

Manual

**DSx1
Laser Diode and TEC Driver**

OsTech e. K.



Overview

The devices of the DSx1 series can precisely and reliably drive diode lasers and peltier elements. They are available as table top devices and as built-in units.

There are two input voltages: 110–220 V AC (DS11) and 24 VDC (DS01). Laser currents up to several hundred amperes are possible. The laser voltage range can be by default from several volts to 48 V and more.

All devices have an integrated pulse generator and can be run pulsed to CW mode. External digital and analog modulation are also possible. The rising and falling edges range from 1 to about 30 μ s.

The standard RS232 interface can be used for configuration, operation and monitoring. Other interfaces are possible. Up to 4 TECs can be connected for temperature control and monitoring. Multiple protection circuits ensure the safe operation of the laser. Every device is checked thoroughly and passes a burn-in.


The default configurations don't fit? We advise you gladly about special adjustments.

Features

- fully digital control, standard interface RS232
- non volatile preconfiguration (EEPROM)
- controllable internal and external fan supplies
- hardware interlock
- temperature protection

Laser driver features

- precise current controlled CW and pulsed laser operation modes
- low power dissipation by active voltage control in CW mode
- multiple laser safety options
- internal digital modulation

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- external analog and digital modulation
 - bias current option for modulation modes
 - contains adjustable driver for pilot laser
 - overvoltage and transient protection
 - voltage, current and temperature limits

TEC driver features

- thermosensor input for NTCs (standard 10 k Ω), PT100, PT1000 or others
- Polynomial and Steinhart-Hart sensor model
- up to 4 PID temperature controllers for TEC coolers
- voltage, current and temperature limits
- target temperature sequencer on request



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1 Introduction

OsTech produces precise and advanced laser drivers. These devices have a multitude of configuration parameters available that you can set by display or serial interface.

Therefore, it is important to read the manual thoroughly before turning on the device for the first time. The instructions must be followed exactly for safe operation and optimum performance of the laser diode.

In case of questions or problems, please contact our service staff.

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Please note that unauthorized opening of the device cancels the two year warranty. Don't break the calibration seal!

2 Technical parameters

2.1 General parameters

input voltage	DS01: 24 V DC \pm 10% DS11: 110–220 V AC
ambient temperature	0 ... 40 °C
humidity	< 95%
<i>housing size</i>	<i>width × height × depth (depth without connectors)</i>
o44 housing	105 mm × 44 mm × 160 mm (4.1 in × 1.7 in × 6.3 in)
o85 housing	105 mm × 85 mm × 160 mm (4.1 in × 3.3 in × 6.3 in)
t85 housing	105 mm × 85 mm × 200 mm (4.1 in × 3.3 in × 7.9 in)
t95 housing	119 mm × 95 mm × 235 mm (4.7 in × 3.7 in × 9.3 in)
t127 housing	200 mm × 127 mm × 277 mm (7.9 in × 5.0 in × 10.9 in)
t192 housing (19 inch, 2 HU)	483 mm × 89 mm × 266 mm (19 in × 3.5 in × 10.5 in)
t193 housing (19 inch, 3 HU)	483 mm × 133 mm × 266 mm (19 in × 5.25 in × 10.5 in)
remote control	PC serial interface RS232

2.2 Laser module

laser diode current	range	1.5 2.5 5 8 12 16 24 32 40 ... 100 A
	resolution	$I_{max}/4000$
	accuracy	$\pm 0.5\%$
laser current limit	range	0 ... I_{max}
	resolution	$I_{max}/4000$

	accuracy	$\pm 2\%$
laser diode voltage	min.	1.2 V
	max.	3 6 9 12 15 18 24 48 V
current noise		1% ... 0.01% of I_{\max} rms
<i>internal pulse mode</i>		
pulse width	range	100 μs ... 2^{32} μs (71 min)
pulse period	range	(pulse width + 100 μs) ... 2^{32} μs (71 min)
time base	accuracy	$\pm 1\%$
pulse to pulse	accuracy	30 μs
rise time	at 2.5 A	$< 2 \mu\text{s}$
	I_{\max}	
	at 4 A I_{\max}	$< 3 \mu\text{s}$
	at 8 A I_{\max}	$< 10 \mu\text{s}$
	at 12 A I_{\max}	$< 15 \mu\text{s}$
	at 16 A I_{\max}	$< 18 \mu\text{s}$
	> 16 A I_{\max}	25–40 μs
	on request	$< 1 \mu\text{s}$... 3 μs
fall time		70% ... 100% of T_{rise}
<i>laser fan control</i>		
voltage	range	1.2 V ... 24 V (adjustable by software)
current	max.	300 mA

