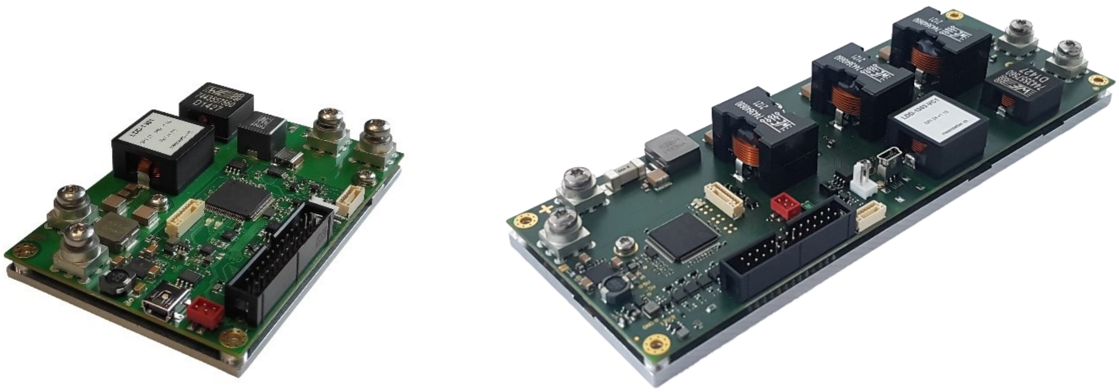
User Manual – LDD-130x



LDD-130x:

LDD-1301
LDD-1303

Member of Berndorf Group

Developed, assembled, and tested in Switzerland

Index

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Document 5261F

LDD-130x Firmware Version v2.00

Release date: 26 June 2024

1 Introduction

This manual covers the functionality of the LDD-130x digital (laser) diode drivers.

Most of the explanations in this document assume that you use the “LDD-130x Service Software”, but all the operations can also be done by your own application if you implement the functionality. Most of the commands are documented in our communication protocol documents.

If you cannot find the feature or setting you need, please do not hesitate to contact our support. We do also provide customized firmware solutions.

1.1 Important Documents

- Datasheets
  - Technical specifications
  - Hardware configurations
  - Ordering information
- Communication Protocols
  - Protocol specification
  - Commands, Parameters
  - Example Applications and APIs
- Temperature & Light Sensor Cable Specifications
  - Pinout
  - Temperature sensor and photodiode assembly
- Temperature Sensor Suggestions
  - Description, part numbers and distributors for NTC sensors
- Application Notes
  - Additional Information about various usages of our devices

1.2 How to Contact Support

For optimal technical assistance we need the following information:

- Configuration file, exported while the error is present
  - Click “Export Config” in the footer
- Monitor History
  - Click “Maintenance” tab” → “Monitor Data Logger” → activate Checkbox “Export all Monitor Values to CSV File (Debug)→ “Export Logged Monitor Data to CSV File”
- A picture showing your system, the controller and the sensor leads.
- Datasheets of your Peltier element, power supply and any other important parts involved in your setup.

You can also use the TeamViewer software from our website for a remote-control session. As soon as you start the tool we will recognize you, but please make sure to call or write us beforehand.

2 Basic Functions

2.1 The Status Bar of Service Software

The bottom row of the software is always visible and shows the following information:

- Connection status
- Device status
    - Ready: Normal standby status (no errors). Output stage disabled
    - Run: Normal operating status (no errors). Output stage enabled
    - Error: Error occurred. Output stage disabled
    - Bootloader: Firmware is being updated
- Operating parameters
    - Output current and voltage

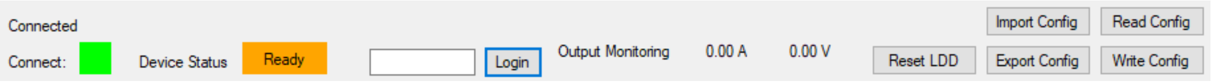


Figure 1. Status bar in the bottom row of the Service Software.

2.1.1 Status LEDs and Service Software Status

LDD-130x devices feature two status LEDs. In normal operation, the green LED is blinking.

In the case of any error occurring, the device enters an error status and the red LED is lit. Power circuitry (output stage) is immediately deactivated to ensure safety. Control, monitoring and communication circuitry remains active. In case of software / configuration errors (i.e. not hardware faults), parameters can be reconfigured on the fly. The device needs to be software-reset or power-cycled to the clear the error status.

Table 1. Status LED description.

Green LED	Red LED	Signification
Blinking slowly (~1 Hz)	-	"Ready" status (no errors). Output stage disabled
Blinking fast (~2Hz)	-	"Run" status (no errors). Output stage active
-	Static on	"Error" status. Output stage disabled
Static on	Static on	"Bootloader" status

When the Service Software is connected to a device, its status is displayed in the bottom of the software window.

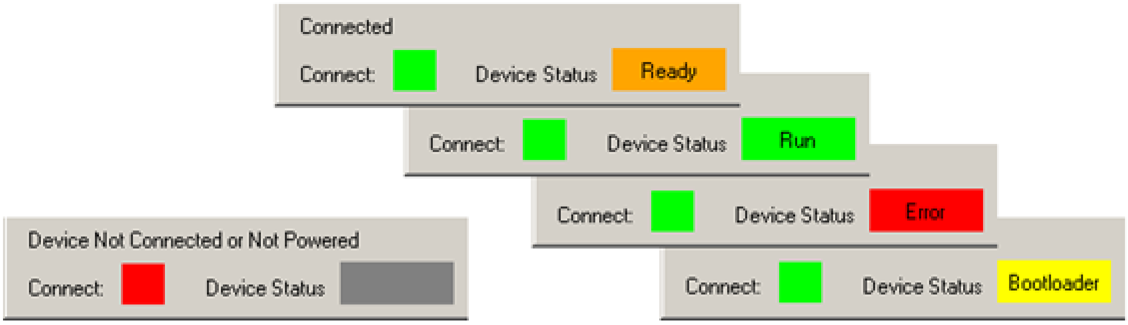


Figure 2. Service Software color codes for connection and device status.

Error Status:

If the device enters the error status, please go to the "Monitor" tab, there you can find the error number and description on the right side of the window.

Alternatively, you can find a list of all errors at the end of this User Manual.

2.1.2 Writing and Reading Device Parameters

Changed parameters are saved to the controller by clicking "Write Config" in the footer. Multiple parameter fields can be written at once. Be aware that also fields in tabs which are not currently displayed are written to the controller.

Parameters are read automatically when a connection to the controller is established.

2.1.3 Importing and Exporting .ini Configuration Files with the Service Software

Device configuration sets can be exported as backup or for support purposes. They are specific to each unit as they contain calibration data.

- Export
  - To save a configuration file on the PC, click on “Export Config” in the bottom right corner of the Service Software.
  - All actual values are also stored. The values are useful for support and analysis.
- Import
  - To load a configuration file from the PC, click on “Import Config” in the Service Software.
  - By default, calibration data is only imported when the serial number in the configuration file matches the connected device’s serial number (this option can be disabled in the relevant tabs at the bottom).

2.2 Remote Control Options

This is an overview of the different remote-control options for the device. It's possible to configure, control and monitor the device using any software which can communicate over an appropriate interface. In the "LDD-130x Communication Protocol 5260" document a list of the software options available from us can be found.

Generally, all parameters available in the Service Software can be read and written by other means using the communication protocol.

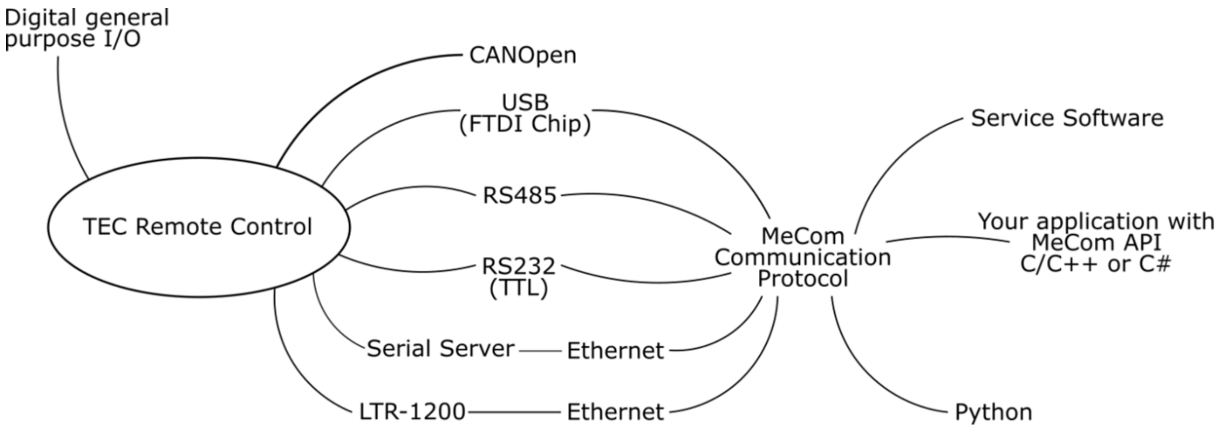


Figure 3. Remote control options.

