Operation Manual

Thorlabs Instrumentation

4 Channel LED Driver

DC4100

2009

THORLABS

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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 come up to your expectations and develop 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

This part of the instruction manual contains every specific information on how to handle and use the DC4100 - 4 Channel LED Driver.

WARNING

This symbol in the manual explains dangers that might result in personal injury or death. Always read carefully the associated information before performing the indicated procedure.

ATTENTION

This symbol in the manual explains hazards that could damage the instrument and connected equipment or may cause data loss.

NOTE

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

Please read these advices carefully!

1 General Information

The LED driver DC4100 is designed for general purpose LED control. It is a 4 channel LED driver, which can supply a high current (up to 1 A) for each channel independently to a high-power LED. This LED driver can also be used to drive the 4 color LED microscope illumination source LED4C - series.

1.1 Safety

ATTENTION

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

Before applying power to your DC4100, make sure that the protective conductor of the 3 conductor mains power cord is correctly connected to the protective earth contact of the socket outlet!

Improper grounding can cause electric shock with damages to your health or even death!

The DC4100 must not be operated in explosion endangered environments!

The LED head, control inputs and outputs must only be connected with duly shielded connection cables.

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

Do not obstruct the air ventilation slots in housing!

Do not remove covers!

Refer servicing to qualified personal!

This precision device is only dispatchable if duly packed into the complete original packaging including the plastic form parts. If necessary, ask for a replacement package.

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).

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 accompanying documentation.

Note: This equipment has been tested and found to comply with the limits for a Class B 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 in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- **Reorient or relocate the receiving antenna.**
- **Increase the separation between the equipment and receiver.**
- **Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.**
- **Consult the dealer or an experienced radio/T.V. technician for help.**

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.

1.2 Ordering Codes and Accessories

Ordering code	Short description
DC4100	**DC4100 - 4 Channel LED Driver**
DC4100-HUB	**Distribution Frame to 4 Standard Thorlabs LED Connectors**
LED4C-x	**4 Color LED Microscope Illumination Source**

Please visit our homepage http://www.thorlabs.com for further information.

2 Getting Started

This section is provided for those interested in getting the DC4100 up and running quickly. The more detailed description and advanced features are described in the following sections.

2.1 Unpacking

Inspect the packaging for damage. If the shipping container seems to be damaged, keep it until you have inspected the contents and you have inspected the DC4100 mechanically and electrically.

Verify that you have received the following items:

- 1 DC4100
- 1 Power cord, connector according to ordering country
- 1 Power supply 12V / 5.5A
- 1 USB cable
- 1 Operation manual
- 1 Applications and driver CD

2.2 Preparation

1. Connect the LED4C-x cable with socket labeled 'LED' at the back of the main control unit. The DC4100-HUB can also be connected to this socket. It is then possible to drive up to 4 LEDs via the standard Thorlabs LED connector (e.g. MxLED series, LEDCx series). See figure below.
2. Connect power supply cable with main control unit, use only the power supply supplied with your DC4100 unit.
3. Plug in power supply.

ATTENTION

Prior to switching on your DC4100, please check if the line voltage corresponds to the input voltage range of the power supply!

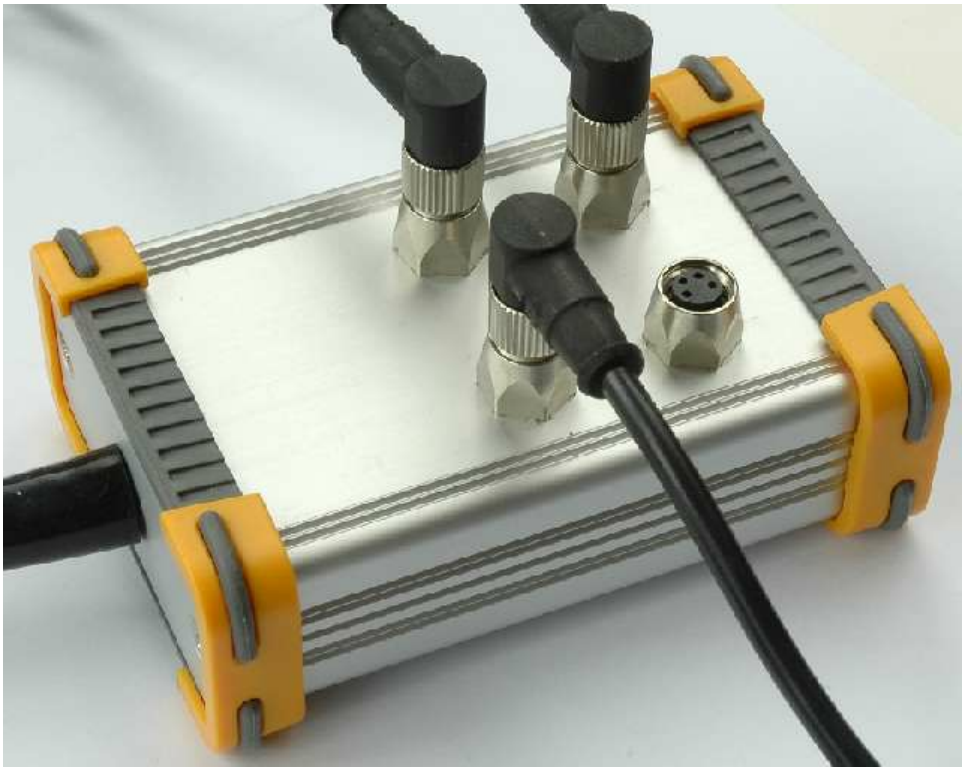

Figure 1 Connecting a LED via the DC4100-HUB

ATTENTION

Please, install the software prior to connect the instrument to your PC via USB interface.

Only use the supplied high speed (USB 2.0) cable not full speed (USB 1.1) cables or thin profile cables with increased resistance, this can cause transmission errors and improper instrument operation!

4. Turn the unit on by pressing the power switch on the rear side of the unit.
5. After the device is powered up, the graphics display will show a 'Welcome' screen for a few seconds.
6. The DC4100 is immediately ready to use after turning on. The rated accuracy is reached, however, after a warming-up period of approximately 10 minutes.