2.2.1 Security breakdown conditions

- interlock open
- internal supply failure
- abnormal transients
- open circuit / no laser connected
- internal overtemperature
- beyond max. power dissipation

2.3 Peltier module

peltier current	range	± 1.5 ± 2.5 ± 4 ± 8 ± 10 ± 12 ± 16 A
	accuracy	$\pm I_{\max}/4000$
peltier voltage	max.	4 8 14 18 24 48 V
temperature controller	range	$-25^{\circ}\text{C} \dots 150^{\circ}\text{C}$, larger on request
	accuracy	typical: < 10 mK max.: < 100 mK
temperature limits	range	$-25^{\circ}\text{C} \dots 150^{\circ}\text{C}$
default lower limit		5°C
default upper limit		35°C

3 Keypad and display menus

3.1 Keypad

<input type="checkbox"/> ▲ UP	▪ increases the digit under the cursor
<input type="checkbox"/> ▼ DOWN	▪ decreases the digit under the cursor
<input type="checkbox"/> ◀ LEFT	▪ moves to the previous input field, unsaved changes are discarded
<input type="checkbox"/> ▶ RIGHT	▪ moves to the next input field, unsaved changes are discarded
<input type="checkbox"/> ● OK or Enter	▪ triggers actions
	▪ toggles checkboxes
	▪ saves a changed value
	▪ moves the cursor position if pressed on an unchanged or already saved value

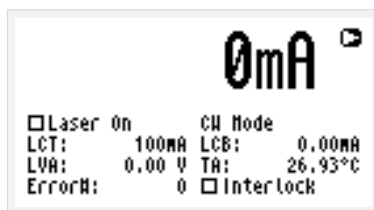
3.2 Display Menus

After power-on the main menu is shown on the display. Some fields can be used to change settings of the device, others only show the current state. You can switch to the next menu with the arrow in the upper right corner. The laser menu is next. Then follow the TEC menus. The last menu is the device menu for general settings.

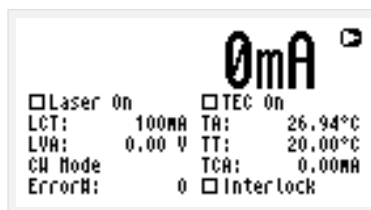
3.2.1 Main Menu

The main menu gives an overview over the current state and allows to control some basic settings. The layout of the main menu depends on the modules in your device and is shown in [figure 3.1](#). The big number shows the present laser current in laser drivers and the current temperature in TEC controllers. The following fields may be available in the main menu:

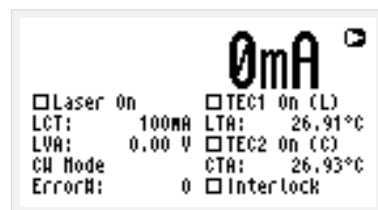
Laser On	switch the laser on and off, can only be changed if the device has no separate laser switch
LCT	laser current target
LVA	laser voltage actual
LCB	laser current bias (for modulation)
CW Mode, ... Mod.	modulation mode
TEC On	switch the TEC controller on and off
TT, LTT, CTT	target temperature
TA, LTA, CTA	temperature actual
TCA, LTCA, CTCA	TEC current actual
TVA	TEC voltage actual
TCL	TEC current limit
Error#	error number (0 = no error)
Interlock	if the interlock is closed



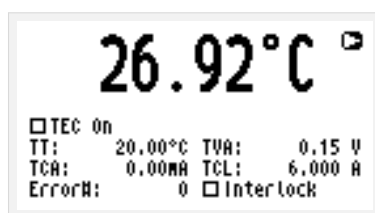
(a) Laser driver without TEC controller.



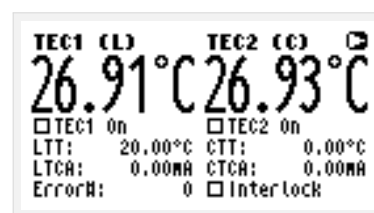
(b) Laser driver with one TEC controller.