2.2.1 Serial Communication

Serial communication is used to send data from a host to an LDD-130x and receive data from the device, respectively. The following physical interfaces are supported:

- USB
- RS485 (check out our TEC Application Note - RS485 Interface, valid for LDD-130x too)
- RS232 TTL[1]

Communication using the Service Software and RS485 is only possible using a USB–RS485 adapter or an Ethernet serial server, since the Service Software only connects to FTDI[2] chips or TCP port 50'000.

2.2.1.1 Addressing specific devices

Assign a unique "Device Address" to the device if multiple devices are operated on the same bus. The "Device Address" can be set on the "Operation" tab when the Service Software has already connected to the device. You can then tell the Service Software to use a specific device address to communicate. To do this, open the "Maintenance" tab and look for "Service Communication Settings". For more application arguments, check our communication protocol document. All devices have a 1-unit load receiver input impedance, allowing up to 32 transceivers on the RS-485 bus.

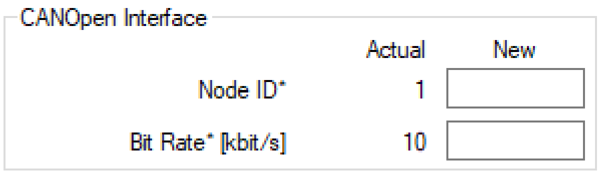
2.2.2 Ethernet Communication

It's possible to use a standard Serial Server to connect our devices to an Ethernet interface. We have tested devices from Lantronix (e.g. XPort, UDS1100) and Moxa (e.g. NPort 5130). Please check TEC Application Note - RS485 Interface, valid for LDD-130x devices too.

[1] Avalaibility dependent on device.
[2] One option is the USB RS485 converter cable from FTDI Chip, available in different lengths.

2.2.3 CANopen

This device supports CANopen according to CiA 301. Please refer to the "LDD-130x Communication Protocol 5260" for further details



2.3 Firmware Updates

You can download the firmware (contained in the software package) from our website and update your devices using the Service Software.

The Service Software and the Firmware are strongly related. Only when a Service Software and a Firmware with a matching Version Number are used the full functionality can be guaranteed. However, it is usually possible to connect to a device with an old Firmware with a new Service Software and vice-versa. Functionality will be limited, but firmware updates are possible.

Matching version numbers: All our published software has a version number similar to this: "vX.YZ". It is important that at least X and Y is matching. Z can be different.

Follow these steps to update devices:

- Read the LDD-130x Software Release Notes
- Backup the current configuration. This is important because it is possible that the current configuration will be lost during the update.
- In the tab "Maintenance" locate "Device Boot Loader".
- If the *.msi* installation package has been used, the correct hex file is already selected, otherwise
    - Click to browse and choose the new .hex file
- Click to "Update"
- The device will reboot once the update completes.
- You can check the firmware version in the tab "Monitor".
- Re-import the before exported *.ini* file (if necessary).
- Fill missing parameter values into new parameter fields (if applicable).

3 Operating the Current Driver

3.1 Theory of Operation

LDD-130x devices feature an output current stage controlled by a PID Controller implemented in the microcontroller.

The devices differentiate themselves in their capabilities. For technical reasons, the position of the current measurement differs, as shown in the diagrams. As a consequence, while in the LDD-1301 the cathode is connected to the board's ground, in the LDD-1303 the cathode also needs to be floating.

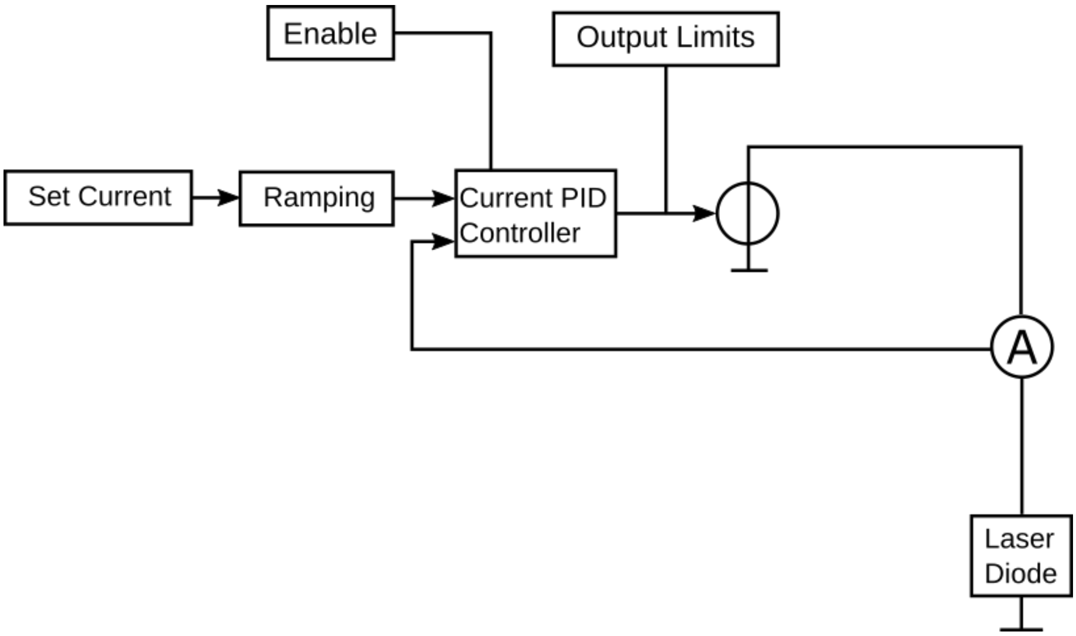


Figure 4. Functional overview of the LDD-1301.

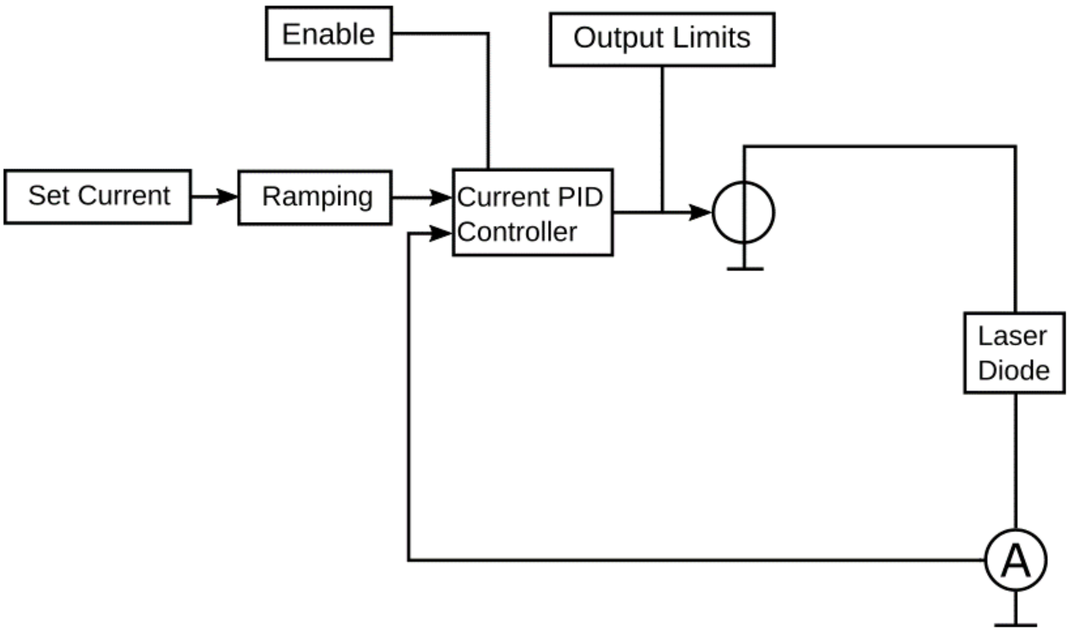


Figure 5. Functional overview of the LDD-1303.

3.2 Driver Settings

3.2.1 Output Settings

In the tab “Operation” you can set the Nominal Output Current to be controlled from five sources:

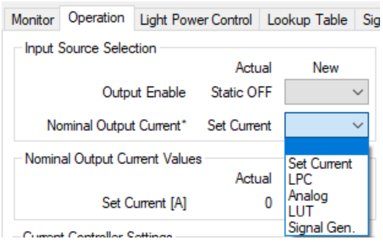


Figure 6. Output Current Selection.

- a parameter (“Set Current”),
- from the light power control feature[3] (“LPC”),
- from the analog input feature[4] (“Analog”),
- from the lookup table feature (“LUT”),
- from the signal generator feature (“Signal Gen.”).

