED brightness set value in percent of currently set limit current	
[:AMPLitude]? [{MIN|MAX}]	Query LED brightness set value in percent of currently set limit current	

Command	Description	SCPI
:ONTime {MIN|MAX|<seconds>}	Set pulse on time in seconds	
:ONTime? [{MIN|MAX}]	Query pulse on time in seconds	
:OFFTime {MIN|MAX|<seconds>}	Set pulse off time in seconds	
:OFFTime? [{MIN|MAX}]	Query pulse off time in seconds	
:COUNt {MIN|MAX|<numeric_value>}	Set the number of pulses. 0 = infinite pulses	
:COUNt? [{MIN|MAX}]	Query the number of pulses	
:IMODulation	LED operating mode “Internal Modulation” specific settings. These settings only have an effect while in internal modulation mode	
[:BRIGhtness]		
:HIGH {MIN|MAX|<num>}	Set the maximum brightness in % of limit current	
:HIGH? [{MIN|MAX}]	Query the maximum brightness in % of limit current	
:LOW {MIN|MAX|<num>}	Set the minimum brightness in % of limit current	
:LOW? [{MIN|MAX}]	Query the minimum brightness in % of limit current	
:FREQency		
[:CW|:FIXed] {MIN|MAX|<hertz>}	Set internal modulation mode modulation frequency	
[:CW|:FIXed]? [{MIN|MAX}]	Query internal modulation mode modulation frequency	
:FUNCtion		
[:SHAPe] {SINusoid*|1|SQUare|2|TRIangle|3}	Set modulation shape function	
[:SHAPe]?	Query modulation shape function 1 = SIN = sinusoid 2 = SQU = square 3 = TRI = triangular	
:TTL	LED operating mode “TTL” specific settings. These settings only have an effect while in TTL mode	
[:CURRent][:LEVel]		
[:AMPLitude] {MIN|MAX|<amps>}	Set the TTL mode forward current value	
[:AMPLitude]? [{MIN|MAX}]	Query the TTL mode forward current value	

UNIT subsystem commands

Command	Description	SCPI
UNIT		Vol.2 §25
:TEMPerature {C|CEL|CELSius|F|FAR|FAHReinheit|K|KELVin}	Sets the temperature unit	Vol.2 §25.3
:TEMPerature?	Returns the temperature unit	Vol.2 §25.3

CALibration subsystem commands

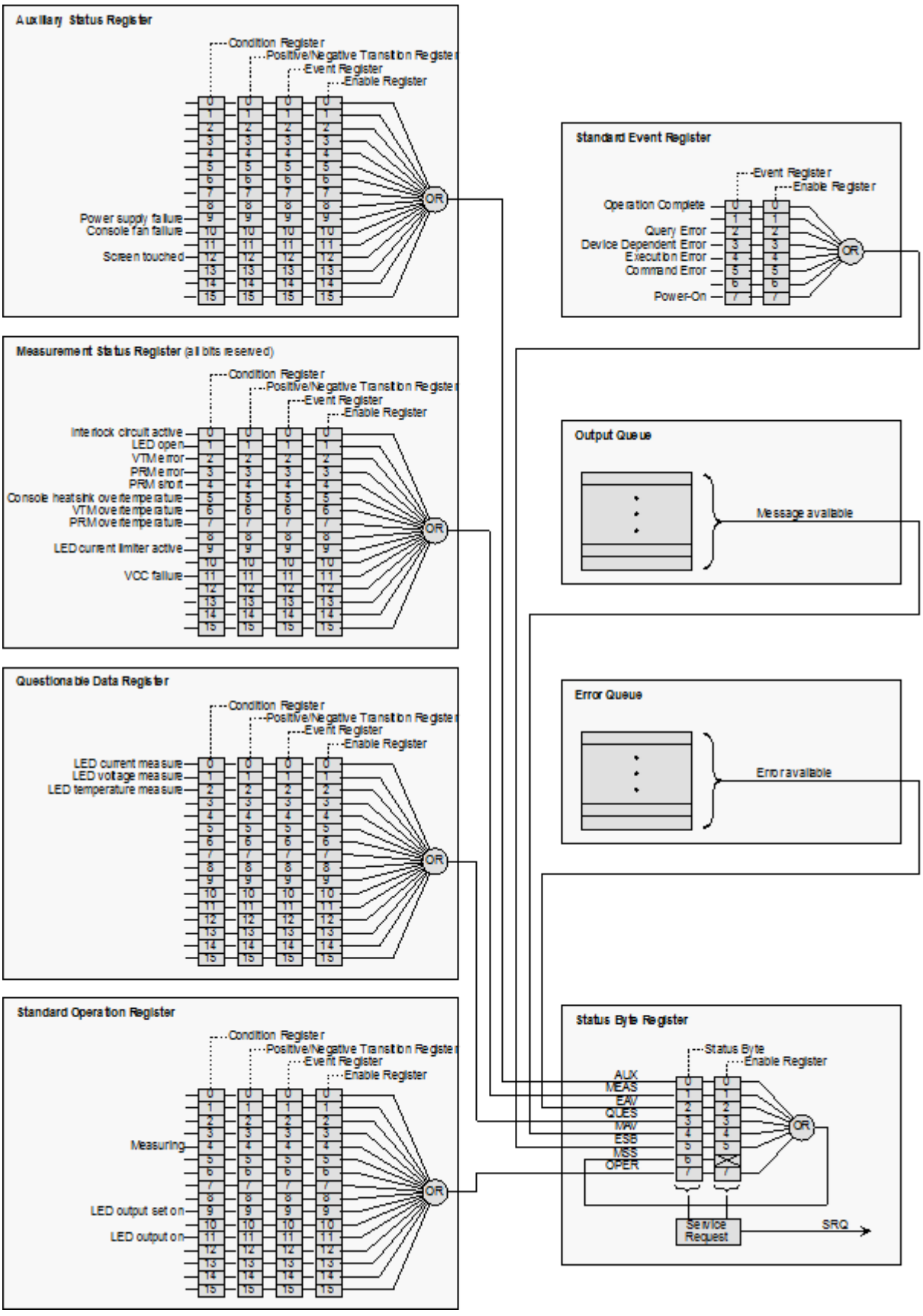
Command	Description	SCPI
CALibration		
:STRing?	Returns the console’s calibration string that was written to the console at the latest calibration procedure (usually the calibration date). Example: “15-Jul-2015”	

Measurement commands

Command	Description	SCPI
ABORt	Aborts current measurement	Vol.2 §24.5
CONFigure[:SCALar]		Vol.2 §3.1
:CURRent[1][:DC]	Configures instrument LED current measurement	
:VOLTage[1][:DC]	Configures instrument LED voltage measurement	
:TEMPerature[1]	Configures instrument for LED head temperature measurement	
CONFigure?	Query configuration	Vol.2 §3.1
INITiate[:IMMediate]	Starts measurement	Vol.2 §24.7.2
FETCh?	Returns last measurement data	Vol.2 §3.2
FETCh		Vol.2 §3.2
:CURRent[1][:DC]?	Get last LED current measurement	
:VOLTage[1][:DC]?	Get last LED voltage measurement	
:TEMPerature[1]?	Get last LED head temperature measurement	
READ?	Starts new measurement (as configured) and read data	Vol.2 §3.3
MEASure[:SCALar]		Vol.2 §3.4
:CURRent[1][:DC]?	Perform LED current measurement	
:VOLTage[1][:DC]?	Perform LED voltage measurement	
:TEMPerature[1]?	Perform LED head temperature measurement	

4.3.3 Status Reporting

The figure below gives an overview of the device's status reporting structure. See also section STATus subsystem commands 44 for a detailed description of the related commands and their syntax.