2.3 Operating Elements

2.3.1 Operating Elements on the Front Panel

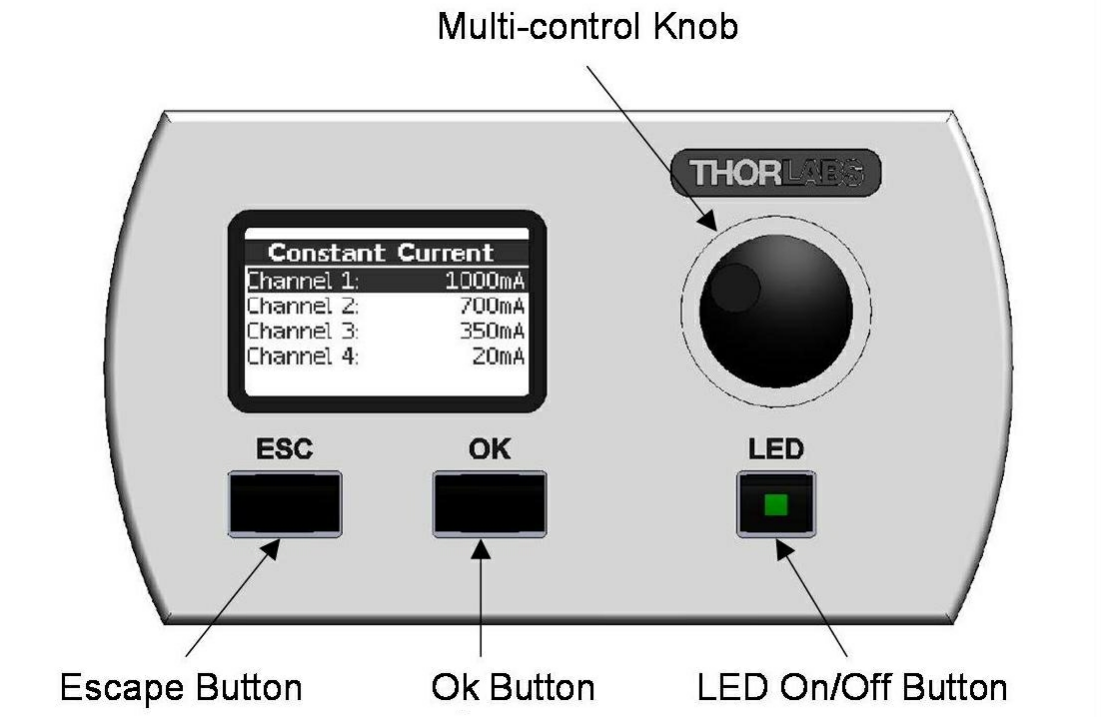

Figure 2 Display and Operating Elements on the Front Panel

2.3.2 Operating Elements on the Rear Panel

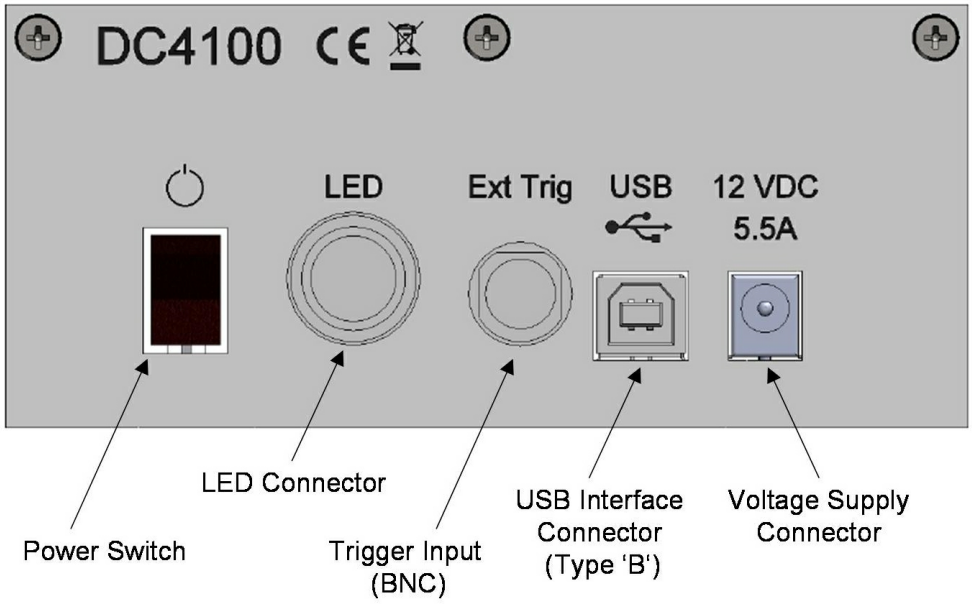

Figure 3 Operating Elements on the Rear Panel

3 Operating the DC4100

The DC4100 can either be controlled via the front panel of the main unit (see chapter Operation and Settings) or by a remote application (see chapter Remote Application).

3.1 Operation and Settings

The following sub chapters contain the description about the operation of the DC4100.

3.1.1 Navigating the Menus

The DC4100 is controlled by three buttons and the multi-control knob on the front panel. The two buttons below the graphics display have an Enter and Escape functionality. The button with LED indicator is used to switch the LED on or off. The multi-control is used to select the desired menu or to change the settings.

After switching on the DC4100 a 'Welcome' screen appears for a few seconds.

Figure 4 Welcome Screen

In case no LED head is connected you will be prompted to switch off the main unit, connect the LED head and switch on the device.

Figure 5 No LED Error Screen

The display will show the screen of one of the three LED operation modes (**Constant Current**, **Brightness** or **External Control Mode**). The 'Main Menu' can be accessed via the 'ESC' button.

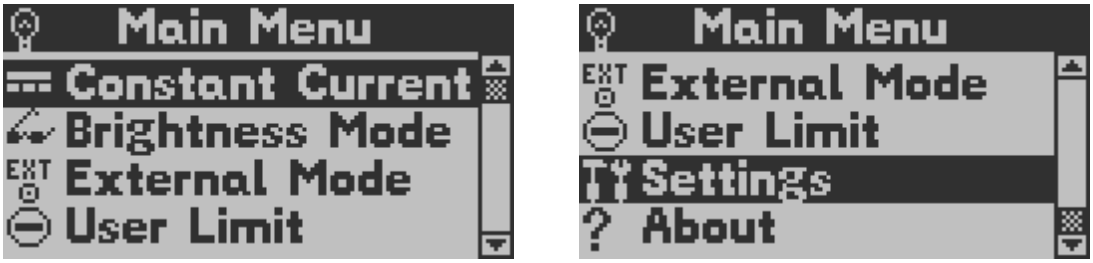

Figure 6 Main Menu

To select an operation mode or a configuration display the multi-control knob is used. Press the 'Ok' button to enter the selected item.

3.1.2 Operation Modes

For safety reasons the LED can be switched on only if one of the three operation modes (Constant Current, Brightness or External Control) is selected.
It is possible to leave the active mode when the LED is switched on and enter the main menu. However, the LED has to switch off before you can enter another operation mode. This can be done while the main menu is selected by pressing the LED button.

The last selected operation mode will be saved. After switching on the DC4100 again this operation mode will automatically be the active mode. All settings are saved and validated after a shut off.

3.1.2.1 Constant Current Mode

The 'Constant Current Mode' provides a constant non-modulated LED current.

The actual current for each channel is displayed. If you connect a Thorlabs LED with an internal EEPROM or the 4 Color LED LED4C the corresponding wavelength will displayed instead of the channel number. There are two different output modes, 'Single Selection' and 'Multi Selection'. The output mode can be selected in the 'Setting' menu (see Settings).
The 'Multi Selection Mode' is illustrated by square indicators. More than one LED at a time can be switched on and is indicated by a little check mark in the square box.
The 'Single Selection Mode' features small circles as output indicators, which are filled with a dot when the LED is on. Only one LED at a time can be switched on within this mode. This is convenient when you want to switch between two LEDs quickly. It is not necessary to switch a LED off prior to switch on another LED.
Select a channel with the multi-control knob and press the 'LED' button to switch the LED on or off, respectively. If you press and hold the 'LED' button for more than 3 seconds you will switch on all LEDs at once. If all LEDs are already on you can switch them off using this procedure.
If no LED is connected to a channel it will be marked with 'n/a'.

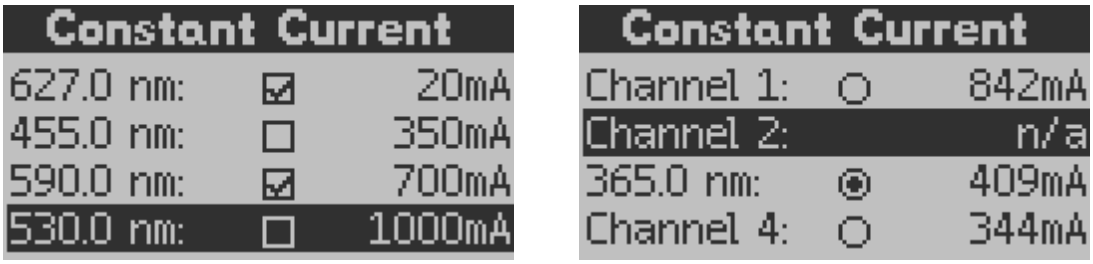

Figure 7 Constant Current Mode: Channel Selection

Before the current of a channel can be changed, the channel has to be selected using the multi-control knob and confirmed with the 'OK' button. A new screen appears and the current of the selected channel can be set directly with the multi-control knob. The change takes affect immediately. To confirm the adjusted current, press the 'OK' button. To cancel the set current, press the 'ESC' button. Both actions bring you back to the channel selection menu. The LED current can be changed when the LED is off as well as when it is in operation. This allows to increase or reduce the brightness of the LED. The current limit is displayed at the bottom of the screen. In the upper left corner the selected channel is displayed.
Return to the main menu with the 'ESC' button.

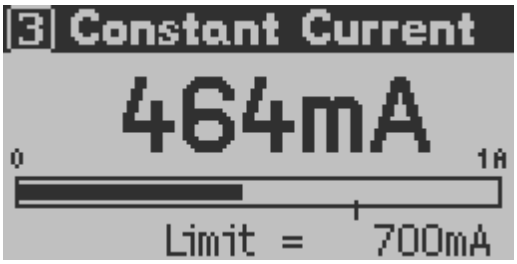

Figure 8 Constant Current Mode: Current Setting

The faster the multi-control knob is turned, the greater is the adjustment ratio of the current. If you move the knob slowly you can set the current with a 1mA resolution. If you move it faster the resolution will increase up to a 200mA resolution.

3.1.2.2 Brightness Mode

This mode can be used to apply a constant current in terms of percentage. This can be useful if two or more beams are superimposed with each other. A maximum current can be defined, which corresponds to 100%. Each channel can be set individually or all channels can be set simultaneously.

The actual brightness in percent for each channel is displayed. If you connect a Thorlabs LED with an internal EEPROM or the 4 Color LED LED4C the corresponding wavelength will displayed instead of the channel number. There are two different output modes: 'Single Selection' and 'Multi Selection'. The output mode can be selected in the 'Setting' menu (see Settings).
The 'Multi Selection Mode' is illustrated by square indicators. More than one LED at a time can be switched on and is indicated by a little check mark in the square box.

The 'Single Selection Mode' features small circles as output indicators which are filled with a dot when the LED is on. Only one LED at a time can be switched on within this mode. This is convenient when you want to switch between two LEDs quickly. It is not necessary to switch a LED off prior to switch on another LED.
Select a channel with the multi-control knob and press the 'LED' button to switch the LED on or off, respectively. If you press and hold the 'LED' button for more than 3 seconds you will switch on all LEDs at once. If all LEDs are already on you can switch them off using this procedure.
If no LED is connected to a channel it will be marked with 'n/a'.

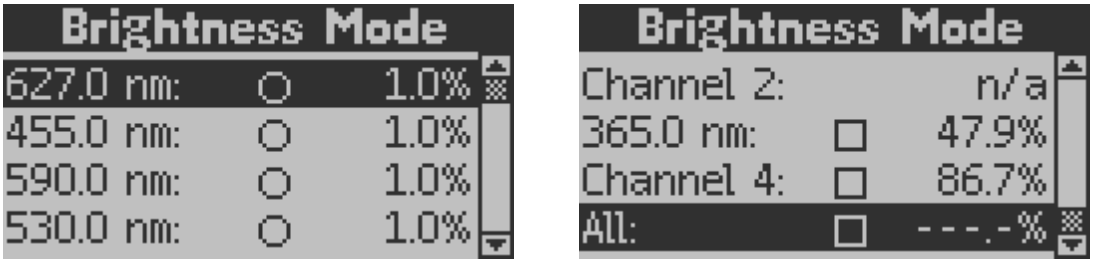

Figure 9 Brightness Mode: Channel Selection

Before the brightness of a channel can be changed the channel has to be selected using the multi-control knob and confirmed with the 'OK' button. A new screen appears and the brightness of the selected channel can be set directly with the multi-control knob. The change takes affect immediately. To confirm the adjusted brightness, press the 'OK' button. To reject the set brightness, press the 'ESC' button. Both actions yield back to the channel selection menu. The LED brightness can be changed when the LED is off as well as when it is in operation. This allows to increase or reduce the brightness of the LED. The resulting current is displayed at the bottom of the screen. In the upper left corner the selected channel is displayed.
Return to the main menu with the 'ESC' button.