The output is activated by “Output Enable”. If saved to flash, this remains active after a power cycle or reset.

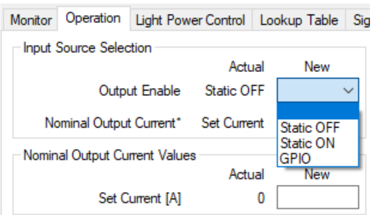


Figure 7. Output Enable Selection.

- In “Static OFF” mode, the enable status is set to disabled.
- In “Static ON” mode, the enable status is set to enabled.
- In “GPIO” mode, the enable status is read from a user-defined GPIO.

The output stage nominal current limit settings allow to define limits for the nominal current that will be enforced regardless of the current you set. These should be set to reflect the normal operation range.

The error thresholds are important safety settings which when crossed, will cause the device to go into error mode and consequently shut down its output stage. You should set these in order to protect your connected diode from regulation or configuration issues. This value should always be set within the absolute maximum current rating of the laser diode you’re using.

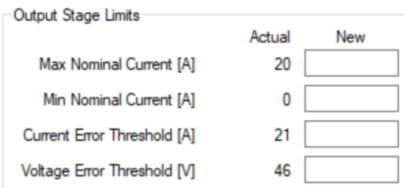


Figure 8. Output Stage Limits.

[3] See the relevant chapter for how to set up the light power control
[4] See the relevant chapter for how to set up the analog input control

3.2.2 Current Controller Settings

These settings, again in the tab “Operation”, define the behavior of the current regulation. The current stage is regulated by a PID controller.

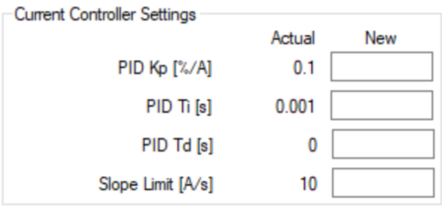


Figure 9. Current Controller Settings.

The proportional term K_p defines the portion [%] of available current that is used to correct the difference [A] between actual and nominal CW current.

The integral term T_i defines the reset time [s] the regulator is allowed to take for correcting a given control deviation. The effect of T_i is weak for large values and strong for small values.

The derivative term T_d opposes changes in control deviation, weighed by unit time [s]. The dampening effect of T_d increases with larger values (e.g. a value of 0 results in bypassing the D component).

The “Slope Limit” acts on internal nominal current ramping and allows the use of more aggressive PID settings.

The “Laser Diode Characteristics” provide the controller with a model of the load, in order to improve the regulation.

4 Operating the Light Power Controller

4.1 Theory of Operation

LDD-130x devices feature an optional cascaded PID Controller to control the emitted light power of laser diodes. This control is also implemented in the microcontroller.

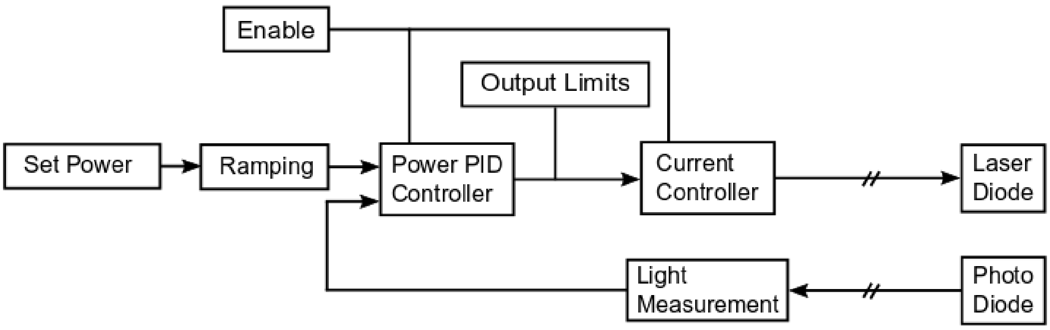


Figure 10. Functional overview of the light power control on LDD-1301/1303.

4.2 Controller Settings

4.2.1 Output Settings

In the tab “Operation” the Nominal Output Current can be set via the normal parameter (“LPC”), meaning the light power PID controller’s output is connected to the input of the PID controller of the current driver.

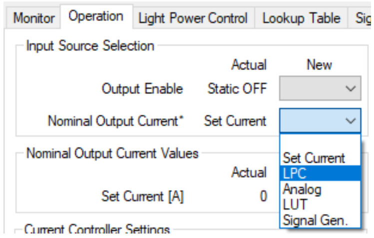


Figure 11. LPC selection.

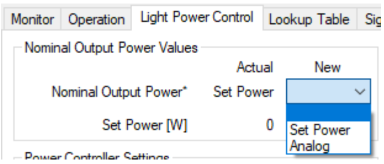


Figure 12. Output Power selection.

In the tab “Light Power Control” the Nominal Output Power can be controlled either over a parameter (“Set Power”) or over the Analog input.

The output is activated by “Output Enable”. If saved to flash, this setting remains active after a power cycle or reset.

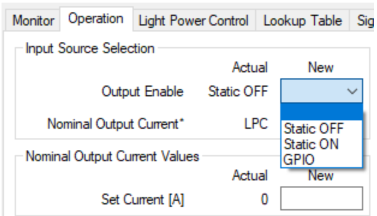


Figure 13. Output Enable selection for LPC.

- In “Static OFF” mode, the enable status is set to disabled.
- In “Static ON” mode, the enable status is set to enabled.
- In “GPIO” mode, the enable status is read from a user-defined GPIO.

The output stage nominal power limit settings allow to define limits for the nominal light power that will be enforced regardless of the light power you set. These should reflect your target operation range.

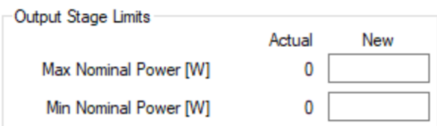


Figure 14. Output Stage Limits for LPC.

4.2.2 Power Controller Settings

These settings, again in the tab “Light Power Control”, define the behavior of the light power regulation. The current stage is regulated by a PID Controller that is regulated by a cascaded PID Controller.

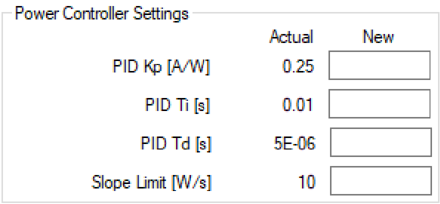


Figure 15: Power Controller Settings for LPC.

The proportional term K_p defines the portion [A] of available light power that is used to correct the difference [W] between actual and nominal CW light power.

The integral term T_i defines the reset time [s] the regulator is allowed to take for correcting a given control deviation. The effect of T_i is weak for large values and strong for small values.

The derivative term T_d opposes changes in control deviation, weighed by unit time [s]. The dampening effect of T_d increases with larger values (e.g. a value of 0 results in bypassing the D component).

The “Slope Limit” acts on internal nominal light power ramping and allows the use of more aggressive PID settings.

5 Lookup Table

It is possible to download a table containing a customized waveform. This waveform can be used to control the laser diode current.

Please make sure that the input source selection is set properly when using a lookup table.

All lookup table functionality is also provided by the communication protocol using the LUT parameters.

5.1 Table Definition

The .csv file is structured as follows.

The header row contains 2 or more columns, the first row being “Table Instance” followed by columns containing the table instance numbers. A maximum of one table instance is currently supported. The following rows define the table instance values, starting from the second row. For further information see “LookupTable Example.csv”.

Up to 1000 samples are possible in each table. Please keep the analog bandwidth and current update rate in mind when defining waveforms. Furthermore, make sure the configured slope limit is suitable for the defined waveform.

For a visualization of the example waveform open the “LookupTable Example.xlsx” Excel sheet.

5.2 LUT Configuration

From within the LDD Service Software, the lookup table configuration can be found in the "Lookup Table" tab.