Status Byte Register

The Status Byte Register gives a summary of all underlying status structures. See also IEEE488.2-1992-§11.2.

Bit #	Mnemonic	Description
7	**OPER**	Standard Operation Status Structure Summary Bit
6	**RQS/MSS**	Request Service / Master Summary Status
5	**ESB**	Standard Event Status Bit
4	**MAV**	Message Available. There is response data available for readout
3	**QUES**	Questionable Status Structure Summary Bit
2	**EAV**	Error Available. There is at least one error in the error queue.
1	**MEAS**	Measurement Status Structure Summary Bit
0	**AUX**	Auxiliary Status Structure Summary Bit

Standard Event Status Structure

The Standard Event Status Structure is described in IEEE488.2-1992-§11.5.

Standard Operation Register

The Standard Operation Status Structure is described in SCPI1999.0-Vol1-§9.3. In addition bit 8..12 are used as output state/on indicators.

Bit #	Mnemonic	Description
15..13		See SCPI1999.0-Vol1-§9.3
12		reserved, read as 0
11	**LEDON**	LED output is currently ON
10		reserved, read as 0
9	**LEDST**	LED output state is ON
8		reserved, read as 0
7..0		See SCPI1999.0-Vol1-§9.3

Questionable Data Register

The Questionable Data Status Structure is described in SCPI1999.0 Vol1 §9.4.

Bit #	Mnemonic	Description
15..13		See SCPI1999.0-Vol1-§9.4 – flags are not implemented
12..3		reserved, read as 0
2	**LEDT**	LED temperature measure
1	**LEDV**	LED voltage measure
0	**LEDC**	LED current measure

Measurement Status Register

The Measurement Status Register Status Byte Register reports device operation and measurement states.

Bit #	Description
15	reserved, read as 0
14	Over temperature (Instrument is too hot)
13	Socket connection failure (Socket missing or unknown socket detected)
12	reserved, read as 0
11	TEC output compliance voltage reached
10	Temperature sensor failure.
9	Temperature window failure.
8	Temperature protection is active.
7	TEC current limit reached
6	reserved, read as 0
5	reserved, read as 0
4	reserved, read as 0
3	LD current limit reached
2	LD interlock is active
1	LD output compliance voltage reached
0	Keylock protection is active

Auxiliary Status Register

The Auxiliary Status Register Status Byte Register reports auxiliary device states.

Bit #	Description
15..13	reserved, read as 0
12	Screen touched
11	reserved, read as 0
10	Console fan failure
9	Power supply failure
8..0	reserved, read as 0

4.3.4 Error Reporting

The device stores errors in a queue containing up to 10 entries. The error queue may be read out by the `'SYSTem:ERRor[:NEXT]?'` command. The following table lists all error numbers and the according descriptive messages. Note: negative numbers are defined by SCPI while positive error numbers are device dependent.

Error	Description
0	No error
1	The error couldn't be specified more precisely
2	Floating point domain error
3	Device temperature too high
4	General GUI error
5	Authentication required for operation
6	Authentication process failed
7	Operation is not allowed in service mode
8	Operation is allowed in service mode only
9	A measurement is currently in process
14	LED head is missing or it is of unknown type
15	Power supply error
20	Operation not allowed while LED output is on
21	Wrong operating mode for this operation
22	INTERLOCK circuit is open
23	LED is overheated
24	Operation not allowed because of a 'OPEN CIRCUIT' condition
26	VTM module error
27	PRM module error
28	PRM module short circuit detected
29	VTM module overheated
30	PRM module overheated
31	Output current limit reached
32	Sensor failed
33	Supply 3.3V digital failed
34	Supply 1.2V digital failed
35	Supply 12V analog failed
36	Supply -12V analog failed
37	Supply 5V analog failed
38	Supply 12V VTM module and internal fan failed

Error	Description
39	Supply 15V external fan failed
40	Supply 5V digital failed
41	Supply 5V reference failed
42	Voltage supply failed
43	Supply fan failed
44	Supply touch screen failed
45	Power supply failed
51	User Current limitation by Max. Current limitation
52	User Current limitation by Power limitation
60	LED forward voltage measure procedure failed
91	Erroneous connection to LED driver A/D converter
100	I²C#0 wires stuck
101	I²C#0 bus error
102	I²C#0 slave address not acknowledged
103	I²C#0 incomplete write operation
104	I²C#0 bus arbitration lost
110	I²C#1 wires stuck
111	I²C#1 bus error
112	I²C#1 slave address not acknowledged
113	I²C#1 incomplete write operation
114	I²C#1 bus arbitration lost
120	I²C#2 wires stuck
121	I²C#2 bus error
122	I²C#2 slave address not acknowledged
123	I²C#2 incomplete write operation
124	I²C#2 bus arbitration lost
130	Nonvolatile memory timed out
131	Nonvolatile memory checksum error
132	Nonvolatile memory address overflow
133	Nonvolatile memory not supported

Error	Description
134	Nonvolatile memory missing
135	Async transfer is already running
140	FPGA configuration error
150	Fan controller not responding
151	Fan failure
170	RAM device failure
171	RAM address bus failure
172	RAM data bus failure
180	Touch controller INT signal failure
181	Touch controller INT signal timeout
182	Touch controller command error
183	Touch controller unrecognized command
184	Touch controller unrecognized header
185	Touch controller command timeout
186	Touch panel is not calibrated
187	Touch controller calibration canceled
188	Touch calibration already running
189	Touch calibration is not running
190	Touch calibration point is out of bounds
200	Value is not editable
201	Operation is not applicable
210	Numeric value error
211	Value minimum reached
212	Value maximum reached
213	Step size lower limit reached
214	Step size upper limit reached
220	Selection limit reached
230	Value is out of range
231	Not editable while output is ON