Figure 10 Brightness Mode: Brightness Setting

The brightness mode offers the opportunity to set the brightness of all channels simultaneously. Select 'All Channels' in the channel selection menu and confirm with the 'OK' button. Now the brightness in percent can be set and will take affect immediately. The value in percent is for all channels the same. The adjusted brightness can be confirmed with 'OK' or rejected with 'ESC'. It will return to the channel selection menu.

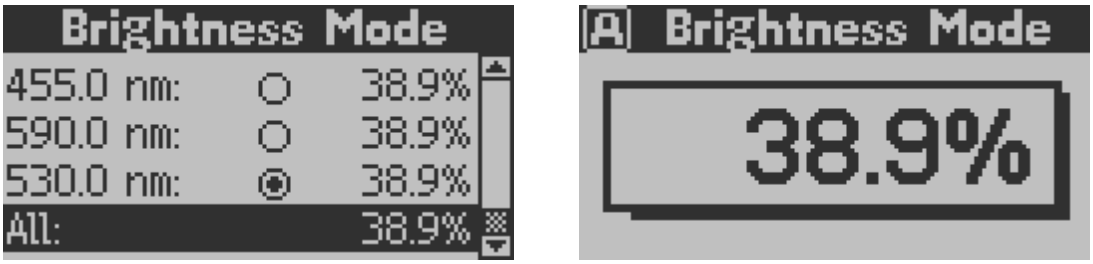

Figure 11 Brightness Mode: All Channels

The current corresponding to 100% brightness is defined by the 'User Limit Current'. Select 'User Limit' from the main menu to change this value.

The faster the multi-control knob is turned, the greater is the adjustment ratio of the brightness. If you move the knob slowly you can set the current with a 0.1% resolution. If you move it faster the resolution will increase up to a 20% resolution.

3.1.2.3 External Control Mode

This mode allows to control the DC4100 by an external signal.
The 'External Control Mode' has no parameter settings. The LEDs can only be controlled via the BNC connector at the rear panel of the DC4100. The applied voltage corresponds to the LED current. 1V is equivalent to a LED current of 100mA. A maximum voltage of 10V can be applied, which results in a current of 1000mA.
Please note: The maximum current is limited by the user defined current limit set in the 'User Limit' menu.

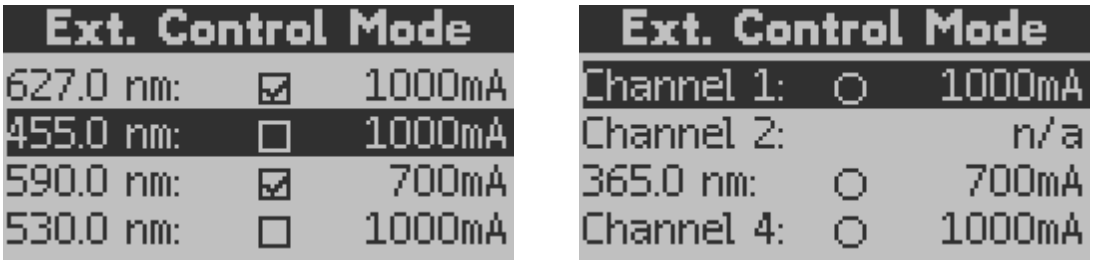

Figure 12 External Control Mode

The Modulation Frequency range is 0 to 100kHz and valid for sine wave modulation. The input will affect all channels. To enable or disable one or more LEDs select the corresponding LED by turning the multi-control knob and press the 'LED' button. Depending on the selected output mode only one LED or all 4 LEDs can be enabled. The output mode can be changed within the 'Settings' menu (see Settings).
The 'Single Selection Mode' allows only one enabled LED at a time. It is indicated by a circle. If an LED is enabled there is a dot within this circle.
The 'Multi Selection Mode' offers the possibility to enable up to four LEDs. It is represented by square boxes and a check mark indicates an enabled LED.

3.1.3 Settings and Configuration

There are settings and system configurations, which can be accessed via the main menu. To enter the main menu from one of the operation modes press the 'ESC' button.

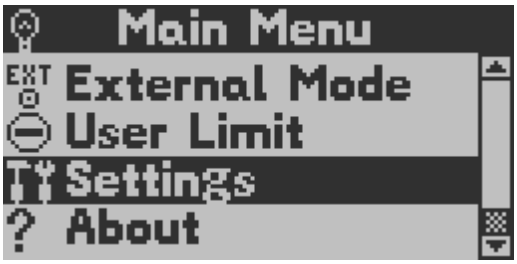

Figure 13 Main Menu

Select an item with the multi-control knob and press the 'Ok' button to access the desired setting or configuration panel.

3.1.3.1 User Limit

The current limit can be changed by selecting 'User Limit'. The following screen appears. Select a channel and confirm with the 'OK' button.

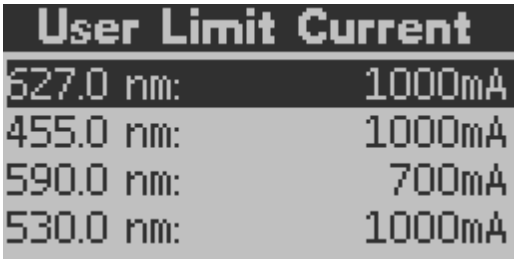

Figure 14 LED Current Limit Setting Menu

Now the LED current limit can be set using the multi-control knob. The new value has to be confirmed with the 'Ok' button or canceled with the 'ESC' button. The LED current limit can be set up to the maximum LED current limit (LED Imax). It is displayed on the bottom of the screen. Certain LED sources have an EEPROM, which contain data about the LED like maximum current. LEDs without an EEPROM will show 1000mA as maximum LED current limit.

NOTE

The User Limit current corresponds to 100% brightness in the 'Brightness Mode'.

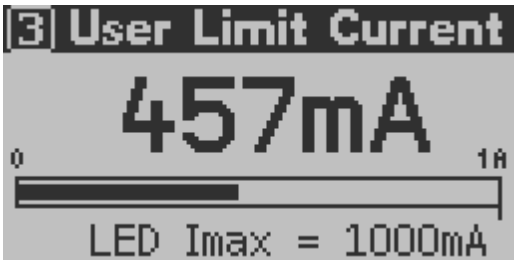

Figure 15 LED Current Limit Setting Channel 4 selected

ATTENTION

A wrong and too high LED maximum current limit can cause damage to the LED. Prior to changing the LED maximum current limit of the LED head check if the LED can handle this current!

LED Configuration

The LEDs maximum current can be reconfigured for LEDs with an EEPROM. This value is valid until the DC4100 is restarted and can be changed in the 'User Limit Current' menu.
This menu entry is hidden in normal operation mode. Go to the 'User Limit' screen described above and select the channel. Then press and hold the 'LED' button for about three seconds.
A sub menu appears and the LEDs maximum current can be set. Press the 'Ok' button to select the 'Maximum Current Limit' menu. The multi-control knob is used to change the value and has to be confirmed with the 'Ok' button or canceled with the 'ESC' button.

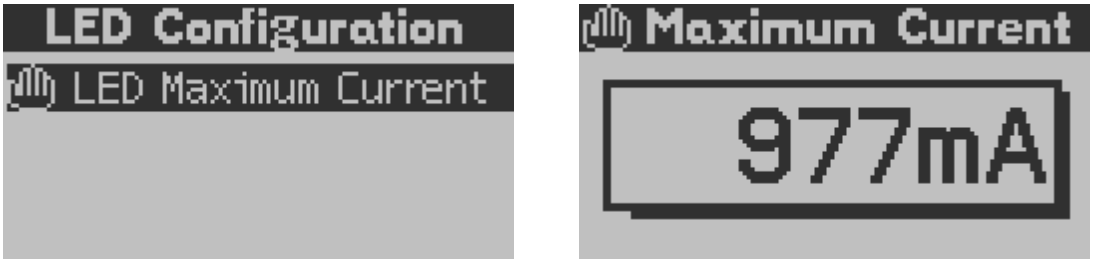

Figure 16 LED Maximum Current

3.1.3.2 Settings

Within the system configuration the LCD backlight brightness can be set. Select 'Settings' from the main menu via the multi-control knob and press 'Ok'. A sub menu appears and the 'Brightness' setting can be accessed by pressing the 'Ok' button. The multi-control knob is used to change the brightness of the LCD backlight between 0 and 100%. Confirm your setting with 'Ok' or cancel it with 'ESC'.