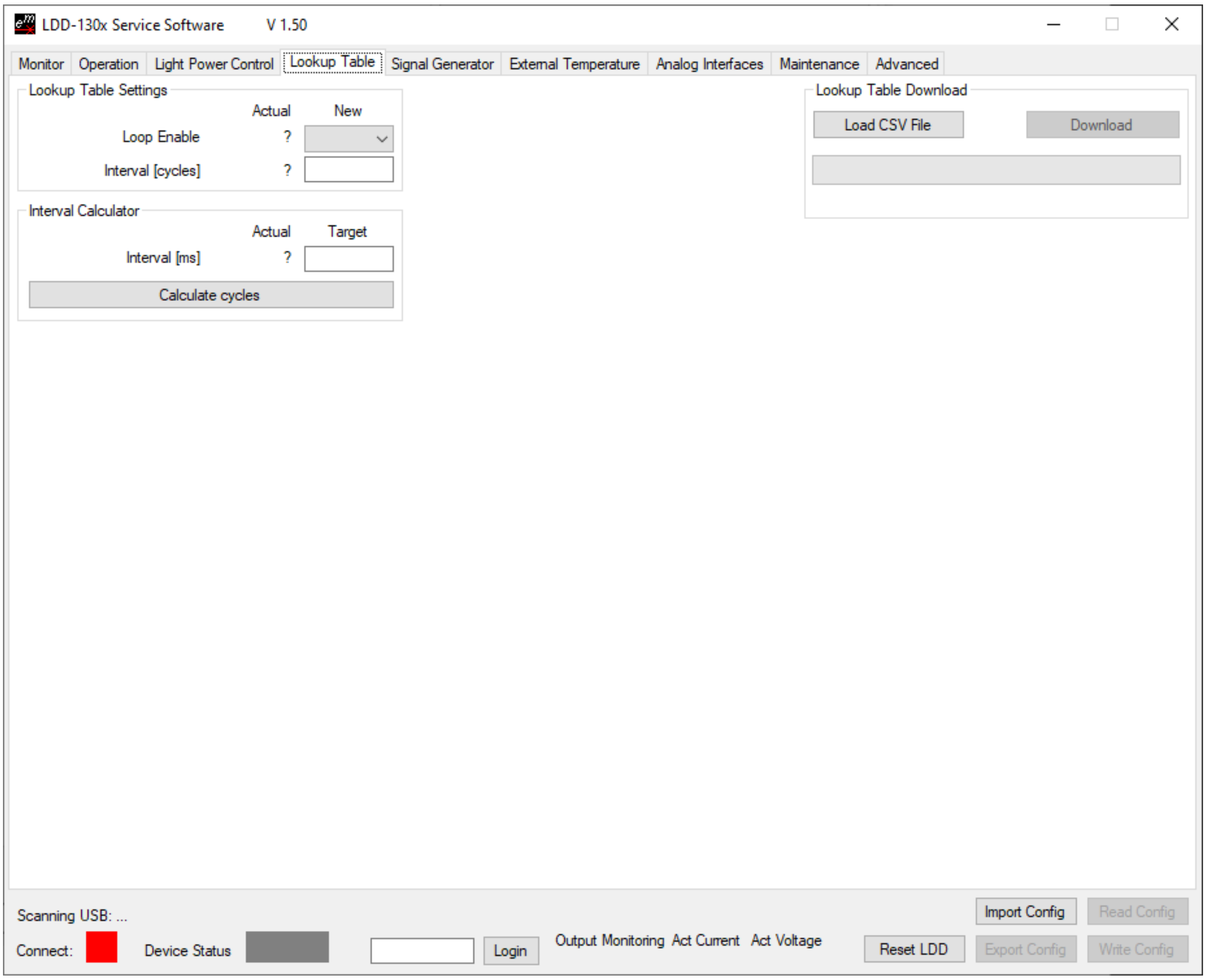


Figure 16. Lookup Table tab

The "Loop Enable" parameter controls whether the table repeats itself indefinitely or stops upon reaching the last record.

The "Interval" parameter controls the sample interval of the table defined in cycles which are 22.85714 microseconds each. Use the interval calculator utility to calculate the closest approximation of your desired interval.

Load the externally generated table into the LDD's memory by using the "Load CSV File" and "Download" buttons. The table is downloaded as a .csv file.

6 Signal Generator

The LDD can generate a set of predefined waveforms which can be used to shape the laser diode current. It is also possible to specify a waveform using a Lookup Table, however the number of data points the table can hold is limited and defining certain waveforms manually may be difficult or tedious. When using the signal generator, the LDD will derive the signal from the mathematical definition of the signal instead.

Please make sure that the input source selection is set properly when using the signal generator. Furthermore, care must be taken when using the communication protocol as time parameters are specified in cycles.

6.1 Configuration

Open the “Signal Generator” tab and select the waveform you need.

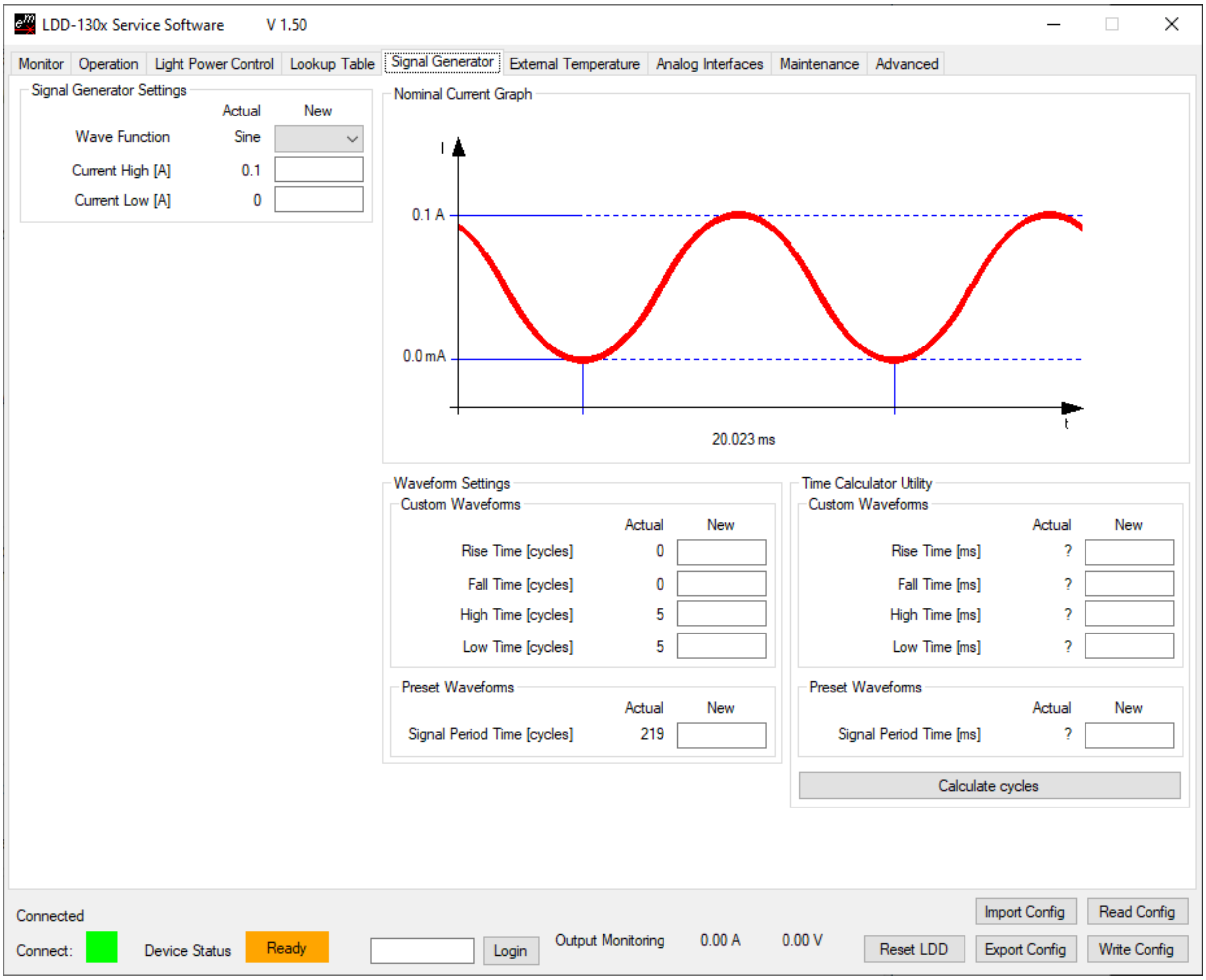


Figure 17. Signal Generator tab

There are two parameters which apply to every kind of waveform: “Current Low” and “Current High”. Those two parameters define the lowest and the highest point of the waveform respectively. “Current High” must be higher than “Current Low”.

The timing parameters are different depending on whether the selected waveform is a custom waveform or one of the preset waveforms. All time parameters are specified in cycles which vary in length depending on the kind of waveform. Custom waveform cycles are 22.85714 µs long while preset waveform cycles are 91.42856 us long (the minimum amount of cycles is 5). Use the time calculator utility to calculate the closest approximation. If you are unsure how the final waveform will look like you can use the current graph as a reference.

6.1.1 Custom Waveform

The custom waveform is the most configurable waveform and allows to define arbitrary trapezoidal waveforms. It has four parameters which are used to configure the rise, fall, high and low time.

6.1.2 Preset Waveforms

Preset waveforms only have one additional configuration parameter "Signal Period Time" which defines the length of the signal. There are three waveform presets: sine, square and triangle.

7 Temperature/Light Measurement and Analog Interfaces

7.1 Temperature Measurement

This input can accommodate NTC sensors.

Error thresholds to protect your load against overheating are available in the “External Temperature” tab. They can be activated via the setting in the “External Temperature Errors Enable” box. The error limits can be set for each input in the “External Temperature Error Limits” box.