(c) Laser driver with two TEC controllers.



(d) Controller for one TEC.



(e) Controller for two TECs.

Figure 3.1: Main menu layout depending on the modules in the device

3.2.2 Laser Menu

The laser menu is shown in [figure 3.2](#). Here you can change laser settings. The following fields are included:

LCL	laser current limit
LVC	compliance voltage (\geq LVA)
LVA	laser voltage actual
LCB	laser current bias (for modulation)
LCLM	limit for average laser current (for modulation)
LTM	laser temperature maximum, laser stops above this temperature
Error#	error number (0 = no error)
CW Mode	no modulation
LMAX	external analog modulation
LMDX	external digital modulation
LMDI	internal digital modulation
LMW	laser modulation width
LMP	laser modulation period
PC	pulse count (= LMDIC command) <ul style="list-style-type: none"> ▪ PC = 1: single pulse ▪ PC = 2: burst of 2 pulses . . . ▪ PC = 0: continuous pulses
LG	gate option

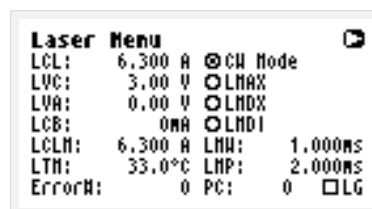


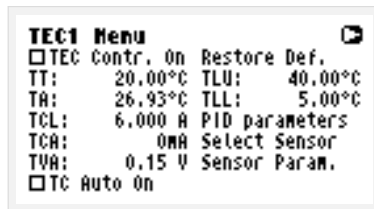
Figure 3.2: Laser menu

3.2.3 TEC Menu

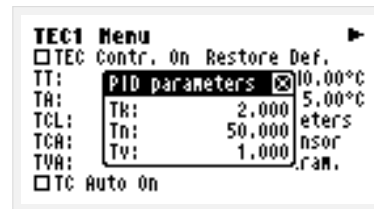
The TEC menu is shown in [figure 3.3a](#). Here you can change TEC controller settings. The following fields are included:

TEC Contr.	On	switch the TEC controller on and off
TT		target temperature
TA		temperature actual
TCL		TEC current limit

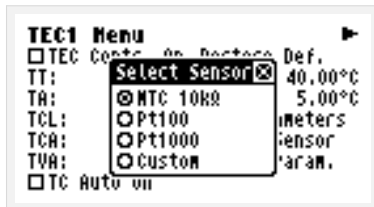
TCA	TEC current actual
TVA	TEC voltage actual
TC Auto On	TEC controller is automatically activated when the temperature is within limits
Restore Def.	restores the default settings for the TEC controller
TLU	upper temperature limit
TLL	lower temperature limit
PID parameters	set the PID coefficients (see figure 3.3b)
Select Sensor	select one of some predefined temperature sensor settings (see figure 3.3c)
Sensor Param.	manually set the temperature sensor settings (see figure 3.3d)



(a) TEC menu.



(b) Dialog: PID Parameters.



(c) Dialog: Select Sensor.



(d) Dialog: Sensor Parameters.

Figure 3.3: TEC Menu and dialogs in it.

3.2.4 Device Menu

The device menu is shown in figure 3.4. Here you can change some general settings and find out the type and serial number of your device. You find the following fields in this menu:

External Control on Start	Switch to external control automatically after power-on. You get the chance to abort this.
Switch to External Control	You can control the device over the RS232 interface after activating this.
Pilot laser	Switch the pilot laser on and off.

Intensity	pilot laser intensity (0...16)
GFD	default fan voltage
Restore Default Settings	Reset all settings in the device to their default values.
Service	Show type, serial number and software version of the device.

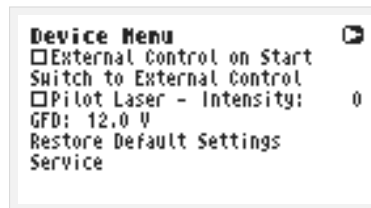


Figure 3.4: Device menu.