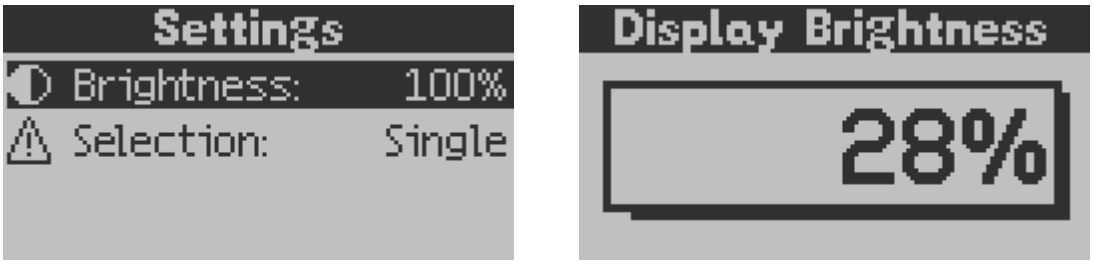

Figure 17 Display Brightness Setting

The additional menu item 'Selection' in the 'Settings' section describes the output mode. The 'Single Selection Mode' allows to switch on only one LED at a time, while within the 'Multi Selection Mode' any configuration and up to all four LEDs can be switched on together.

3.1.3.3 About

The item 'About' gives information about the firmware version, serial number of the DC4100 and the connected LED head if available.

Figure 18 About Panel

3.2 Remote Application

The DC4100 remote software can be used to operate the DC4100 - 4 Channel LED Driver via the PC. The device has to be connected to the PC by an USB cable.

3.2.1 Requirements

To operate the DC4100 on a PC your system needs to fulfill the following

Minimum Hard- and Software Requirements:

- Operating system: Windows 2000®, Windows XP® SP2, Windows Vista® or higher
- USB 2.0 high speed port (USB 1.1 full speed port is also usable)

3.2.2 Installation

3.2.2.1 The Installation Menu

Insert the '**Thorlabs DC4100 - 4 Channel LED Driver CD 1.0**' (or higher) CD-ROM in your CD/DVD drive. It automatically starts up and displays the installation start screen.

In case this 'auto start' feature is disabled on your computer please execute the 'Autorun\Autorun.exe' file on the CD.

Figure 19 Autorun Menu

NOTE

Please be aware that you need a 'VISA runtime engine' installed on your system to operate the DC4100 remote application.

3.2.2.2 Installing VISA Runtime Engine

A VISA runtime 4.3.0 or higher has to be installed on your system to operate the DC4100 remote application.
You may install the National Instruments©® VISA runtime engine provided on the installation CD. You may also download the latest NI-VISA runtime engine from the National Instruments©® web site (www.ni.com/visa).

In case you want to use the VISA engine provided on the installation CD select 'NI-VISA™ Engine'. An installation wizard will be started. If you are running Windows VISTA©® you might be prompted to change to the 'Elevated Mode'. Please ask your administrator for help when you do not have administrator privileges.

Follow the instructions of the installation wizard.

3.2.2.3 Installing the Remote Application

Select 'DC4100 - Application software' from the installation menu to start the installation wizard. If you are running Windows VISTA©® you might be prompted to change to the 'elevated mode', as shown in the following figure. Please ask your administrator for help when you do not have administrator privileges.

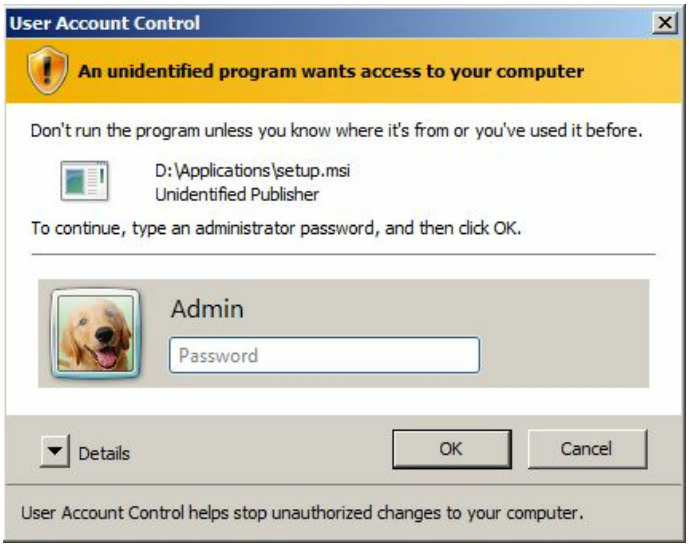

Figure 20 Request for Administrator Privileges

After the DC4100 remote application installation wizard finished the initialization, you will be prompted to specify the installation path. Follow the instruction of the installation wizard in order to install the remote software and drivers for the DC4100. During the installation process a separate installation wizard will start to register the device drivers on your system. The system will inform you that the software installation has not passed the Windows logo test. This will happen twice.
Ignore the warning and click 'Continue Anyway'.

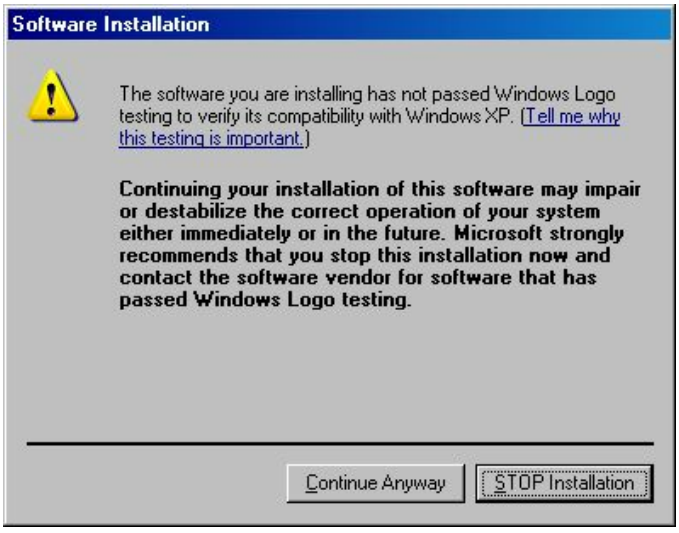

Figure 21 The Windows Logo Test

3.2.2.4 Driver Installation

The necessary driver for the DC4100 - 4 Channel LED Driver unit is automatically copied to the system folder during the installation of the DC4100 remote application.

ATTENTION

The following procedure will only be necessary for Windows XP/2000©®.

When you first connect a device the 'Found New Hardware Wizard' will start to install the new device. Depending on the configuration of your system you might be asked if you want to connect to 'Windows Update to search for Software'.

First the 'USB to DC4100 Bridge' will be installed:

1. Please select 'No, not this time' and click 'Next' to continue.
2. Select 'Install the software automatically' and click 'Next' to continue.
3. A message appears informing that the software has failed the Windows logo test. Click 'Continue Anyway'.
4. Finalize the installation by clicking 'Finish'.

After this first installation the 'DC4100 - 4 Channel LED Driver will be installed. Repeat step 1 to 4.

3.2.3 Operating the DC4100 by the Remote Application

The DC4100 remote application can be used to operate a DC4100 - 4 Channel LED Driver via the PC.
Every setting made, will automatically be used by the device. The parameters are updated/synchronized once every second.

3.2.3.1 Connecting a Device

Please connect the DC4100 to your PC with the shipped USB cable. The USB socket is labeled 'USB' at the back of the main control.
After starting the application the following window is displayed.

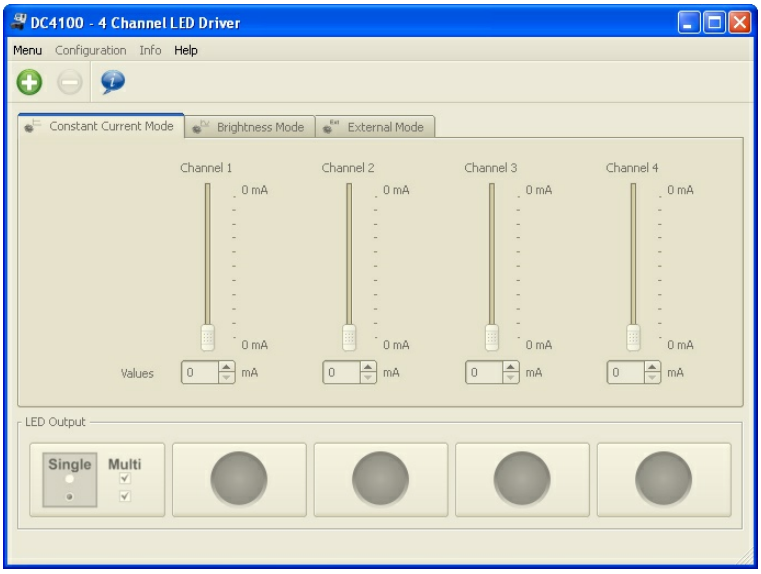

Figure 22 The Start Screen

Use the green button or the menu option 'Connect...' to open the device selection dialog.

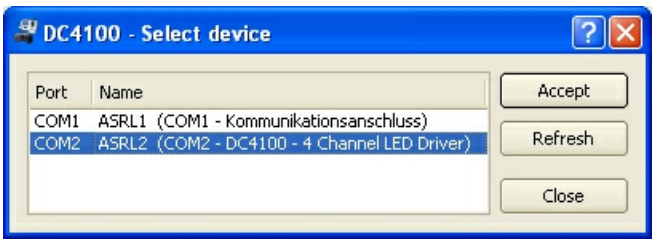

Figure 23 The Device Selection Dialog

Select your DC4100 - 4 Channel LED Driver by double-clicking or pressing the 'Accept' button. The device will be connected and the last active mode will be entered. The upload of the actual values on the system may take some seconds.