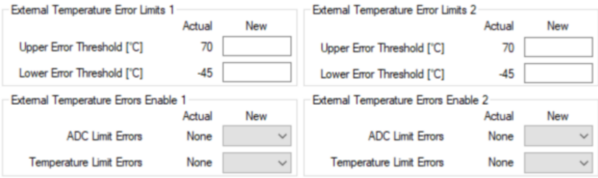


Figure 18. External Temperature Error Settings.

If the “ADC Limit Errors” are enabled, an error will be thrown if the NTC sensor has reached a resistance value that is at the edge of the measurable range of the controller. It offers a selection of different threshold detections, one for only the upper value, another only for the lower value and one for both.

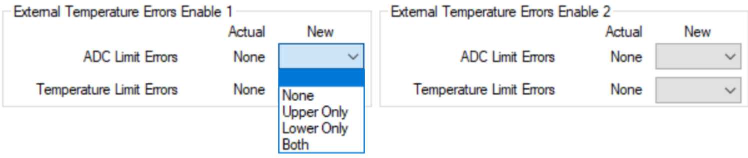


Figure 19. External Temperature Errors Enable for ADC Limit Errors.

If the “Temperature Limit Errors” are enabled, the crossing of the thresholds set in “External Temperature Error Limits” will be detected and cause an error. It offers a selection of different threshold detections, one for only the upper value, another only for the lower value and one is for both.

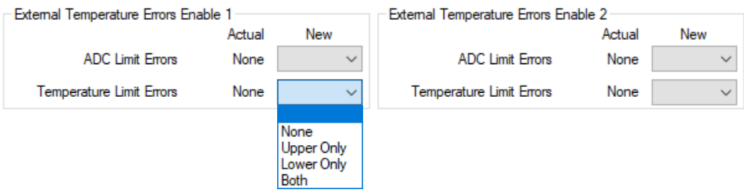


Figure 20. External Temperature Errors Enable for Temperature Limit Errors.

The “External Temperature Measurement Settings” allow an additional user calibration for each input.

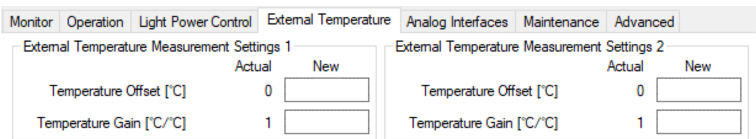


Figure 21. External Temperature Measurement Settings.

The “External Temperature Measurement Limits” are calculated values showing the range of measurable resistance of the input. The corresponding maximum and minimum temperatures are calculated for each temperature input using the sensor characteristic found in tab “Advanced” > “External Temperature Measurement”, in “External NTC Sensor Characteristics”.

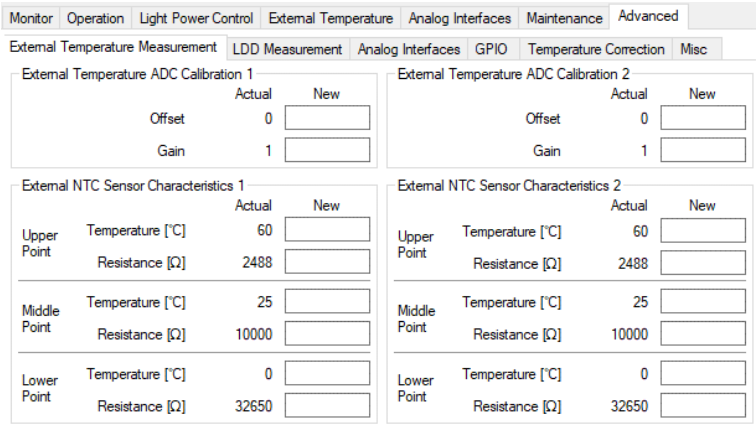


Figure 22. External NTC Sensor Characteristics settings.

7.1.1 Temperature Correction of the Output

In the “Advanced” > “Temperature Correction” tab you can activate a temperature-dependent contribution to the set current.

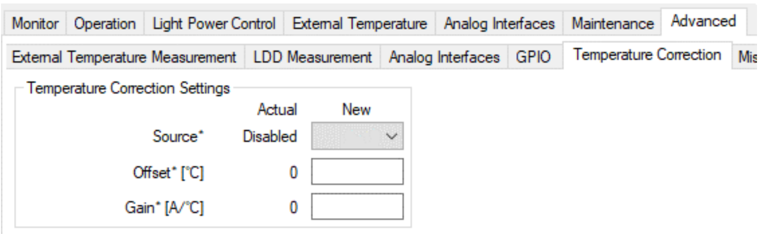


Figure 23. Temperature Correction Settings.

This can be used to compensate variations in the light output of your laser due to temperature variations, in the absence of optical feedback. The Gain and Offset parameters are used in the following formula:

$$I = I_{set} + \text{Gain} \cdot (T - \text{Offset})$$

Where T is the temperature input you selected via Source, I_{set} is the nominal current you set as when using the controller normally, and I is the actual nominal current that the LDD will follow. This final value can be observed in the Monitor tab as the “Nominal Output Current (Ramp) [A]” parameter.

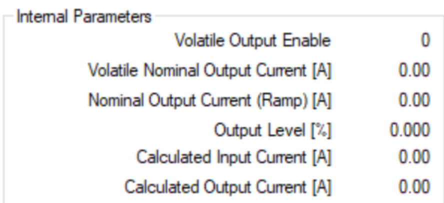


Figure 24. Monitor Value of the Nominal Output Current (Ramp).

7.2 Light Measurement

The optional light measurement input offers the possibility to observe the photodiode current via a parameter shown on the Monitor tab (Figure 24). In absence of the feature the value will be stay on NA.

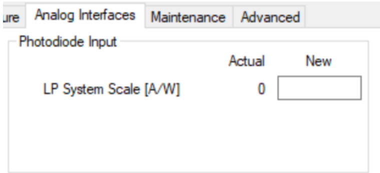


Figure 25. Light Power Factor.

Through the parameter “LP System Scale” LP_{Gain} (Figure 23), the conversion factor to translate the photodiode current I_{Ph} into an emitted light power P_{Light}, can be defined, this is required for operating with the light power control. This parameter depends on the photodiode and the optical coupling of the system. You can set this arbitrarily in the absence of an absolute reference measurement.

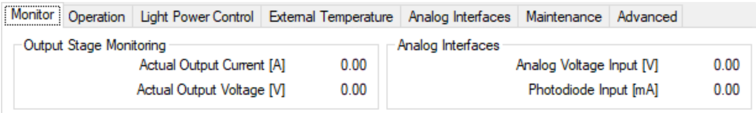


Figure 26. Monitor value of the Photodiode Input.

$$P_{Light} = \frac{I_{Ph}}{LP_{Gain}}$$

The above formula shows the relationship between the emitted light power and the photodiode current LP_{Gain}. The value is also displayed in the Monitor tab plus the output level of the PID.

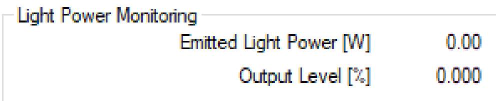


Figure 27. Monitor value of the Emitted Light Power.

7.2.1 Photodiode Input Setting

In the tab “Advanced” >“Analog Interfaces” you can set a resistance value for the photodiode input. Note that “Photodiode Rs” depends on the LPC hardware configuration and does not need to be modified by the end user.

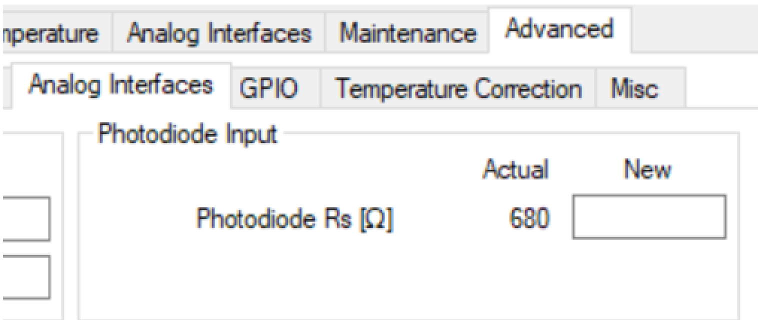


Figure 28. Photodiode Input setting.

The values correspond to each LPC configuration according to the following table:

Photodiode Rs [Ω]	LPC Configuration [mA]
5600	0.5
2700	1
1300	2
680	4

Table 2. LPC configurations.

7.3 Voltage Output

The voltage output (tab “Analog Interfaces”) can be used to provide a synchronization output (i.e. a voltage signal with the same waveform as the measured output current) or a voltage signal controlled by the “Set Value [V]” parameter. Configure the “Signal Source” to select between those two modes.