Error	Description
250	Unable to switch operating mode while LED output is on
251	A stored value is out of bounds and has been coerced
252	Empty storage - push and hold button to store setpoints
253	Setpoints stored
260	Unable to leave panel while LED output is on (safety mode)
261	Unable to switch LED output on in menu panel (safety mode)
270	No LED connected
271	Unknown LED head type
272	LED head memory data invalid
273	LED head memory version not supported
274	A mandatory LED head feature is not supported by the device
275	The forward voltage required by the LED head is not supported by the device. Occurrence of LED OPEN is highly possible
276	The maximum forward current allowed by the LED head can't be reached by the device
277	Can not assign LED head memory to terminals
278	The head data does not fit into the EEPROM
301	1-Wire line is shorted
302	No 1-Wire device found
304	No 1-Wire device on net
305	1-Wire bridge reset bit RST is set
307	1-wire file system: can't find path
308	1-wire file system: can't open file
309	1-wire file system: can't read file
310	1-wire file system: can't close file
312	Invalid 1-wire device handle
313	Invalid 1-wire device address
320	Invalid 1-Wire bridge channel
321	Invalid 1-Wire bridge index
-100	General command error

Error	Description
-101	Invalid character
-102	Syntax error
-103	Invalid separator
-104	Data type error
-105	GET not allowed
-108	Parameter not allowed
-109	Missing parameter
-110	Command header error
-111	Header separator error
-112	Program mnemonic too long
-113	Undefined header (Unknown command)
-114	Header suffix out of range
-115	Unexpected number of parameters
-120	Numeric data error
-130	Suffix error
-131	Invalid suffix
-150	String data error
-151	Invalid string data
-200	General execution error
-210	General trigger error
-211	Trigger ignored
-212	ARM ignored
-213	Init ignored
-220	Parameter error
-221	Settings conflict
-222	Data out of range
-223	Too much data
-224	Illegal parameter value
-230	Data corrupt or stale
-240	Hardware error
-310	System error
-311	Memory error

Error	Description
-313	Calibration memory lost
-314	Save/recall memory lost
-315	Configuration memory lost
-321	Out of memory
-330	Self-test failed
-340	Calibration failed
-350	Queue overflow
-363	Input buffer overrun
-365	Time out error
-410	Query INTERRUPTED

5 Maintenance and Service

Protect the DC2200 from adverse weather conditions. The DC2200 is not water resistant.

Attention

To avoid damage to the instrument, do not expose it to spray, liquids or solvents!

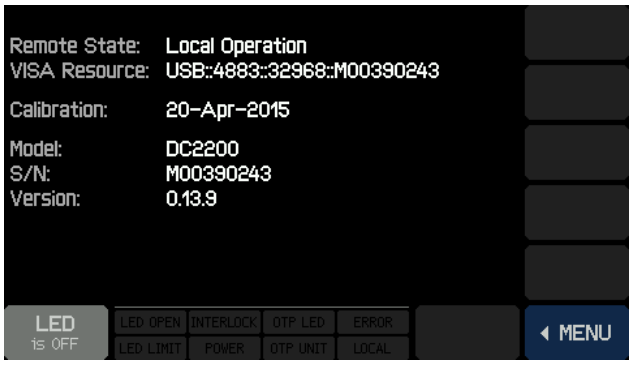
The unit does not need a regular maintenance by the user. It does not contain any modules and/or components that could be repaired by the users themselves. If a malfunction occurs, please contact Thorlabs GmbH 76 for return instructions.

Do not remove covers!

5.1 Version Information

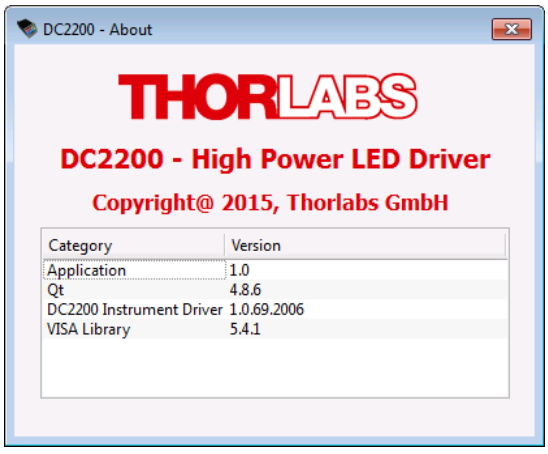
DC2200 System Information

Menu INFO



DC2200 Remote Control Software

Menu Help

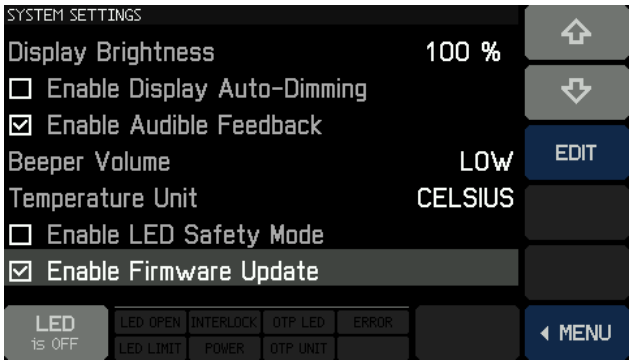


5.2 Firmware Update

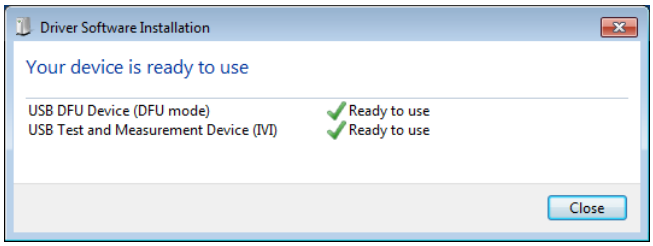
In order to update the DC2200 firmware, a newer firmware image (file extension *.dfu) and the Thorlabs DFU Wizard are required.

The DFU Wizard is a software tool to upload a firmware image to the DC2200. You will find it installed to your computer after downloading and installing the DC2200 Software package from our web site. Here (tab "Firmware") the up-to-date firmware image can be found as well. Please download it and remember the location on your computer where you saved it to.