You can disconnect the DC4100 by clicking on the 'Disconnect' button or by selecting 'Menu -> Disconnect'.

3.2.3.2 Constant Current Mode

The constant current can be selected by pressing the 'Constant Current Mode' tab.

You can change the value directly by typing into the numeric control, use the small arrows or changing the slider. If you enter a numerical value you have to press 'Enter' to confirm it. The maximum value depends on the user current limit, which is set in the configuration menu.

The individual LEDs can be switched on or off by clicking on the LED figure below the corresponding slider. See picture below, channel 2 and channel 4 are switched on.

The button in the left lower corner is used to change between the output modes 'Single Selection' and 'Multi Selection'. Within the 'Single Selection Mode' only one LED can be switched on while within the 'Multi Selection Mode' up to four LEDs can be used.

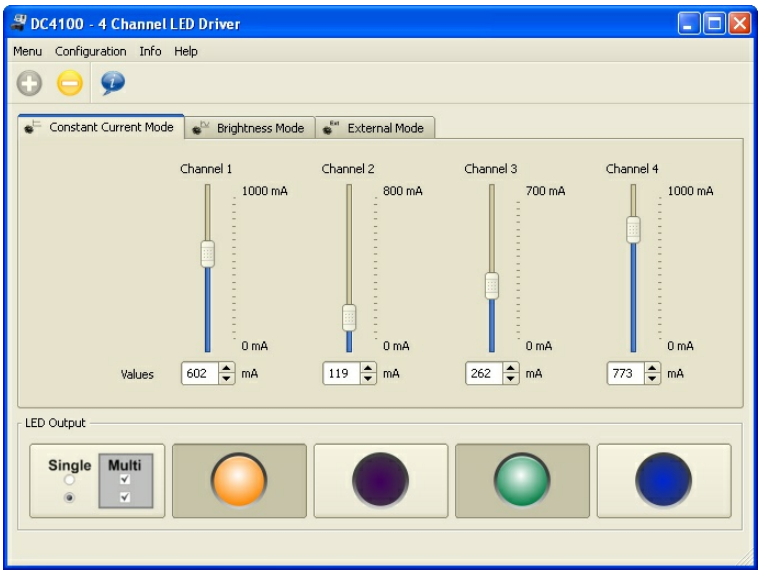

Figure 24 Constant Current Mode

If no LED is connected the controls for the corresponding channel are disabled. Some LEDs feature an EEPROM, which contains information such as current limit and wavelength. The wavelength is displayed as color. In the above picture a LED with a wavelength of 630nm (red) is connected to channel 1. If this information is not available the LED is displayed grey.

3.2.3.3 Brightness Mode

The internal modulation mode can be selected by pressing the 'Brightness Mode' tab.

You can change the value directly by typing into the numeric control, by using the small arrows or by changing the slider. If you enter a numerical value you have to press 'Enter' to confirm it. The maximum value is 100% and corresponds to the user limit current, which is set in the configuration menu. The resulting current for each LED channel is displayed below the numeric control.

Each channel can be set individually by the corresponding control element. Using the control elements 'All Channels' will set the same brightness values for each channel.

The individual LEDs can be switched on or off by clicking on the LED figure below the corresponding slider. See picture below, channel 3 (amber LED) is switched on.

The button in the left lower corner is used to change between the output modes 'Single Selection' and 'Multi Selection'. Within the 'Single Selection Mode' only one LED can be switched on while within the 'Multi Selection Mode' up to four LEDs can be used.

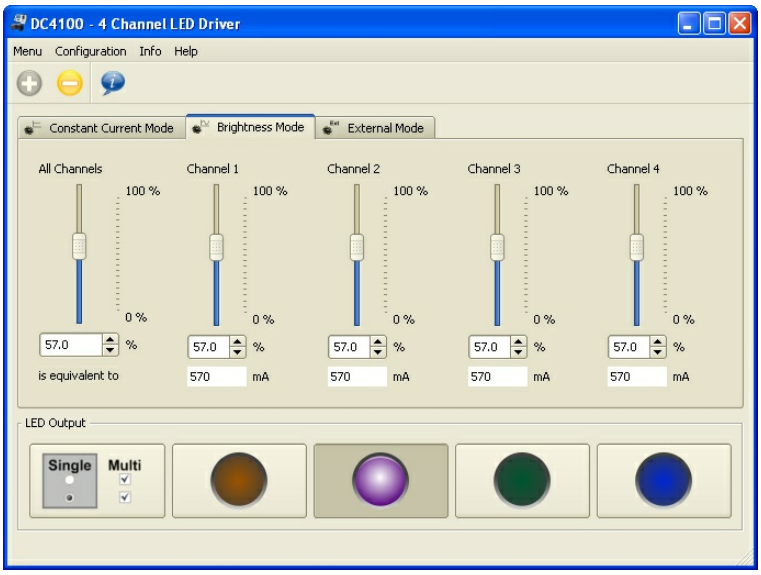

Figure 25 The Brightness Mode

3.2.3.4 External Control Mode

The 'External Control Mode' can be selected by pressing the 'External Control Mode' tab.

In this mode the LED can only be controlled via the BNC connector at the rear panel of the DC4100. The applied voltage corresponds to the LED current. 1V is equivalent to a LED current of 100mA. A maximum voltage of 10V can be applied, which will result in a current of 1A. All LED channels will be addressed by the control voltage. They can be enabled or disabled by clicking on the LED figure below the corresponding channel indicator.

The button in the left lower corner is used to change between the output modes 'Single Selection' and 'Multi Selection'. Within the 'Single Selection Mode' only one LED can be enabled while within the 'Multi Selection Mode' up to four LEDs can be used.

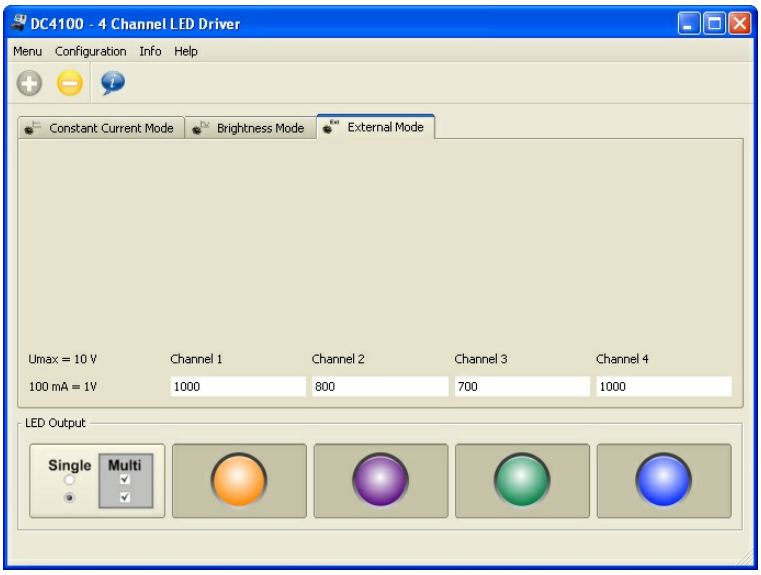

Figure 26 The External Control Mode

3.2.3.5 User Limit Current

The user can set an individual current limit. Some of the Thorlabs LED heads feature an EEPROM, where the LEDs maximum current limit is stored. The user current limit has to be below or equal to this maximum current limit.
Select 'Configuration -> User Limit Current...' from the menu.

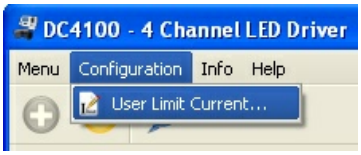

Figure 27 User Limit

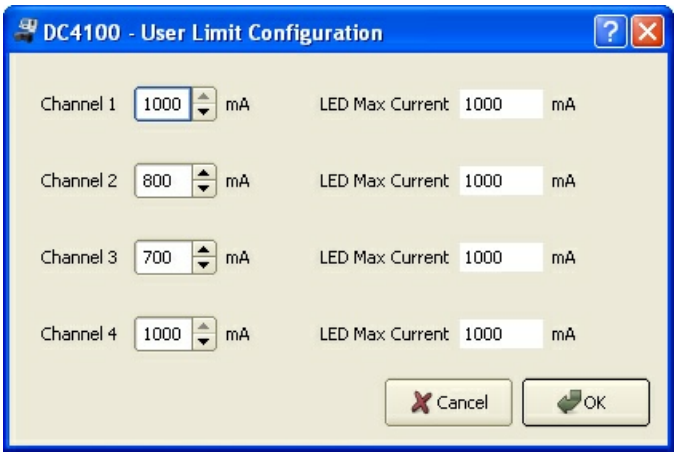

Figure 28 User Limit Dialog

3.2.3.6 Device Information

Select 'Info -> Device Information...' from the menu to obtain data about the DC4100 unit.

Figure 29 Device Information

The following screen appears containing the serial number, device name, manufacturer, driver version and firmware revision.