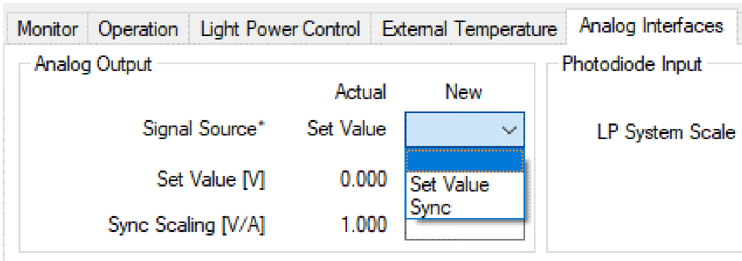


Figure 29. Analog Output settings.

This output runs with a frequency of 10 Hz.

“Sync Scaling [V/A]” allows to set the output current to output voltage ratio.

7.4 Voltage Input

The analog voltage input is displayed in the “Monitor” tab (Figure 29). To control the output current through this analog input, the Nominal Output Current in the tab “Operation” can be set to “Analog” (this needs to be followed by a reset).

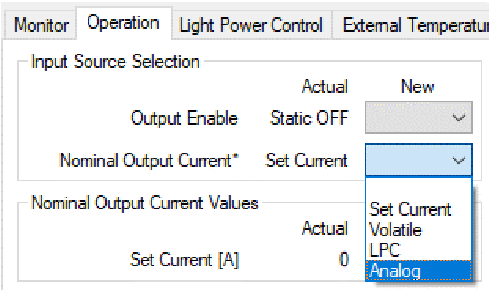


Figure 30. Output Current Setting for Analog Input.

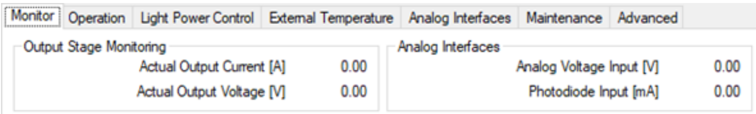


Figure 31. Monitor value of the Analog Voltage Input.

The output current set by the Analog Input follows the formula below where *I* is the output current, $V_{AnalogIN}$ is the input voltage and *G* is the scaling factor “Current Factor [A/V]”

$$I = V_{AnalogIN} \cdot G$$

The Current Factor parameter is used to convert the Analog Input Voltage into a corresponding Output Current and can be found in the tab “Analog Interfaces”, in the “Analog Input” box.

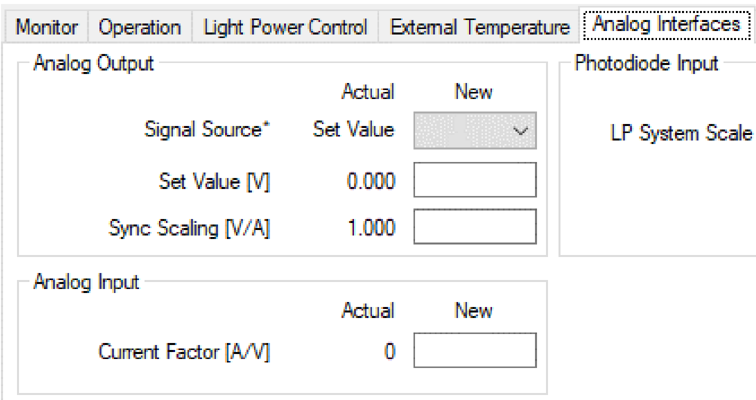


Figure 32. Analog Input Setting.

8 Data Logging

8.1 Monitor Data Logger

For external plotting and data analysis, logged data can be exported to a .csv file, in the “Maintenance” tab in the box “Monitor Data Logger”.

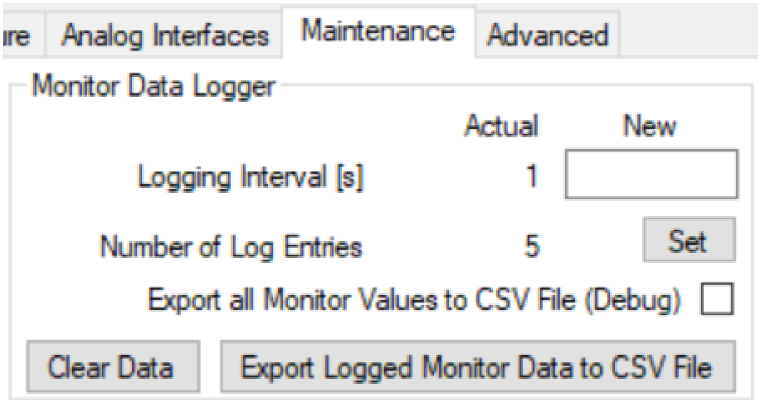


Figure 33. Monitor Data Logger.

- Each log entry is time stamped.
- At relaunch of the software the log is erased and the log interval is set to the smallest value of 1 s.
- The general data logging duration is not limited. It depends on the available RAM on the PC and the logging interval.
- For critical long-term monitoring we recommend exporting the log regularly and to relaunch the Service Software occasionally (e.g. every couple of days).
- The exported file of the logged data contains the value of various monitor parameters such as the output current.
- Select “Export All Monitor Values to CSV File (Debug)” to export more values, which can be useful if you send the file to Meerstetter for diagnosis.

9 External Hardware

9.1 GPIO Control Signals

The GPIO control signals can be used for general purpose I/O (GPIO) or for predefined functions. The functions described in Table 3 can be independently assigned to the GPIO signals in the “Advanced” → “GPIO” tab. Many functions are separately available as several channels. For those functions, the channel can be chosen in the “Advanced” → “GPIO” tab as well. For the functions which are not available in multiple instances this setting has no effect.

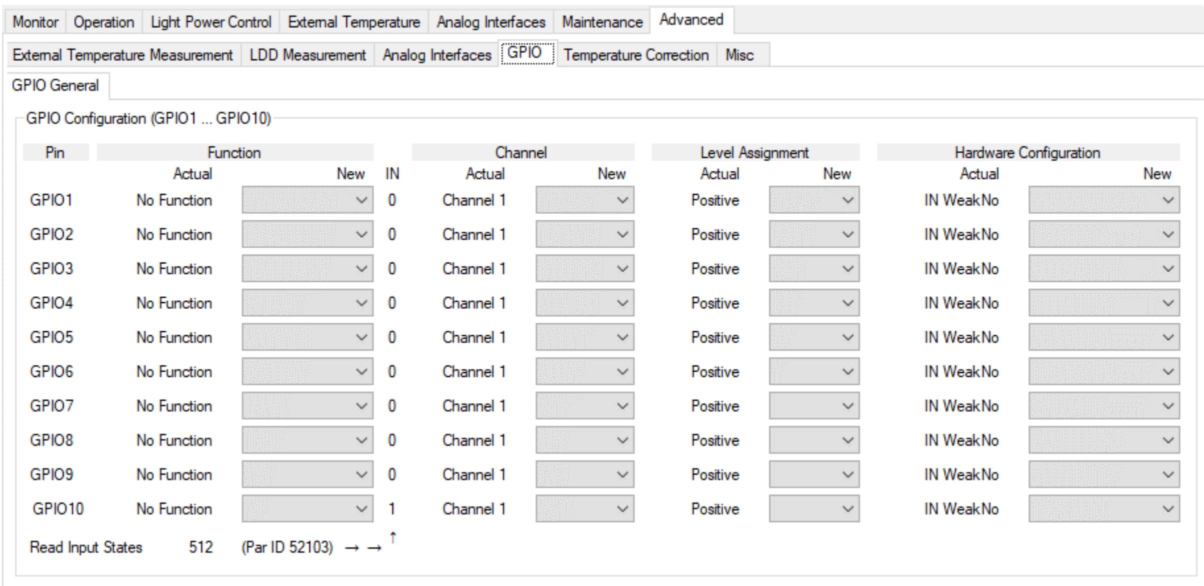


Figure 34. GPIO settings.

Table 3. Available functions for the GPIO signals.

Function Name	Description
No Function	The GPIOx has no function. The pin is at high impedance state.
Signal Control	The GPIOx signal is used as digital I/O, controlled by the communication interface. Refer to the communication protocol document for more information.
LDD OK	The GPIOx signal is logic 1 if the device is in the “Ready” or “Run” status.
HW Enable (edge)	Same as “HW Enable” but requires an active edge after reset.
HW Enable	The GPIOx signal is used as input to enable the output of the driver. In the “Operation” tab select “GPIO” as “Output Enable” source. If the signal is logic 1, the driver output is enabled.
Fan PWM	The GPIOx signal is used as PWM output for the Fan Control feature. Only selectable for GPIO5 and GPIO6 (see chapter 9.2 Cooling Fans). For this function, the "Hardware Configuration" is usually set to "Out Push-Pull" to properly drive the PWM input of the fan.
Fan Tacho	The GPIOx signal is used as frequency input for the fan control feature (see chapter 9.2 Cooling Fans). For this function, the "Hardware Configuration" is usually set to "IN Weak Up", because the fan’s tacho output usually has an open collector output.