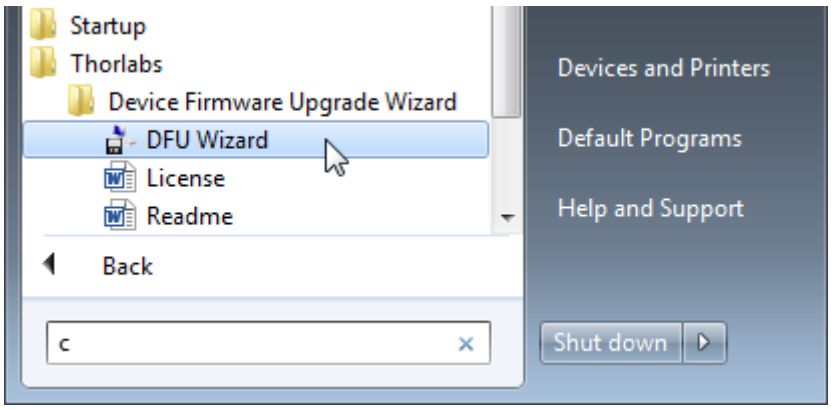
1. Switch on your DC2200, select the **SYST**em Settings menu and check the box "Enable Firmware Update":

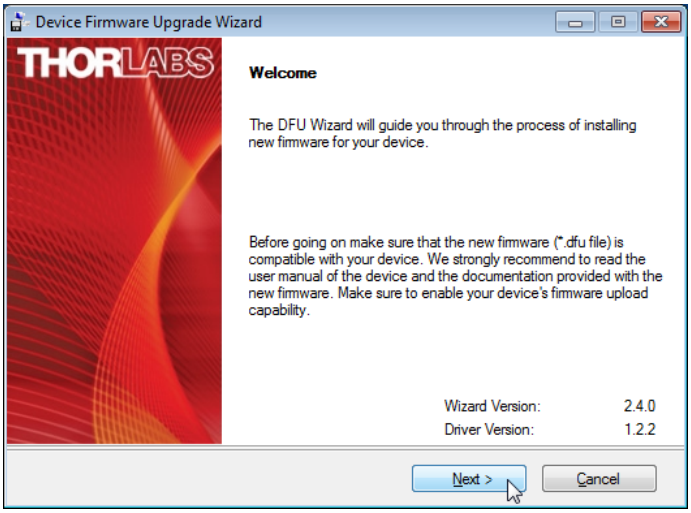


2. Connect your DC2200 to the computer using the supplied USB cable. The computer recognizes the connected device and installs the required driver software:

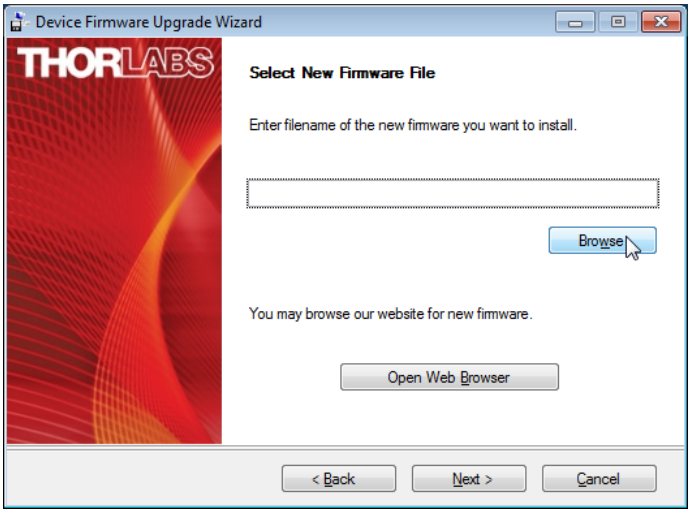


3. Start the DFU Wizard and follow the steps as shown in the screen shots below:

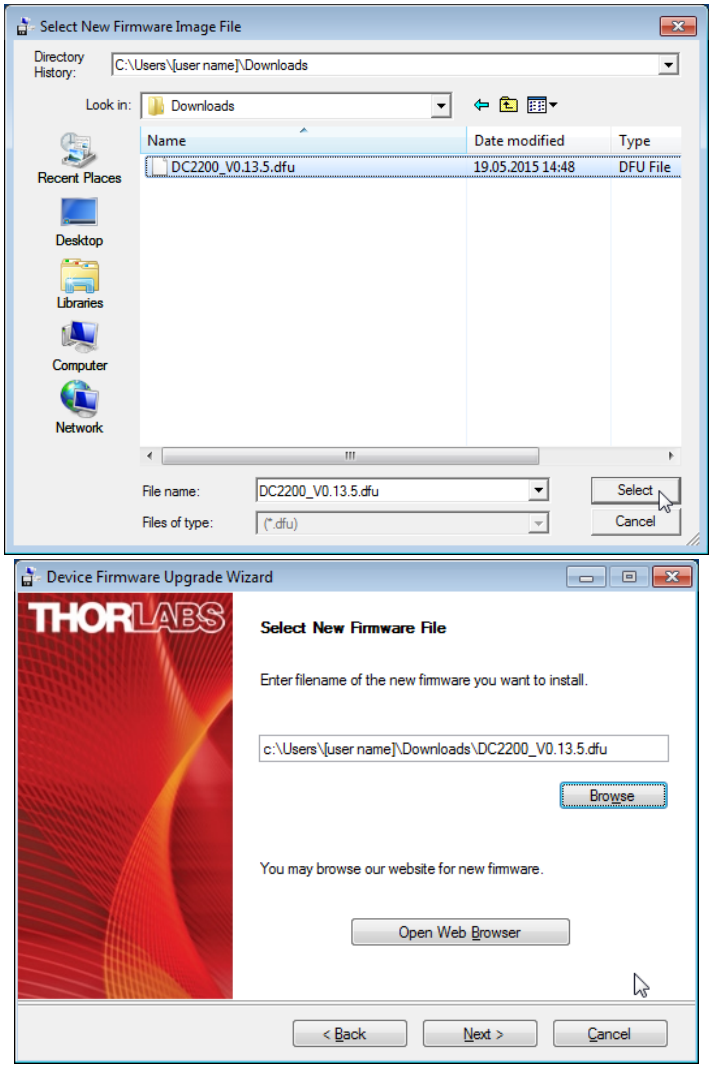




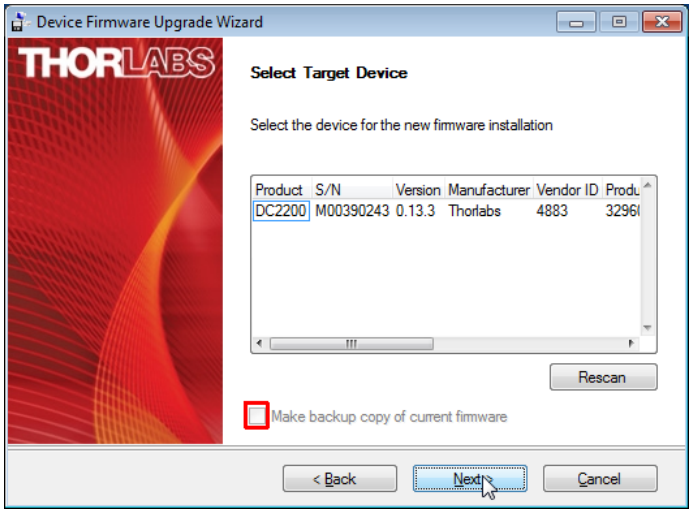
4. Click **Next >** to continue.