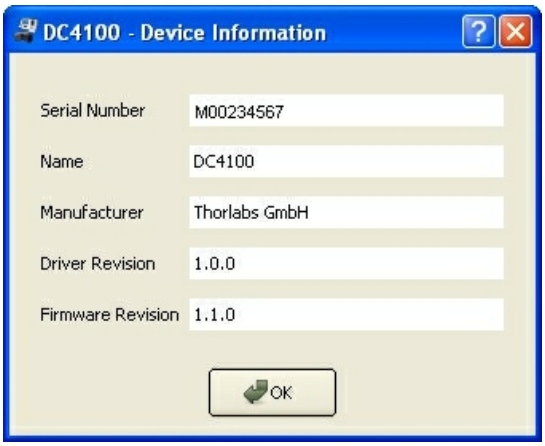

Figure 30 Device Information Dialog

If a channel information was selected the appropriate panel appears giving information about the connected LED. The head data is only available if the LED comes with an EEPROM. The following parameter are available: name, type serial number, wavelength and forward bias.

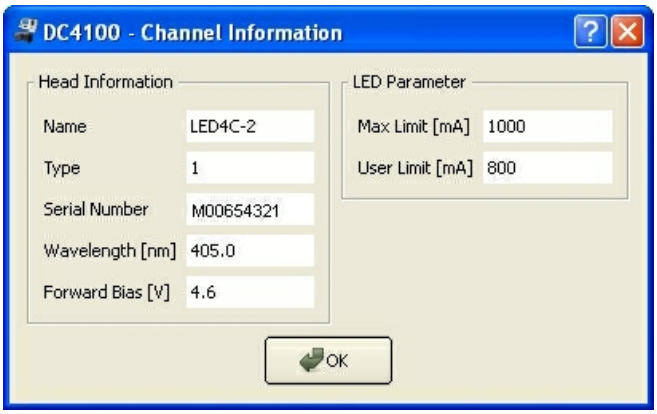

Figure 31 Head Information Dialog

3.2.3.7 Help Menu

Within the topic 'Help' of the menu you can access the help file of the DC4100, visit the Thorlabs website, view the license agreement and get information about applications.

3.3 Changing a LED

The DC4100 - 4 Channel LED Driver is not hot-pluggable. The unit needs to be switched off prior to connecting or exchanging a LED.

Thorlabs offers a wide range of LEDs, which can connected to the DC4100 directly or via the DC4100-HUB. Check our website www.thorlabs.com. You can also connect your own LED.

The following picture shows the female connector of the DC4100-HUB. It is a standard M8x1 sensor circular connector. Pin 1 and 2 are the connection to the LED. Pin 3 and 4 are used for the internal EEPROM, please do not use these connections.

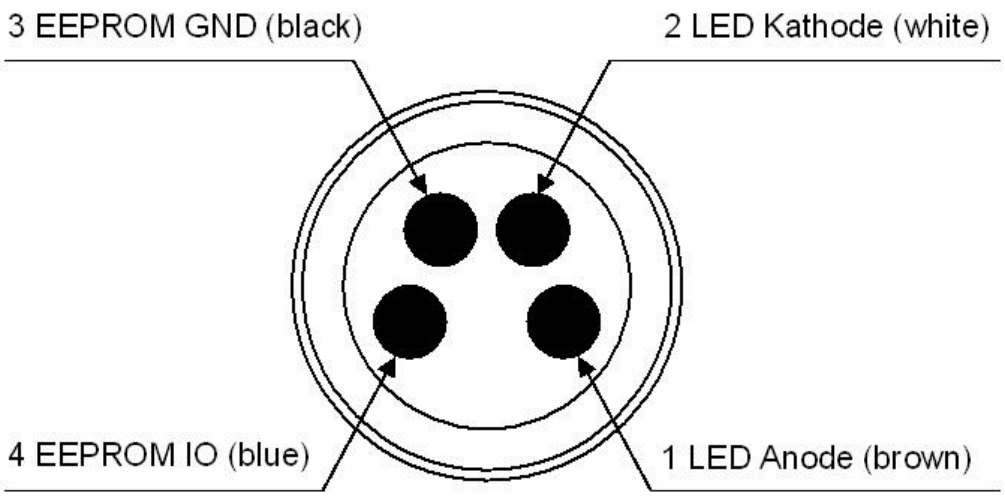

Figure 32 Female Connector of the DC4100-HUB

4 Computer Interface

The DC4100 has an USB 2.0 interface that allows to send commands from a host computer to the instrument using the DC4100 - VISA Instrument Driver. The connection between PC and DC4100 is accomplished by an USB cable with a male type 'A' connector at the PC side and a type 'B' connector on the instrument side.

See chapter Command List for a complete command reference.

4.1 Connecting a Computer

ATTENTION

To successfully complete the installation of the DC4100 USB driver, you must have Administrator privileges on the PC, on which you are performing the installation.

Prior to connecting the DC4100 with the PC, please insert the CD that was shipped with the instrument and install the DC4100 drivers. If the following message appears after the installation, you have to install NI-VISA from the distribution CD or from the National Instruments web site.

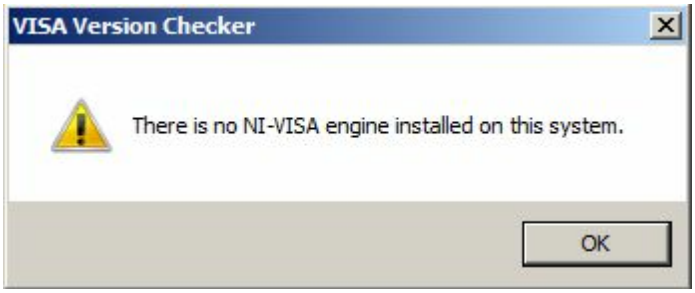

Figure 33 No VISA Engine installed

After successfully installing the software connect the DC4100 to a USB port of your PC. The PC will sequentially find a DC4100 and a DFU device. Please follow the instructions of the dialog screens and allow the installation.

4.2 DC4100 Utility Software

The DC4100 comes with an utility software, by which the DC4100 can be remotely operated.
Additionally the DC4100 comes with a driver package, which can be used by C/C++/LabVIEW and every programming language supporting DLLs.
Please refer to the manuals, which are copied on your system when installing the device driver.

NOTE

Please be aware that you need a VISA engine installed on your system to use the DC4100 - VISA Instrument Driver.

The DC4100 sample applications will be copied to your VXIPNP directory during the driver package installation. The default VXIPNP directory is “C:\VXIPNP” or starting with NI-VISA version 4.2 “C:\Program Files\IVI Foundation”. You can find the sample applications in:

„C:\VXIPNP\WinNT\Thorlabs DC4100\sample”

or

„C:\Program Files\IVI Foundation\WinNT\Thorlabs DC4100\sample”

4.3 Command Reference

4.3.1 Command List

Command	Description
DC4100_setLimitCurrent	Set User Current Limit
DC4100_getLimitCurrent	Get User Current Limit
DC4100_setMaxLimit	Set Maximum Current Limit
DC4100_getMaxLimit	Get Maximum Current Limit
DC4100_setOperationMode	Set Operation Mode
DC4100_getOperationMode	Get Operation Mode
DC4100_setSelection Mode	Set Selection Mode
DC4100_getSelection Mode	Get Selection Mode
DC4100_setLedOnOff	Set LED On or Off
DC4100_getLedOnOff	Gets the LED Output State
DC4100_setConstCurrent	Set Constant Current
DC4100_getConstCurrent	Get Constant Current
DC4100_setPercentalBrightness	Set percental Brightness
DC4100_getPercentalBrightness	Get percental Brightness
DC4100_setDispBright	Set Display Brightness
DC4100_getDispBright	Get Display Brightness
DC4100_getStatusRegister	Get Status Register
DC4100_errorMessage	Error Message
DC4100_identificationQuery	Identification Query
DC4100_revisionQuery	Revision Query
DC4100_getHeadInfo	LED Head Identification Query
DC4100_getWavelength	Get LED Wavelength
DC4100_getForwardBias	Get LED Forward Bias

Table 1 Command List

4.3.1.1 Description

4.3.1.1.1 Set User Current Limit

Command:	DC4100_setLimitCurrent
Parameter:	LED channel Current limit in ampere
Response:	None
Description:	Sets the current limit for specified channel. This limit may not exceed the LEDs limit specified in the LED head.

4.3.1.1.2 Get User Current Limit

Command:	DC4100_getLimitCurrent
Parameter:	LED channel
Response:	Current limit in ampere
Description:	Returns the current limit for specified LED channel.

4.3.1.1.3 Set Maximum Current Limit

Command:	DC4100_setMaxLimit
Parameter:	LED channel Maximum current limit in ampere
Response:	None
Description:	Sets the LEDs maximum current limit in ampere. This limit takes only affect until the next restart of the system.

4.3.1.1.4 Get Maximum Current Limit

Command:	DC4100_getMaxLimit
Parameter:	LED channel
Response:	Maximum current limit in ampere
Description:	Gets the LEDs maximum current limit in ampere. This value is specific for each LED channel.

4.3.1.1.5 Set Operation Mode

Command:	DC4100_setOperationMode
Parameter:	Operation mode
Response:	None
Description:	Sets the operation mode.

4.3.1.1.6 Get Operation Mode

Command:	DC4100_getOperationMode
Parameter:	None
Response:	Operation mode
Description:	Gets the actual operation mode.

4.3.1.1.7 Set Selection Mode

Command:	DC4100_setSelectionMode
Parameter:	Selection mode
Response:	None
Description:	Sets the selection mode.

4.3.1.1.8 Get Selection Mode

Command:	DC4100_getSelectionMode
Parameter:	None
Response:	Selection Mode
Description:	Gets the selection mode.