Function Name	Description
Toggle HW Enable	Toggled version of the hardware enable. A button press causes the state of the hardware enable to switch. Debouncing is built-in in the firmware.
LDD Run	The GPIOx signal is logic 1 if the device is in the “Run” status.
Pump	The GPIOx signal is set to logic 1 to enable a pump or other cooling devices. Use the "CHx Pump Control" settings to configure the behavior. Two pump control channels are available.
Dev Addr +1 Dev Addr +2 Dev Addr +4	The GPIOx signal is used as input signal. For each pin which is logic 1 and with this function enabled, 1, 2 or 4 is added to the device address. This is only done once at startup.
Fan Stop	The GPIOx signal is used as input signal. If this function is enabled and the corresponding pin is 1, the fan is disabled. If the pin is 0 the fan runs normally.
Fix 0	Sets the GPIO output to fixed 0. Can be inverted using the "Level Assignment".
Pulse Input	When this pin is logic 0 the target current used by the current control loop is set to the Value of “Min Nominal Current”. When the pin is logic 1, the target current is left unaltered. (= Nominal Current) When multiple pins are configured as Pulse Input the GPIO with the highest number is used. If no GPIO is configured as Pulse Input the target current is left unaltered.

The Logic Level of each pin can be assigned under “Level Assignment” in the “GPIO” tab. For inputs, Logic Level “Positive” means that a high voltage is read in as logic 1 while a low voltage (Pin connected to GND) is logic 0. This can be inverted by setting the parameter to “Negative”. For outputs, the logic level inverts the Signal when set to “Negative”. This means that the “LDD OK” signal outputs 0V when the LDD is in “Ready” or “Run” status and the Level Assignment is set to “Negative”

The Pins can be Individually configured under “Hardware Configuration” in the “Advanced” → “GPIO” tab. When a signal is used as an input the hardware configuration must be set accordingly or the function will not be operational.

Table 4. GPIO Pins Hardware Configuration

Function Name	Description
In WeakNo	The GPIO Pin is configured as Input. No PullUp or PullDown Resistor is activated.
In WeakUp	The GPIO Pin is configured as Input. A weak PullUp Resistor to 3.3V of approximately 50kΩ is activated.
In WeakDown	The GPIO Pin is configured as Input. A weak PullDown Resistor of approximately 50kΩ is activated.
OUT PushPull	The GPIO Pin is configured as Push Pull Output. No PullUp or PullDown Resistor is activated.
OUT OD NoPull	The GPIO Pin is configured as an Open Drain Output. No PullUp or PullDown Resistor is activated.
OUT OD WeakUp	The GPIO Pin is configured as an Open Drain Output. A weak PullUp Resistor to 3.3V of approximately 50kΩ is activated.

For input signals like buttons, it is usually easier to set the pin to “Negative” logic and “In Weak Up”. This way the switch can be connected between the GPIO pin and GND.

9.2 Cooling Fans

Up to two fans can be connected and controlled by the device. The "Fan Control Feature" is intended to keep the temperature below a specified temperature, by using the slowest fan speed possible. This can be used to cool the LDD itself. Please refer to chapter 9.1 on how to configure the fan control signals.

9.2.1 Fan Requirements

The "Fan Control Feature" is only compatible to fans with the following features:

- PWM control signal input to control the fan speed. The device generates a 25 kHz or 1 kHz PWM signal from 0 to 100%. 3.3 V voltage level.
- Optional, but recommended: frequency generator signal output which represents the rotation speed. The output should be an open collector output signal.

For the logic level voltage definitions of the LDD, please refer to the datasheet.

9.2.2 Fan Recommendations

To obviate the need for a separate power supply, it is recommended to use a fan with the same supply voltage as the LDD needs.

We have tested the following fans, which fulfill the above-mentioned requirements. All fans stop (0 rpm) at 0% PWM signal.

Table 5. Recommended fans.

Fan	**Manufacturer P/N**	**DigiKey P/N**	**Voltage [V]**	**Power [W]**	**Dimensions [mm]**		
					L	H	W
1	FFB0424VHN-TZT4	603-1818-ND	24	2	40	40	28
2	AFB0624EH-SP50	603-1803-ND	24	6	60	60	25
3	PFB0824DHE-YDG	603-2028-ND	24	32	80	80	38
4	AFB1224EHE-EP	603-1735-ND	24	20	120	120	38
5	FFB0412VHN-TP03	603-1206-ND	12	2	40	40	28
6	AFB0612DH-TP11	603-1211-ND	12	10	60	60	25
7	EFC0812DB-F00	603-1159-ND	12	4	80	80	15
8	FFC1212D-F00	603-1789-ND	12	17	120	120	25
9	PF40281BX-000U-S99	259-1666-ND	12	11	40	40	28

9.2.3 Optimized Settings

The following values are optimal settings for the CHx Fan Speed Controller parameters in combination with the corresponding fan. The bypass option ("Bypassing Speed Controller") is used for fans with integrated speed controller, to disable the speed controller.

Table 6. Suggested fan settings.

Fan	0% Speed [rpm]	100% Speed [rpm]	Kp [%/rpm]	Ti [s]	Td [s]	Bypass
1	-	-	-	-	-	Yes
2	-	-	-	-	-	Yes
3	-	-	-	-	-	Yes
4	-	-	-	-	-	Yes
5	0	10000	0.005	0.5	0	No
6	0	10000	0.005	0.5	0	No
7	0	4200	0.005	0.5	0	No
8	0	4400	0.005	0.5	0	No
9	0	22500	-	-	-	Yes

9.2.4 Connecting the Fan to the Device

- If the fan supports the same supply voltage as the LDD, it is recommended to connect the fan's GND and VCC to the LDD's GND and VIN, respectively.
- If a separate power supply is used for the fan, make sure that the two GND terminals of the power supplies are connected. Never leave the fan's GND unconnected when the fan is powered. Otherwise, the GPIOx pins may be destroyed.
- Assign the correct function to the GPIO signals (see chapter 9.1 GPIO Control Signals).
- The PWM input of the fan must be connected to GPIO5 or GPIO6, since only these outputs generate a PWM signal. As an example, you can configure the GPIO as follows:
  - Pin: GPIO5
  - Function: Fan PWM
  - Level Assignment: Positive
  - Hardware Configuration: OUT PushPull
- The frequency output signal of the fan can be connected to any of the GPIO signals. As an example, you can configure the GPIO as follows:
  - Pin: GPIO4
  - Function Fan Tacho
  - Level Assignment: Positive
  - Hardware Configuration: IN WeakUp

9.2.5 Control Function

The fan control feature uses two PID controllers.

The first PID controller sets the required cooling power depending on the temperature of the heatsink. In most cases only P control is used. We recommend a value of 30 %/°C for Kp. Thus, for a target temperature of 40 °C the fan will rotate with 0% speed at 40 °C and 90% speed at 43 °C.

This required cooling power is then converted into a nominal fan speed. For example, if the minimum and maximum fan speeds are set to 1000 rpm and 11000 rpm, respectively, the required cooling power of 50% is converted into a nominal fan speed of 6000 rpm.

The second PID controller sets the fan speed by varying the PWM output signal until the nominal fan speed is reached.

The "Fan Speed Controller" should be set up before without temperature regulation of the heatsink. This can be done by setting both the "Target Temperature" and the "100% Speed" to a high value. This allows to use the "0% Speed" as a fixed rotation speed. The fan should reach the nominal speed as fast as possible.

It is possible to stop the fan by an external GPIOx signal. This is useful, e.g., if a door of a compartment is opened (see chapter 9.1 GPIO Control Signals).

If a hysteresis is needed the parameters "Min Speed Start" and "Min Speed Stop" can be used. If those values are set to zero, they will be ignored.

9.2.6 Fan Parameter Description

Table 7. CHx Fan Control Enable

Parameter Name	Options and Description
Fan Control Enable	• Disabled • Enabled: Enables the fan controller

Table 8. CHx Fan Temperature Controller

Parameter Name	Options and Description
Actual Temperature Source	• External 1: the actual temperature for the temperature controller is taken from the external temperature input 1. • External 2: the actual temperature for the temperature controller is taken from the external temperature input 2. • Device: the actual temperature for the temperature controller is taken from the temperature of the LDD's output stage.
Target Temperature	Target temperature (set point) for the temperature controller
Kp, Ti, Td	PID controller parameters for the temperature controller

Table 9. CHx Fan Temperature Controller

Parameter Name	Options and Description
0% Speed	Minimum rotation speed
100% Speed	Maximum rotation speed
Min Speed Start	Minimal speed above which the fan is started
Min Speed Stop	Minimal speed below which the fan is stopped
Kp, Ti, Td	PID controller parameters for the Fan Speed Controller
Bypassing Speed Controller	• Yes: Disables the Fan Speed Controller. "Relative Cooling Power" is written directly to the PWM output. • No: The built-in speed controller is used.
Fan Surveillance	Disables Error 175 (ERROR_FAN_CONTROL_LIMIT) and Error 176 (ERROR_FAN_BLOCKED) This can be used when no tachometer signal is available.