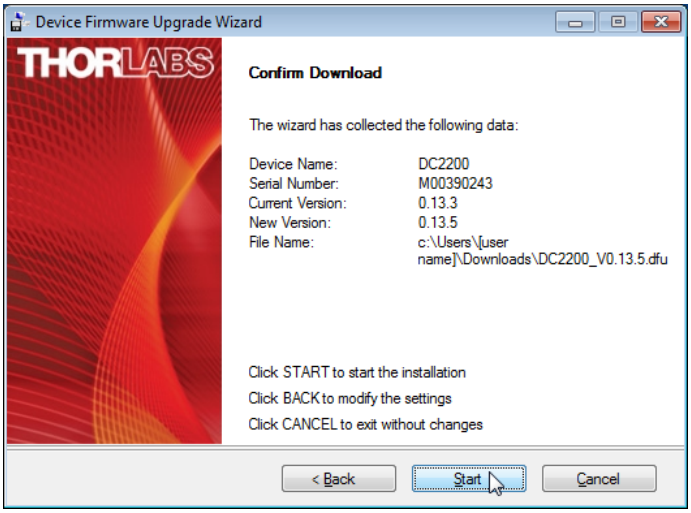
5. Click **Browse** to select the downloaded *.dfu file, then **Select**:



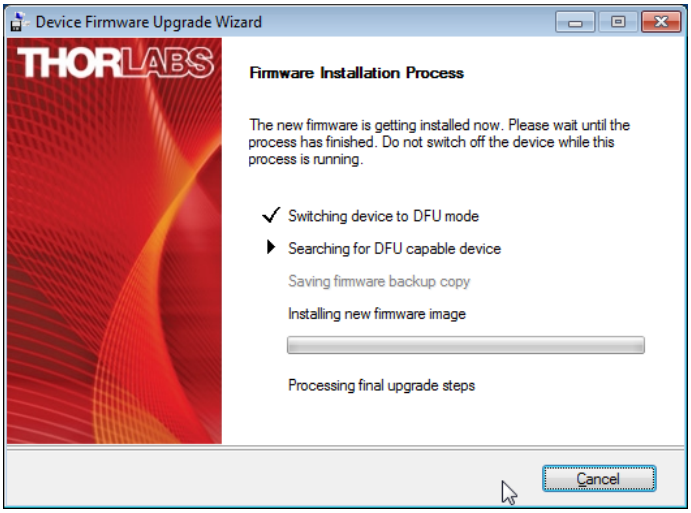
6. Click **Next >** to continue.



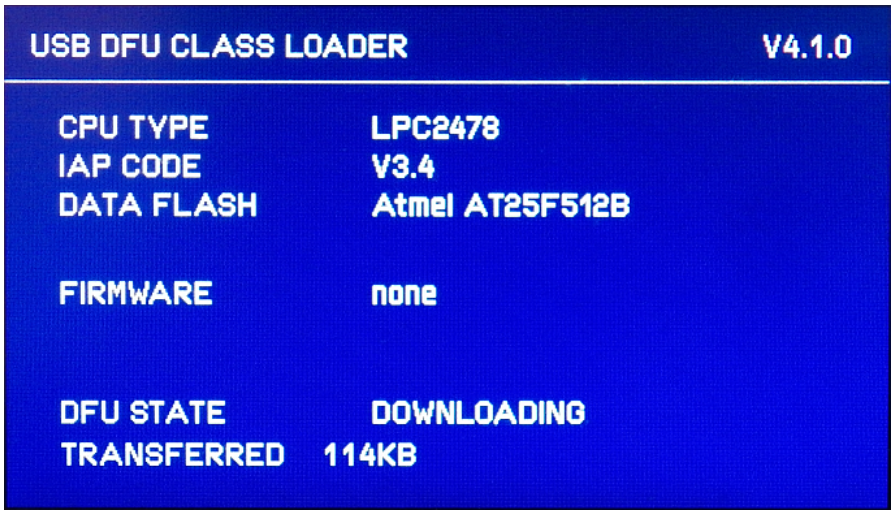
7. If you wish to save a backup of your current firmware, please check the appropriate box in above screen.



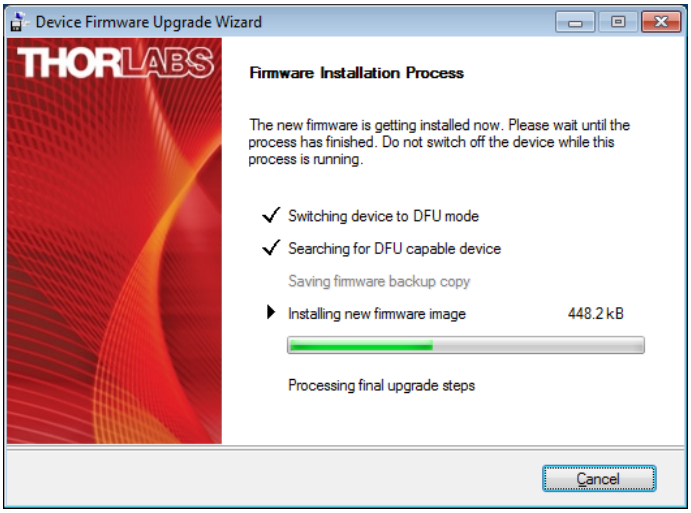
8. Click **Start**. The DFU Wizard searches for DFU capable devices, ...



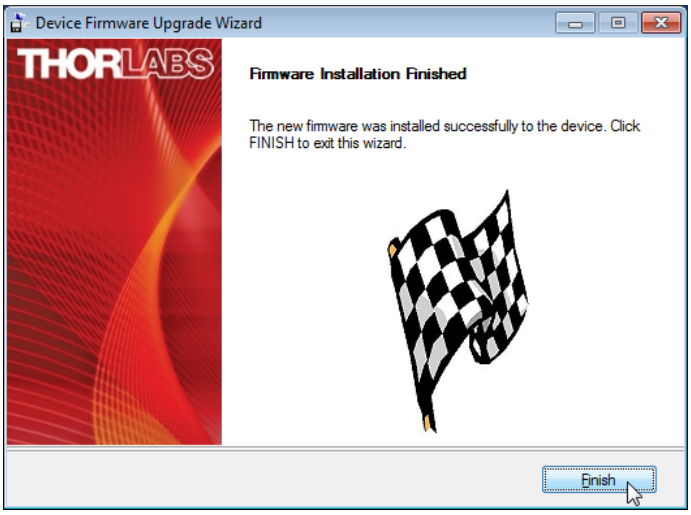
9. ... switches the DC2200 to DFU upload mode



10. and begins the upload:



11. Do NOT interrupt the process, this may cause your DC2200 to become inoperable!



12. Click **Finish**. The DFU application closes, and the DC2200 reboots with the new firmware.
13. Disconnect the USB cable.

5.3 Error Messages

Error messages are displayed in the status bar of the DC2200 display. There are indicators that might light up, or text messages may come up.