4.3.1.1.9 Set LED OnOff

Command:	DC4100_setLedOnOff
Parameter:	LED channel LED output
Response:	None
Description:	Sets the LED on or off.

4.3.1.1.10 Get LED OnOff

Command:	DC4100_getLedOnOff
Parameter:	LED channel
Response:	LED output state
Description:	Gets the LED output state.

4.3.1.1.11 Set Constant Current

Command:	DC4100_setConstCurrent
Parameter:	LED channel Constant current in ampere
Response:	None
Description:	Sets the current for one channel used in the constant current mode.

4.3.1.1.12 Get Constant Current

Command:	DC4100_getConstCurrent
Parameter:	LED channel
Response:	Constant current in ampere
Description:	Gets the current of a specified channel used for the constant current mode.

4.3.1.1.13 Set Percental Brightness

Command:	DC4100_setPercentalBrightness
Parameter:	LED channel Percental brightness
Response:	None
Description:	Sets the percental brightness for one LED channel.

4.3.1.1.14 Get Percental Brightness

Command:	DC4100_getPercentalBrightness
Parameter:	LED channel
Response:	Brightness in percent
Description:	Gets the percental brightness of one LED channel in %.

4.3.1.1.15 Set Display Brightness

Command:	DC4100_setDispBright
Parameter:	Display brightness in %
Response:	None
Description:	Sets the display brightness.

4.3.1.1.16 Get Display Brightness

Command:	DC4100_getDispBright
Parameter:	None
Response:	Display brightness in %
Description:	Returns the current limit for specified LED channel.

4.3.1.1.17 Get Status Register

Command:	DC4100_getStatusRegister
Parameter:	None
Response:	Status register value
Description:	Reads the content of the instruments status register. Refer to chapter StatusReporting.

4.3.1.1.18 Error Message

Command:	DC4100_errorMessage
Parameter:	Error Code
Response:	User readable message string
Description:	This function takes the error code returned by the instrument driver functions, interprets it and returns it as an user readable string.

4.3.1.1.19 Identification Query

Command:	DC4100_identificationQuery
Parameter:	None
Response:	Manufacturer name Device name Serial number Firmware version
Description:	This function returns the device identification information.

4.3.1.1.20 Revision Query

Command:	DC4100_revisionQuery
Parameter:	None
Response:	Instrument driver revision Firmware revision
Description:	This function returns the instrument driver revision and the device firmware revision.

4.3.1.1.21 LED Head Identification Query

Command:	DC4100_revisionQuery
Parameter:	LED channel
Response:	LED type Serial number
Description:	This function returns the LED head identification information for the specified channel.

4.3.1.1.22 Get Wavelength

Command:	DC4100_getWavelength
Parameter:	LED channel
Response:	LED wavelength
Description:	This function returns the wavelength information for specified channel.

4.3.1.1.23 Get Forward Bias

Command:	DC4100_getForwardBias
Parameter:	LED channel
Response:	LED forward bias
Description:	This function returns the forward bias for specified channel.

4.4 Status Reporting

The DC4100 stores the status in a register. It can be accessed via the 'DC4100_getStatusRegister. The following table lists all status numbers and the according descriptive messages. Each bit represents an error.

Status Bit	Name	Description
Bit 0	VCC Fail Changed	The bit 'VCC Fail' has changed.
Bit 1	VCC Fail	The power supply is out of range.
Bit 2	OTP Change	The bit 'OTP' (Over Temperature) has changed.
Bit 3	OTP	Over temperature (OTP) in the chassis was detected. The LED head was switched off.
Bit 4	No LED1 Changed	The bit 'No LED1' has changed.
Bit 5	No LED1	The LED at channel1 is not connected.
Bit 6	No LED2 Changed	The bit 'No LED2' has changed.
Bit 7	No LED2	The LED at channel2 is not connected.
Bit 8	No LED3 Changed	The bit 'No LED3' has changed.
Bit 9	No LED3	The LED at channel3 is not connected.
Bit 10	No LED4 Changed	The bit 'No LED4' has changed.
Bit 11	No LED4	The LED at channel4 is not connected.
Bit 12	LED Open1 Changed	The bit 'LED Open 1' has changed.
Bit 13	LED Open1	LED channel 1: No LED is connected.
Bit 14	LED Open2 Changed	The bit 'LED Open 2' has changed.
Bit 15	LED Open2	LED channel 2: No LED is connected.
Bit 16	LED Open3 Changed	The bit 'LED Open 3' has changed.
Bit 17	LED Open3	LED channel 3: No LED is connected.
Bit 18	LED Open4 Changed	The bit 'LED Open 4' has changed.
Bit 19	LED Open4	LED channel 4: No LED is connected.
Bit 20	Limit1 Changed	The bit 'Limit 1' has changed.
Bit 21	Limit1	LED channel 1: The adjusted current is greater than the current limit and was coerced to the limit.
Bit 22	Limit2 Changed	The bit 'Limit 2' has changed.

Bit 23	Limit2	LED channel 2: The adjusted current is greater than the current limit and was coerced to the limit.
Bit 24	Limit3 Changed	The bit 'Limit 3' has changed.
Bit 25	Limit3	LED channel 3: The adjusted current is greater than the current limit and was coerced to the limit.
Bit 26	Limit4 Changed	The bit 'Limit 4' has changed.
Bit 27	Limit4	LED channel 4: The adjusted current is greater than the current limit and was coerced to the limit.
Bit 28	Interface Refresh	The user has changed settings.

Table 2 Status Bit List

4.5 Firmware Update

Firmware upgrades can be done by the user via the USB interface.

You need the batch file DC4100_Firmware_Update.bat and the hex file DC4100. hex. Both files have to be in the same directory.

Connect the DC4100 with a USB cable to your computer. Check the COM port of the DC4100. It has to be COM1, COM2, COM3 or COM4. If not please change the COM port to one of the listed COM ports.

Before you switch on the DC4100 press the LED button and keep it pressed while you switch on the device. The DC4100 shows 'DC4100 BOOTLOADER' in its display. Start the batch file. The new firmware will be uploaded to the DC4100.

Please refer to www.thorlabs.com for the latest DC4100 firmware version that can be downloaded as a *.hex file.
Do not switch off the DC4100 or disconnect the USB cable during the firmware download.

5 Maintenance and Service

5.1 Maintenance

Protect the DC4100 from adverse weather conditions. The DC4100 is not water resistant.

ATTENTION

To avoid damage to the DC4100, do not expose it to spray, liquids or solvents!

The unit does not need a regular maintenance by the user.

If necessary the unit and the display can be cleaned with a cloth dampened with water.

The DC4100 does not contain any modules that could be repaired by the user himself. If a malfunction occurs, the whole unit has to be sent back to *Thorlabs*. Do not remove covers!

5.2 Version and other Information

The menu entry 'Help -> About Thorlabs' displays application relevant data.

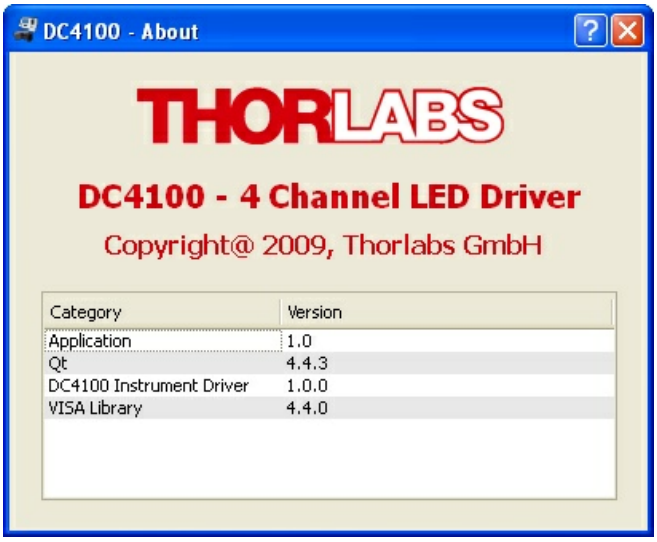

Figure 34 About Screen

In case of a support request, please submit the software version of the application. This will help to locate the error.

Visit Thorlabs website www.thorlabs.com for available updates to download.

5.3 Troubleshooting

The DC4100 features protection circuits to prevent damage of the unit. The user will be informed about the occurrence of errors. Example:

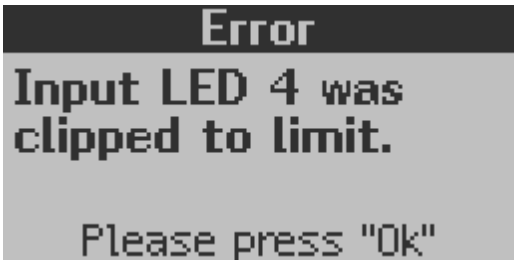

Figure 35 Error Message

The following table summarizes possible errors:

Message Text	Explanation and Impact	Elimination
Clipped to Limit Error	The current of the specified channel was reduced to the set current limit. This can happen in the 'External Control Mode', when a voltage was applied to the external trigger input representing a current, which is higher than the limit.	Decrease the input voltage.
LED Open Error	The LED is switched off, because the maximum forward voltage was reached. If a LED with more than 5V forward voltage was connected this error can occur.	Only LEDs with a forward voltage below or equal to 5V can be driven with the DC4100. The forward voltage depends on the actual current. Reduce the current to a forward voltage level of 5V or less.
Over Temperature Error	The temperature within the DC4100 case reached the maximum limit and all channels are switched off.	Make sure that the ventilation slots are not covered. It is necessary to ensure an air ventilation through the DC4100 unit.
Software Installation failed	The software cannot be installed on the computer.	Be sure to have **administrative rights** on your computer, which enables you to install software at all. Ask your system administrator to give you such rights or to do the installation himself. See Software Installation for details.