4 Hardware setup preparations

These steps must be followed:

- Make sure that the power supply unit is disconnected from main.
- Use an approved personal grounding bracelet or other means for ESD protection during the assembly of the laser or other electronics.
- Connect your laser to the proper connectors of the driver unit.
- Remove the shortage clip from the laser. While turned off the laser output of the driver unit is internally shortened.
- Connect the power supply unit to the proper supply voltage.
- Make sure that the interlock connector is closed.
- Make sure that the emergency button (the large red button at the front side) is unbolted.
- Make sure that an appropriate temperature sensor for the laser is connected. The laser driver needs a temperature signal.
- Please note laser safety regulations!
- Turn the key switch on.



5 Laser control

5.1 Preparations

First the laser current limit and the laser compliance voltage have to be setup. To adjust the laser current limit using the display:

- go to the Laser Menu by pressing and
- go to the LCL input field by pressing to adjust the laser current limit
- to move the cursor position press several times
- to increase/decrease the digit press / as often as necessary
- after adjusting the value press to enter the new value

Now adjust the laser compliance voltage (LVC input field) to the voltage drop over the laser.

These values can also be set by using the RS232 interface (see [chapter 7](#)). To do this use the commands LCL and LVC.

5.2 CW mode

The mode of operation can be selected in the laser menu. The CW mode is active when all the modulation modes (LMDI, LMDX and LMAX) are unchecked.

5.2.1 Switching on the laser

Go to the main menu and adjust the laser current target in the LCT input field. The selected value has to be within the laser current limit and the max. operating current of your laser module. Enable the LON/OFF input field to switch on the laser. The LED on the front panel will start blinking and the actual current will be displayed. Disabling it switches off the laser and causes the red LED on the front panel to stop blinking. The actual current 0.00 A will be displayed.

Pressing the emergency button at the front panel interrupts the power supply immediately. Unbolt it by twisting.

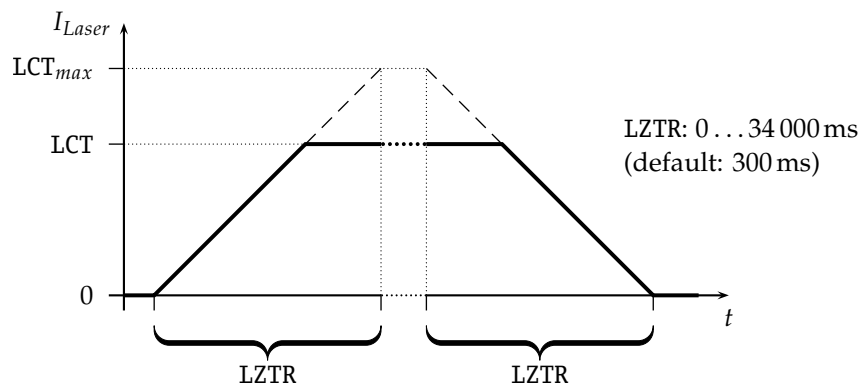


Figure 5.1: Laser current on-off ramp in CW mode. The ramp is active at any change of laser current.

When using the RS232 interface the command LR may be used to switch the laser on. The command LS switches the laser off.

5.2.2 Ramp on laser switching

In CW mode the ramp on laser run and stop is activated by default. However, this function is not available over the display menus. For using it you need to control the driver over an RS232 interface. With e.g. LZTR2000 you can set the time to reach the maximum current of your driver. The slope of the ramp would be $LCT_{max}/2000$ ms in this example. During the laser stop ramp, you can turn off the laser immediately by sending LS again. You can disable the ramp with LZTR0. The default value for LZTR is 300 ms. [Figure 5.1](#) shows how LZTR works. For a list of other commands see [chapter 9](#).

5.2.3 Power control mode

The power control mode is only available in CW mode and consists of two independent parts:

- the photo current control loop which works independent
- the laser power coefficients which do a translation from a power value into a value for the photo current

To initiate the power control you must first prepare the laser for proper operation in CW mode (see [section 5.1](#)). Don't forget to adjust the laser current limit.

Before turning the laser on you must connect the photosensor between the PDC (cathode) and the GND (anode) pins at the laser connector. After this you should test whether the sensor works well. For this run the laser and check with the LPCA command (laser photo current actual) its operation. The default maximum photo current is 700 μA , but can be increased on request.

Enter your target photo current with the LPCT command. Initialise the photo current control mode by the command LPCCR (laser photo current control run). Now you can run and stop the laser by LR and LS. As soon as you start the laser the driver begins continuously to track and control the photo current.