Indicators

LED OPEN Possible reasons:

- The forward voltage of the LED exceeded the internal limit (e.g. by disconnecting the LED)
- This indicator may be masked by a text error message ("LED output connection was tripped")

Troubleshooting:

- Check LED connection

LED LIMIT Possible reasons:

- The LED current set value exceeds the current limit
- In external modulation mode, the external modulation amplitude leads to exceeding the LED current limit.

Troubleshooting:

- Lower the LED current set value.
- Lower the external modulation voltage.

INTERLOCK Possible reasons:

- The interlock circuit was interrupted.

Troubleshooting:

- Check, if the interlock jumper is plugged in to the interlock connector (3) 8.
- If you have installed an external Interlock Circuit 69, check it.

POWER Possible reasons:

- Internal supply voltage error.
- The indicator may light up temporarily when switching the output terminal from LED2 to LED1, or when the User Current Limit of terminal LED1 is changed between values ≤ 4.0 A and > 4.0 A.

Troubleshooting:

- No action required, if the indicator lights up just shortly.
- If the indicator is permanently on, please contact Thorlabs 76.

OTP LED (Only for SOLIS Series LED with internal temperature sensor)

Possible reasons:

- The LED temperature exceeded 95° C.

Troubleshooting:

- The LED switches off in this case automatically.
- Prior to switching it on again, please make sure that the airflow around the LED is not obstructed and that ventilation slots are not covered.

OTP UNIT Possible reasons:

- The DC2200 heated up internally beyond 85° C.

Troubleshooting:

- The DC2200 switches off in this case automatically.
- Prior to switching it on again, please make sure that the fan works properly and that ventilation slots are not covered.

ERROR Possible reasons:

- General device error:
  - The LED current set value exceeds the current limit
  - hardware failure
  - memory loss (calibration data)
  - USB communication error

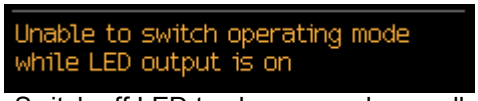
Troubleshooting:

- Switch the DC2200 off and on again.
- If the error persists, please contact Thorlabs 76.

Text messages

Beside above error indicators, text error messages may appear in the status bar, for example:

LED connection failure



Switch off LED to change mode or call a menu

In Edit mode: Upper or lower step size reached

In Edit mode: A value has reached its minimum or maximum

Text error messages are displayed for about 3 sec and then disappear.

6 Appendix

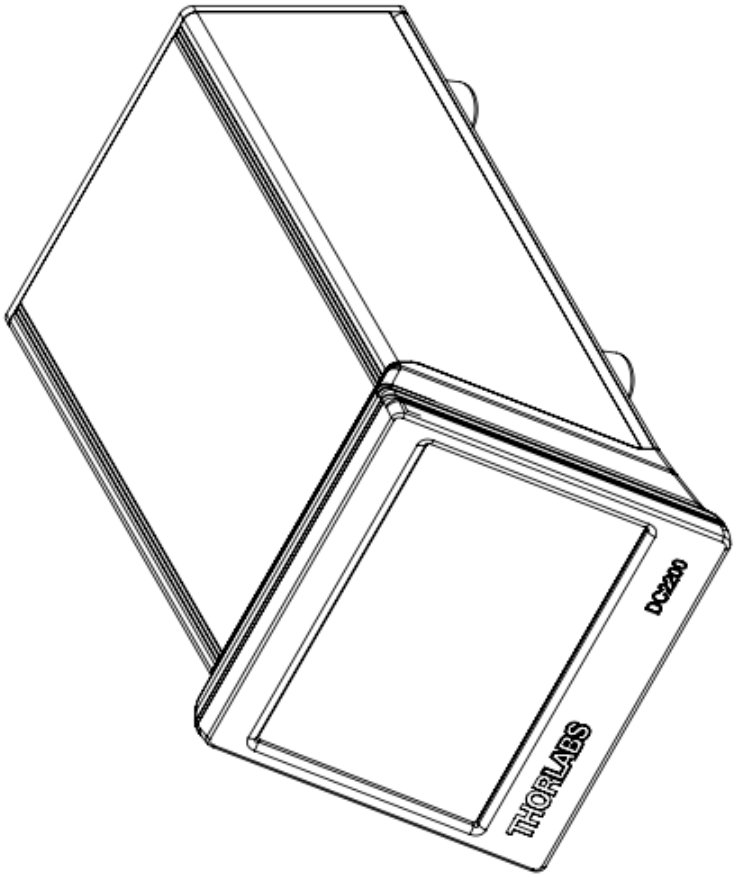
6.1 Technical Data

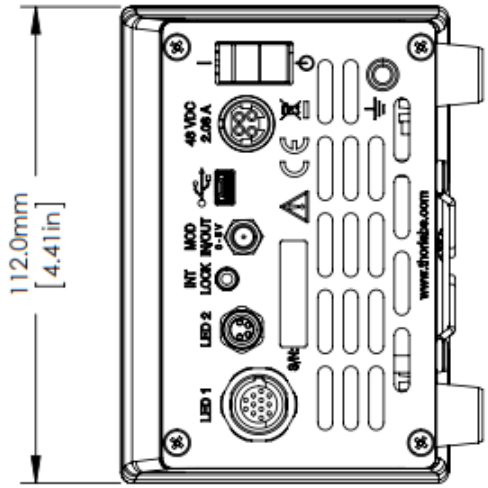
		Terminal LED1	Terminal LED2
Constant Current Mode			
Current / Max. LED Forward Voltage		1.0 A / 50.0 V 2.0 A / 35.0 V 4.0 A / 15.0 V 5.0 A / 10.0 V 10.0 A / 5.0 V	1.5 A / 50.0 V 2.0 A / 35.0 V
Setting / Measurement Resolution (Display)		0.1 mA	
Accuracy	Current Range 0.0 - 2.0 A	-	±(0.1% + 1 mA)
	Current Range 0.0 - 4.0 A	±(0.1% + 2 mA)	-
	Current Range 4.0 - 10.0 A	±(0.1% + 4 mA)	-
Noise and Ripple (1 Hz - 10 MHz, rms, typically)	Current Range 0.0 - 2.0 A	-	< 110 µA
	Current Range 0.0 - 4.0 A	< 100 µA	-
	Current Range 4.0 - 10.0 A	< 200 µA	-
Current Limit			
Setting Resolution (Display)	Current Range 0.0 - 2.0 A	-	0.1 mA
	Current Range 0.0 - 4.0 A	0.1 mA	-
	Current Range 4.0 - 10.0 A		-
Accuracy	Current Range 0.0 - 2.0 A	-	±(0.12% + 1.6 mA)
	Current Range 0.0 - 4.0 A	±(0.12% + 3 mA)	-
	Current Range 4.0 - 10.0 A	±(0.12% + 6 mA)	-
Measurement			
LED Current Resolution (Display)		0.1 mA	
LED Current Accuracy	Current Range 0.0 - 2.0 A	-	±(0.1% + 1 mA)
	Current Range 0.0 - 4.0 A	±(0.1% + 2 mA)	-
	Current Range 4.0 - 10.0 A	±(0.1% + 4 mA)	-
LED Voltage Resolution [1])		1 mV	
LED Voltage Accuracy [1])		±(0.1% + 25 mV)	
PWM Mode			
Frequency		0.1 Hz - 20 kHz	
Duty Cycle		0.1 % to 99.9 %	
Counts		1 to 1000; infinite	
Pulse Mode			
On Time		0.001 ms - 10 s	
Off Time		0.001 ms - 10 s	
Counts		1 to 1000; infinite	
Internal Modulation Mode			
Waveforms		Sine, Square, Triangle	
Modulation Frequency Range		20 Hz - 100 kHz	