Message Text	Explanation and Impact	Elimination
LED cannot be switched on	After pressing the LED button the LED does not emit light.	Check if the LED current is set to a value larger than 0mA. A LED can only be switched on if one of the 3 operation modes is selected.

Table 3 Error Table

6 Application Note

This chapter contains the background knowledge about LED drivers.

6.1 LED Driver

A simple definition of a LED driver:

A LED driver is a circuit that can produce enough current through a LED to get light.

There are many ways to realize such a circuit. The most simple solution would be a voltage source, a series resistor and the LED. This is of course not economic and will not meet most requirements especially for high power LEDs.

There are a wide range of solutions for LED drivers which can be divided in three categories:
1. Linear LED driver
2. Switching LED driver
3. Combination of linear and switching LED driver

Linear Driver
A linear voltage driver can be used to generate a constant current. A shunt is in series with the load (LED). The voltage drop of the shunt is proportional to the current and is measured and provides a feedback signal to adjust the output voltage and therefore the current.
The main advantages are the low output current ripple and its EMC compatibility. There are no switching elements in the circuit. Therefore it is applicable for fluorescence microscopy illumination. Due to the adjustment of the LED current with a linear driver a high dissipation loss can be generated. This results in heat and depends on LED type and current. The efficiency can be quite low.

Switching Drivers
A switching driver with a constant current output is an efficient LED driver especially for high power LEDs.
The working principle is based on an inductor in series with a LED load or a capacitor parallel to a LED load. The inductor or capacitor, respectively, accumulates the energy during the switch on state. This energy is used to supply a current through the LED. There exists different concepts like the Buck driver which converts a higher supply voltage into a lower LED forward voltage and the Boost driver which converts a lower supply voltage into a higher LED forward voltage. It is also possible to combine both methods to a Buck- Boost- solution.
The main advantage is the high efficiency. Furthermore, a high supply voltage range can be realized without a high dissipation loss. Compared to linear drivers a switching driver shows a not only a quite large ripple on the output current which can be as high as 20%. They also need careful considerations regarding EMC. Because of these disadvantages this method is not suitable for microscopy LED illumination.

Combination of Linear and Switching Drivers

This method combines the advantages of both method. A switching driver is used to adjust the supply voltage to value near the LED forward bias. A following linear driver generates a constant current with low ripple. The heat dissipation is reduced to a minimum.

The disadvantage of this method is the use of more expensive components which also need more space than conventional constant current linear or switching drivers.

7 Appendix

7.1 Warranty

Thorlabs GmbH warrants material and production of the DC4100 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 (Germany)* or to a place determined by *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 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 faulty free and uninterrupted operation of the unit, of the soft- 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 conditions 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 and without notice.

7.2 Certifications and Compliances

Certifications and Compliances		
Category	**Standards or description**	
EC Declaration of Conformity - EMC	Meets intent of Directive 2004/108/EC [1] for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:	
	EN 61326-1:2006	Electrical equipment for measurement, control and laboratory use – EMC requirements: Immunity: complies with basic immunity test requirements [2,3].

		Emission: complies with EN 55011 Class B Limits [2,3,4], IEC 610003-2 and IEC 61000-3-3.
	IEC 61000-4-2	Electrostatic Discharge Immunity (Performance Criterion B)
	IEC 61000-4-3	Radiated RF Electromagnetic Field Immunity (Performance Criterion A)[5]
	IEC 61000-4-4	Electrical Fast Transient / Burst Immunity (Performance Criterion B)
	IEC 61000-4-5	Power Line Surge Immunity (Performance Criterion A)
	IEC 61000-4-6	Conducted RF Immunity (Performance Criterion A)
	IEC 61000-4-11	Voltage Dips, Short Interruptions and Voltage Variations Immunity (Performance Criterion A / C [6])
	IEC 61000-3-2	AC Power Line harmonic Emissions
	IEC 61000-3-3	Voltage Fluctuations and Flicker
FCC EMC Compliance	Emissions comply with the Class B Limits of FCC Code of Federal Regulations 47, Part 15, Subpart B [2,3,4].	
EC Declaration of Conformity - Low Voltage	Compliance was demonstrated to the following specification as listed in the Official Journal of the European Communities: Low Voltage Directive 2006/95/EC [7]	
	EN 61010-1:2001	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use - Part 1: General Requirements
U.S. Nationally Recognized Testing Laboratory Listing	UL 61010-1 2nd ed.	
	ISA-82:02.01 2nd ed.	
Canadian Certification	CAN/CSA C22.2 No. 61010-1 2nd ed.	
Additional Compliance	IEC 61010-1:2001	
Equipment Type	Test and Measuring	
Safety Class	Class I equipment (as defined in IEC 60950-1:2001)	

[1] Replaces 89/336/EEC.

[2] Compliance demonstrated using high-quality shielded interface cables shorter than or equal to 3 meters.

[3] Compliance demonstrated with DC4100-HUB or LED4C series installed at the LED port.

[4] Emissions, which exceed the levels required by these standards, may occur when this equipment is connected to a test object.

[5] Ext Trig port capped at IEC 61000-4-3 test.

[6] Performance Criterion C was reached at voltage interruptions test level 0% for 250 / 300 cycles and is permitted at this test level.

[7] Replaces 73/23/EEC, amended by 93/68/EEC

7.3 Technical Data

7.3.1 Common Data

Line Voltage (Ext. Power Supply)	100 ... 240VAC (-10%, +10%)
Line Frequency (Ext. Power Supply)	50 ... 60Hz
Power Consumption (max)	45VA
Supply mains over Voltage	Category II (Cat II)
Input Voltage (DC4100 chassis)	12VDC
Operating Temperature [1)]	0 ... +40 °C
Storage Temperature	-40 ... +70 °C
Relative Humidity	Max. 80% up to 31 °C decreasing to 50% at 40 °C
Pollution Degree (indoor use only)	2
Operation Altitude	< 3000 m
Warm-up Time for rated Accuracy	10 min
Weight	< 1 kg
Dimensions (W x H x D) without operating elements	160 x 80 x 150 mm³
Dimensions (W x H x D) with operating elements	160 x 80 x 168 mm³

[1)] non condensing

7.3.2 Technical Data

All technical data are valid at 23 ± 5°C and 45 ± 15% rel. humidity.

LED Current Range (for each Channel)	0 ... 1000mA
LED Current Resolution	1mA
LED Current Accuracy	±10mA
LED Forward Voltage (for each Channel)	max. 5V
Modulation Frequency Range (External Control Mode only)	0 ...100kHz (Sine Wave)
Modulation (External Control Mode only)	arbitrary
Trigger Input (External Control Mode only)	max. 10V 1V corresponds to 100mA

7.4 Letter of Volatility

Manufacturer: Thorlabs GmbH
Model Number: DC4100

Memory Size	Memory Type Purpose	Volatility	User Data	Method of Clearing
8kByte	SRAM (ATmega1281): • Program SRAM	yes	no	Power down
128kByte	FLASH (ATmega1281): • Program Code	no	no	Cannot be cleared by user
4kbyte	EEPROM (ATmega1281): • User settings	no	yes	Can be overwritten with the device
1kByte	EEPROM (FTDI FT232R): • VID, PID • IO Configuration	no	no	Cannot be cleared by user
256Byte	SRAM (FTDI FT232R): • USB receive buffer	yes	no	Power down
128Byte	SRAM (FTDI FT232R): • USB transmit buffer	yes	no	Power down

7.5 Thorlabs 'End of Life' Policy (WEEE)

As required by the WEEE (Waste Electrical and Electronic Equipment Directive) of the European Community and the corresponding national laws, Thorlabs 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 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 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.)

If you wish to return a Thorlabs unit for waste recovery, please contact Thorlabs or your nearest dealer for further information.

7.5.1 Waste Treatment on your own Responsibility

If you do not return an 'end of life' unit to Thorlabs, 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.

7.5.2 Ecological Background

It is well known that WEEE 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 live products will thereby avoid negative impacts on the environment.

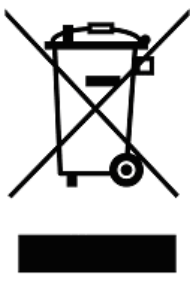

Figure 36 Crossed out 'Wheelie Bin' Symbol

7.6 List of Acronyms

The following acronyms and abbreviations are used in this manual:

AC	Alternating Current
AGND	Analog Ground
DC	Direct Current
DGND	Digital Ground
DLL	Dynamic Link Library
EEPROM	Electrically Erasable Programmable Read-Only Memory
FCC	Federal Communications Commission
FLIM	Fluorescence Lifetime Imaging
GUI	Graphical User Interface
IEC	International Electrotechnical Commission
LCD	Liquid Crystal Display
LED	Light Emitting Diode
PC	Personal Computer
PCB	Printed Circuit Board
PWM	Pulse Width Modulation
USB	Universal Serial Bus
WEEE	Waste Electrical and Electronic Equipment Directive

7.7 List of Figures

7.8 List of Tables

7.9 Copyright

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

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Please call our hotline, send an Email to ask for your nearest distributor or just visit our homepage **http://www.thorlabs.com**

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