The second step is to adjust the power coefficients, so that you can use power values in Watt. For this:

- adjust a LPT value (laser power target), it should have a typical or a maximum value
- now run the laser in normal CW mode and set up the current until the laser emits exact the target laser power. An external power meter is necessary for this. Now execute the LPT command to fix the actual photocurrent value to this laser power.

Now you can get the laser power by the command LPA, set the power target by the LPT command, run the power control mode by the LPCCR command. Start and stop the laser by LR and LS.

5.3 Gate option

There is a gate option which can be used in CW mode as well as in internal digital modulation mode. You may switch on and off the internally generated laser current by the modulation input. Optionally, a separate gate pin may be layed out. In this case the gate option is also available in the external modulation modes. The gate option is activated by the command LGR and deactivated by LGS. Additionally, the LMDXNR command can be used to negate the modulation input.

5.4 Modulation modes

The modulation modes can be selected in the laser menu. Changing modulation modes turns off the laser. You may start the laser again in the main menu.

Please note that the preparations—as described in [section 5.1](#)—have to be done first. In modulation modes the measured currents and voltages displayed in the main

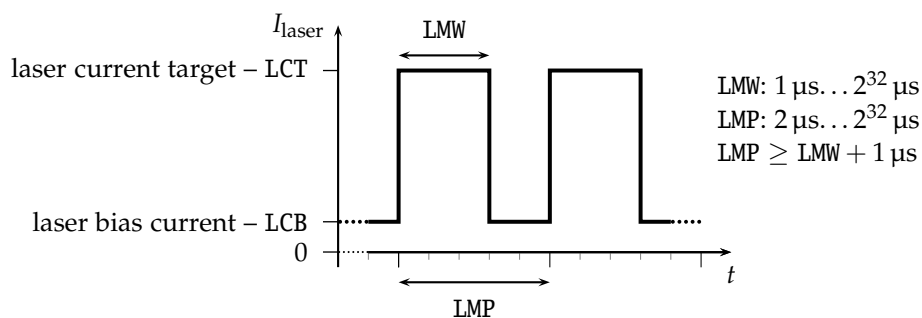


Figure 5.2: continuous pulse mode

menu **show the mean values** not the peak values. These measured values may differ from the adjusted ones caused by the low speed of the AD converter. Don't care about this. The real values are within the limits as described above.

5.4.1 Internal digital modulation mode

The driver is able to modulate the laser current by internally generated pulses. This internal modulation mode may be activated by checking the LMDI input field in the laser menu or entering the LMDIR command.

Continuous pulse mode

Unless configured otherwise, pulses are generated continuously as you can see in [figure 5.2](#). You have to enter the pulse width (duration) and pulse period in μs . Take care of the right proportions of these values. The pulse width may be changed by the LMW command and the pulse period may be changed by the LMP command. They can be set freely in steps of $1 \mu\text{s}$.

You can run and stop the laser by the commands LR and LS.

Single pulse mode, n-pulses mode

This mode—which is illustrated in [figure 5.3](#)—is useful if you want to generate only a single pulse or a certain number of pulses. To activate it first select the internal digital modulation mode as stated above. Then enter the command LMDIC n where n is the number of pulses you want to be generated. After entering the LR command the number of pulses will be generated. Afterwards, the driver enters the *OFF state* automatically. You don't need to enter LS.

Assigning 0 to LMDIC switches to the continuous pulse mode described above.

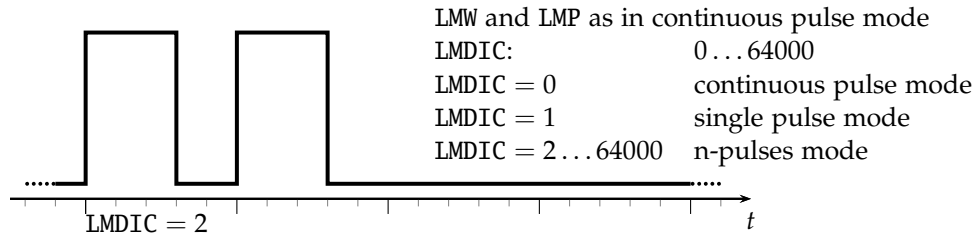


Figure 5.3: single pulse mode, n-pulses mode

External trigger mode

To switch to this mode activate the gate option in single pulse mode/n-pulses mode. The gate option (see [section 5.3](#)) has a different meaning in this mode. Activating it enables you to trigger the beginning of the generated pulses externally. If LGR is activated and LR was entered the driver generates the defined number of pulses as soon as a low-high transition at the modulation input occurs.