10 Special Functions

10.1 Parameter Handling

10.1.1 Settings Dump (.mepar File) with the Service Software

In cases where many or all settings of a LDD-130x device are to be changed from a host software or a host microcontroller, a settings dump function is available. This generates a file which can be dumped to a LDD-130x using third party host systems.

- Every parameter which is labeled with “New”, that contains information will be stored in the .mepar file.
- In the “Maintenance” tab click “Create File” in the box “Create *.mepar file (for Settings Dump)”.

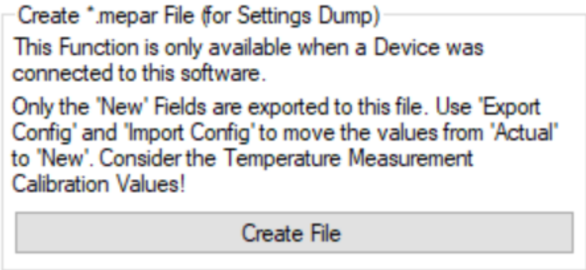


Figure 35. Settings Dump.

- For every parameter stored in the .mepar file, a line contains the parameter string that is specific to function, firmware and device type.
- Using the MeCom communication protocol, the .mepar file can be sent line-by-line to one or several devices. These batch configurations will immediately become active.
- It is also possible to download just one single setting (i.e., one line of the .mepar file) directly from the Service Software to a device.
- Copy a line from the file and paste it in the field. Click “Send String”.

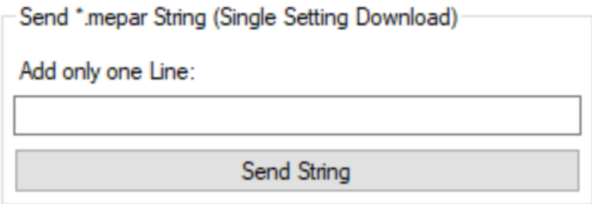


Figure 36. Single Setting Download.

11 Troubleshooting and Errors

11.1 Quick Reference

Table 10. Typical Problems

Problems	Possible Reason	Possible Solution
The Service Software is not starting	The Service Software does not work with 64-bit versions of Microsoft Visual C++ 2015 Redistributable Package	Make sure that the correct version (32-bit) of Microsoft Visual C++ 2015 Redistributable Package is installed.
The output is suddenly switched off	An error happened.	Check the error message in the "Monitor" tab.
The firmware is too old	The firmware is too old to connect to the Service Software.	Please update the firmware as described in 2.3 Firmware Updates .
Error 105 shows up while the output current is rising.	1303: The input voltage is insufficient to reach the voltage necessary to drive the set current. 1301: Possibly Hardware Damage	Check if the voltage requirements on the datasheet are respected and ensure that the output power of your supply is sufficient to avoid voltage drops.
Error 103	• The input voltage is insufficient. • The PID controller is set up too aggressively or incorrectly	
Error 102	Load with too low compliance voltage is used or short-circuit at output.	Check Load for short-circuit or load with higher compliance voltage.

11.2 Error Numbers, Instances and Parameters

- Error Numbers from 1 through 99, excluding 30 through 39, designate error conditions that are universal across the whole range of Meerstetter TEC Controllers and laser diode drivers. Error numbers starting from 100 designate conditions that are specific to LDD-130x devices (see tables below).
- Error Instance can designate the involved instance of a functionality or be useful information for Meerstetter Engineering technical support.
- Error Parameters are additional information to help Meerstetter Engineering technical support in the processes of error diagnosis or remote debugging.

11.2.1 Error Numbers 1 – 99 (universal)

Table 11. Processor Errors

#	Description	Error Condition
1 – 10	MCU system malfunction	-

Table 12. HMI Errors

#	Description	Error Condition
11	Emergency stop was triggered by LTR-1200	-
12	LTR-1200 HMI regularly sends 'free' signals to all rack-internal devices such that they can activate their output stages (if enabled)	No signal received for more than one second

Table 13. Parameter System Errors

#	Description	Error Condition
20-21	Internal parameter system malfunction	-
22	Parameter set corrupt	Configuration flash empty or defect (fix: see error #23)
23	Parameter set incompatible with current firmware version	Load .ini file saved prior to FW update, or Default.ini
24	Firmware does not recognize valid device	-
25	Internal parameter system malfunction	Access to a non-existing instance
26	Internal limit system malfunction	-
27	Parameter write or read wrong datatype function used	-
28	Parameter write value out of range	-
29	Parameter save to flash called from interrupt	-

Table 14. Power Supply Errors

#	Description	Error Condition
30	Input voltage net too low	< 10.5 V
31	Input voltage net too high	> 63 V (for HW version ≥ v1.20) > 55 V (for HW version < v1.20)
32	Internal 12 V power net too low	< 10.7 V
33	Internal 12 V power net too high	> 13.5 V
34	Internal 5 V power net too low	< 4.7 V
35	Internal 5 V power net too high	> 5.25 V
36	Internal 3.3 V power net too low	< 3.1 V
37	Internal 3.3 V power net too high	> 3.5 V
38	Internal −5 V power net too low	< −6 V
39	Internal −5 V power net too high	> −4 V

Table 15. Flash Memory Errors

#	Description	Error Condition
50	On-board flash failure	Write Timeout
51	On-board flash failure	Erase Timeout
52	On-board flash failure	Invalid Address

Table 16. Communication Error

#	Description	Error Condition
53	Send buffer overflow error	-
54	CANopen internal error	-

Table 17. Device Temperature and Hardware Errors

#	Description	Error Condition
60	Device running too hot	See datasheet.
61	Communication error with I/O hardware during factory test	-

11.2.2 Error Numbers 100 - … (specific to LDD-130x devices)

Table 18. Power Output Errors

#	Description	Error Condition
100	Output overcurrent	> “Current Error Threshold”
101	Output overvoltage	> “Voltage Error Threshold”
102	PID lower limit error	Too long in lower limitation (0, 0.1 % margin) and Output current > 0.05 A
103	PID upper limit error	Too long in upper limitation (0.96, 0.1 % margin)
104	Fast switchoff output overcurrent error	Device overcurrent
105	Input overcurrent	> 57 A, > 500 ms
110	Interlock error	Interlock low If you are not using the interlock connector, this function can be disabled via the DIP switch.

Table 19. Current Measurement Errors

#	Description	Error Condition
120	Phase current measurement offset too high.	-
121	Phase current measurement offset too low.	-

Table 20. Internal Power Stage Errors

#	Description	Error Condition
130	Excessive phase asymmetry	-
131	Measured and calculated output currents too different	-
132	Excessive balancing factor	-

Table 21. External Temperature Measurement Errors

#	Description	Error Condition
140	12bit ADC raw value below safety margin	< 40 (1%)
141	12bit ADC raw value above safety margin	> 4050 (99%)
142	Measured temperature too low	< “Lower Error Threshold”
143	Measured temperature too high	> “Upper Error Threshold”

Table 22. Various Errors

#	Description	Error Condition
183	No package has been received within the specified Watchdog timeout time	-

A Change History

<table>
<tr><th>Date of change</th><th>Version</th><th>Changed/ Approved</th><th>Change / Reason</th></tr>
<tr><td>20 December 2021</td><td>A</td><td>RS/HS</td><td>• Initial Release</td></tr>
<tr><td>1 April 2022</td><td>B</td><td>HS/PV</td><td>• Error 102 edited
• Describe temperature correction function</td></tr>
<tr><td>29 August 2022</td><td>C</td><td>CU/RS</td><td>• Describe the theory of light power control
• Light Measurement edited</td></tr>
<tr><td>6 September 2022</td><td>D</td><td>CU/RS</td><td>• Chapter 3, 4 and 5 edited (add auxiliary pictures, detailed text descriptions)
• Chapter 6, 7 and 8 edited (auxiliary pictures added)</td></tr>
<tr><td>23 September 2022</td><td rowspan="2">E</td><td>ML/CU</td><td>• Add CANopen to the overview picture
• Add Capture 2.2.3 CANopen</td></tr>
<tr><td>15 March 2023</td><td>CU/RS</td><td>• Document and firmware version updated
• Picture of the CANOpen interface added
• Picture of the power controller settings updated and the unit of the PID Kp value corrected in chapter 4
• Error condition of the error number 31 corrected to 63V for the newer HW versions
• Quick References restored because confused information was included
• Pictures new updated</td></tr>
<tr><td>25 June 2024</td><td>F</td><td>SC/RS</td><td>• Add: Signal Generator section
• Add: Lookup Table section
• Mod: GPIO function list updated
• Add: Cooling Fans section
• Mod: removed all mentions of volatile parameters</td></tr>
</table>