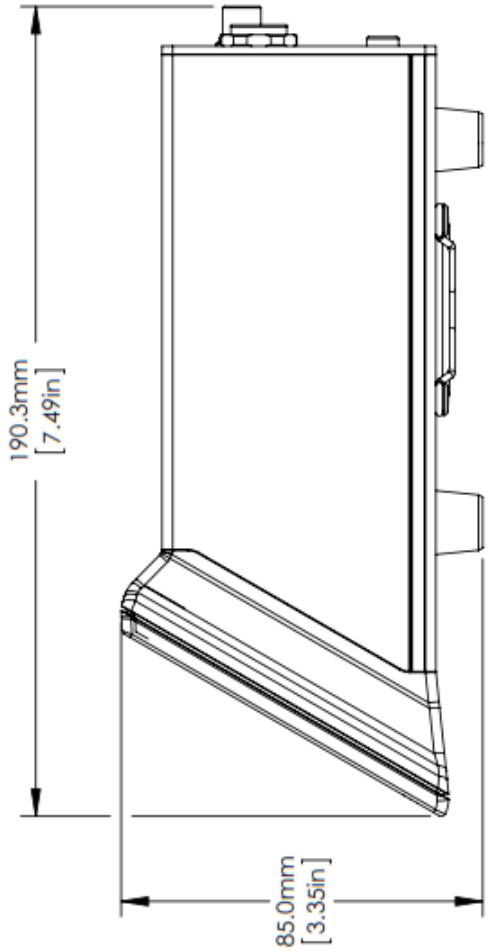
		Terminal LED1	Terminal LED2
External Modulation Mode			
Input Impedance		10 kΩ	
Max. Input Voltage		5.0 V	
Small Signal Bandwidth (sine) [3])		DC - 250 kHz	
Modulation Coefficient	Current Range 0.0 - 2.0 A	-	400 mA / V
	Current Range 0.0 - 4.0 A	800 mA / V	-
	Current Range 4.0 - 10.0 A	2000 mA / V	-
TTL Modulation Mode			
Input Impedance		10 kΩ	
TTL Modulation Bandwidth [4])		DC - ≥18 kHz	
Low Voltage		0.0 - 0.8 V	
High Voltage		2.0 - 5.0 V	
SMA Connector			
External Modulation Input Input Impedance Max. Input Voltage		10 kΩ 5.0 V (analog) / TTL Level	
Internal Modulation Monitor Output Min. Load Impedance Output Voltage Level		50 Ω TTL Level	
General			
Operating Temperature Range [2])		0 - 40 °C	
Storage Temperature Range		-40 to 70 °C	
Dimensions (W x H x D)		112.0 x mm 85.0 x mm 190.3 mm	
Weight		0.9 kg	

[1]) 2-wire measurement - be aware of the voltage drop across the LED cable caused by the LED current.
[2]) non-condensing
[3]) Small Signal Bandwidth: Modulation not exceeding 20% of full scale current
[4]) Given for an output current at "High" TTL level not exceeding 10% of the selected current range limit.
Warm-up time for rated accuracy: < 10 min.
All technical data are valid at 23 ± 5°C and 45 ± 15% rel. humidity (non condensing)

6.2 Dimensions







6.3 Interlock Circuit

Interlock

The hardware interlock is a safety feature, accessible via the INT LOCK connector (3) 8 on the rear panel. By default, a short circuit jumper is installed to the jack.

The interlock interface represents a current source (~1 mA when the LED is switched on), where the voltage across the external circuit is observed. As soon as this voltage rises above the TTL H Level, the external circuit is considered "open" and the LED current output is disabled.

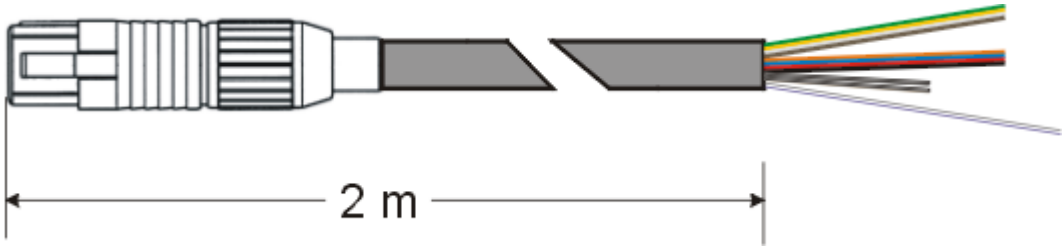
Instead of the jumper, an external emergency switch (opener) can be connected to the interlock, as well as an external circuit (total resistance < 1 kΩ).

6.4 Connect a Custom LED

You can connect a custom LED to your DC2200 using the supplied connection cables.

Custom High Power LED (up to 10 A - Terminal LED1)

Use the supplied cable CAB-DC2200:



Connection scheme:

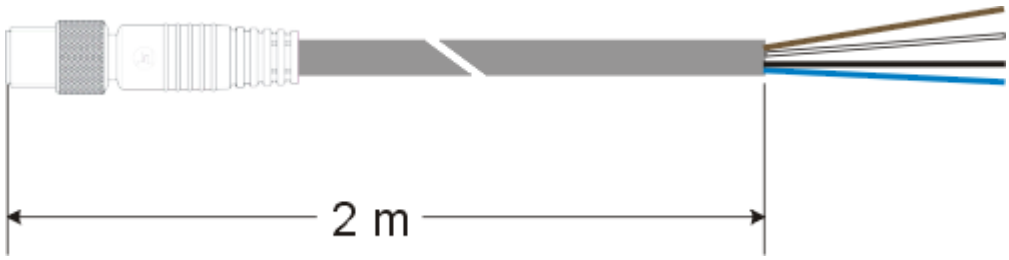
Pin	Color	Description
1	green	LED cathode
2	yellow	LED cathode
3	gray	6 V - 13 V power supply for fan
4	orange	LED anode
5	blue	LED anode
6	red	LED anode
7	black	LED anode
8	white	LED cathode
9	brown	LED cathode
10	violet	Ground power supply for fan
11	white and black striped	**DO NOT CONNECT**
12	white and brown striped	**DO NOT CONNECT**

Attention!

Do **NOT** connect anything to the bi-color wires (white / black and white / brown striped)! The DC2200 might be damaged!

Custom Standard LED (up to 2 A - Terminal LED2)

Use the supplied cable CAB-LEDD1:



Connection scheme:

Pin	Color	Description
1	brown	LED anode
2	white	LED cathode
3	black	**DO NOT CONNECT**
4	blue	**DO NOT CONNECT**

Attention!

Do **NOT** connect anything to the black and blue wires! The DC2200 might be damaged!

6.5 Certifications and Compliances

EU Declaration of Conformity

in accordance with EN ISO 17050-1:2010

We: Thorlabs GmbH

Of: Hans-Boeckler-Str. 6, 85221 Dachau/München, Deutschland

in accordance with the following Directive(s):

2014/35/EU	Low Voltage Directive (LVD)
2014/30/EU	Electromagnetic Compatibility (EMC) Directive
2011/65/EU	Restriction of Use of Certain Hazardous Substances (RoHS)

hereby declare that:

Model: ***DC2200***

Equipment: ***High Power LED Driver***

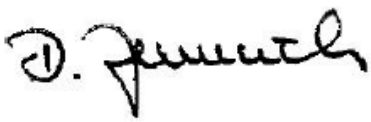
is in conformity with the applicable requirements of the following documents:

EN 61010-1	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use.	2010
EN 61326-1	Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements	2013

and which, issued under the sole responsibility of Thorlabs, is in conformity with Directive 2011/65/EU of the European Parliament and of the Council of 8th June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment, for the reason stated below:

does not contain substances in excess of the maximum concentration values tolerated by weight in homogenous materials as listed in Annex II of the Directive

I hereby declare that the equipment named has been designed to comply with the relevant sections of the above referenced specifications, and complies with all applicable Essential Requirements of the Directives.

Signed:  *On:* 08 July 2015

Name: Dorothee Jennrich

Position: General Manager

EDC - DC2200 -2015-07-08

CE 15

6.6 Warranty

Thorlabs GmbH warrants material and production of the DC2200 for a period of 24 months starting with the date of shipment. During this warranty period Thorlabs GmbH will see to defaults by repair or by exchange if these are entitled to warranty.

For warranty repairs or service the unit must be sent back to Thorlabs GmbH. The customer will carry the shipping costs to Thorlabs GmbH, in case of warranty repairs Thorlabs GmbH will carry the shipping costs back to the customer.

If no warranty repair is applicable the customer also has to carry the costs for back shipment.

In case of shipment from outside EU duties, taxes etc. which should arise have to be carried by the customer.

Thorlabs GmbH warrants the hard- and/or software determined by Thorlabs GmbH for this unit to operate fault-free provided that they are handled according to our requirements. However, Thorlabs GmbH does not warrant a fault free and uninterrupted operation of the unit, of the software or firmware for special applications nor this instruction manual to be error free. Thorlabs GmbH is not liable for consequential damages.

Restriction of Warranty

The warranty mentioned before does not cover errors and defects being the result of improper treatment, software or interface not supplied by us, modification, misuse or operation outside the defined ambient stated by us or unauthorized maintenance.

Further claims will not be consented to and will not be acknowledged. Thorlabs GmbH does explicitly not warrant the usability or the economical use for certain cases of application.

Thorlabs GmbH reserves the right to change this instruction manual or the technical data of the described unit at any time.

6.7 Copyright and Exclusion of Reliability

Thorlabs GmbH has taken every possible care in preparing this document. We however assume no liability for the content, completeness or quality of the information contained therein. The content of this document is regularly updated and adapted to reflect the current status of the hardware and/or software. We furthermore do not guarantee that this product will function without errors, even if the stated specifications are adhered to.

Under no circumstances can we guarantee that a particular objective can be achieved with the purchase of this product.

Insofar as permitted under statutory regulations, we assume no liability for direct damage, indirect damage or damages suffered by third parties resulting from the purchase of this product. In no event shall any liability exceed the purchase price of the product.

Please note that the content of this document is neither part of any previous or existing agreement, promise, representation or legal relationship, nor an alteration or amendment thereof. All obligations of *Thorlabs GmbH* result from the respective contract of sale, which also includes the complete and exclusively applicable warranty regulations. These contractual warranty regulations are neither extended nor limited by the information contained in this document. Should you require further information on this product, or encounter specific problems that are not discussed in sufficient detail in the document, please contact your local *Thorlabs GmbH* dealer or system installer.

6.8 Thorlabs 'End of Life' Policy

As required by the WEEE (Waste Electrical and Electronic Equipment Directive) of the European Community and the corresponding national laws, Thorlabs GmbH offers all end users in the EC the possibility to return “end of life” units without incurring disposal charges.

This offer is valid for Thorlabs GmbH electrical and electronic equipment

- sold after August 13th 2005
- marked correspondingly with the crossed out “wheelie bin” logo (see figure below)
- sold to a company or institute within the EC
- currently owned by a company or institute within the EC
- still complete, not disassembled and not contaminated

As the WEEE directive applies to self contained operational electrical and electronic products, this “end of life” take back service does not refer to other Thorlabs GmbH products, such as

- pure OEM products, that means assemblies to be built into a unit by the user (e. g. OEM laser driver cards)
- components
- mechanics and optics
- left over parts of units disassembled by the user (PCB’s, housings etc.).

Waste treatment on your own responsibility

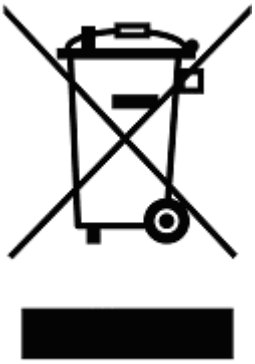
If you do not return an “end of life” unit to Thorlabs GmbH, you must hand it to a company specialized in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.

WEEE Number (Germany) : DE97581288

Ecological background

It is well known that waste treatment pollutes the environment by releasing toxic products during decomposition. The aim of the European RoHS Directive is to reduce the content of toxic substances in electronic products in the future.

The intent of the WEEE Directive is to enforce the recycling of WEEE. A controlled recycling of end-of-life products will thereby avoid negative impacts on the environment.



Crossed out
"Wheelie Bin" symbol

6.9 List of Acronyms

DFU	Device Firmware Update
GUI	Graphic User Interface
LED	Light Emitting Diode
PWM	Pulse Width Modulation
TTL	Transistor- Transistor Logic
USB	Universal Serial Bus

6.10 Thorlabs Worldwide Contacts

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THORLABS

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