5.4.2 External digital modulation

The external digital modulation mode may be activated by entering the LMDX command. If this mode is active and the laser is run (LR) then the laser is activated by a TTL high-level at the modulation input and vice versa. The command LMDXNR negates this logic so that the laser will be activated by TTL low-level. This mode is similar to the CW mode with the gate option activated. However, in this mode you can set a laser bias current (LCB).

5.4.3 External analog modulation

The external analog modulation mode is selected by entering the LMAX command. In this mode the laser current can be controlled by the voltage at the AMOD input where 4 V corresponds to I_{\max} . The compliance voltage (LVC) has to be set before and the laser has to be run by LR.

The input has an internal terminating resistor of 10 k Ω . If you want to connect e.g. a 10 V signal, you should use a 15 k Ω resistor in series externally.

5.5 Pilot laser control

The driver supports a pilot laser function. One pin at the laser & peltier connector is reserved for this purpose. In *ON state* a voltage between 4.0 and 5.0 V is applied. The maximum output current is 150 mA. In *OFF state* the output is near 0 V level. With PLR and PLS you can turn the pilot laser *ON* and *OFF*. With the command PP *n* you may set the pulse width modulation value with a base frequency of 62 Hz. The modulation parameter *n* can take values between 0 and 16. The meaning of those values is as follows:

$n = 0$	pilot laser OFF
$n = 1$	duty cycle 6.25 % - ON duration 16 ms
$n = 2$	duty cycle 12.5 % - ON duration 32 ms
...	...
$n = 16$	pilot laser ON

6 Temperature controller and sensors

As you can have more than one TEC controller, the temperature sensor or TEC controller is selected by a prefix, in this chapter written as x . So, x has to be replaced by a digit (or letter) to select the temperature sensor or TEC. The first temperature sensor or TEC corresponds to 1, the second to 2, the third to 3 and so on. As the first temperature sensor or TEC is usually used for a laser and the second for a crystal, a deprecated option for selecting them is the use of the letters L and C, respectively.

6.1 PID controller parameters

The temperature controller in devices with TEC support has a PID structure with the common formulas:

$$G_c(s) = k_p \left(1 + \frac{1}{T_n s} + T_v s \right)$$

$$u(t) = k_p \left(e(t) + \frac{1}{T_n} \int e(t) dt + T_v \frac{de(t)}{dt} \right)$$

$$k_p \quad - \text{proportional gain} \quad - x\text{TCCK}$$

$$T_n = T_i \quad - \text{integral time} \quad - x\text{TCCN}$$

$$T_v = T_d \quad - \text{derivative time} \quad - x\text{TCCV}$$

The values of these three variable parameters have to be found. After Ziegler-Nichols for example you can calculate

$$k_p = 1.2 \cdot \frac{T}{L}$$

$$T_n = 2 \cdot L$$

$$T_v = 0.5 \cdot L$$

Here, T is the base time constant and L is the delay time, both derivated from a step response. Note that the so found parameters differ slightly from the theoretical values. In practice typical value ranges for a TEC circuit are:

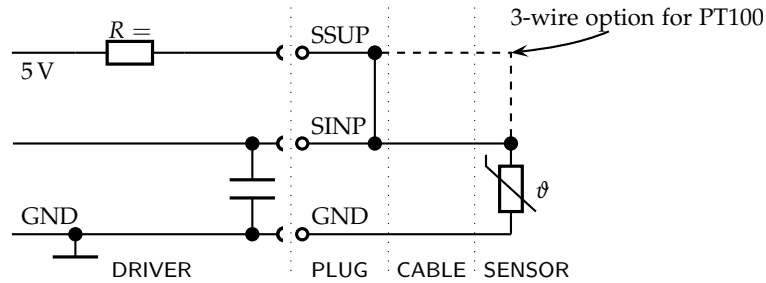


Figure 6.1: schematic for connecting a temperature sensor

LTCCK:	0.2...5
LTCCN:	5...50
LTCCV:	0.2...2

If you don't know anything about the TEC circuit, you may set $xTCCK = 0.2$, $xTCCN = 2$ and $xTCCV = 0.1$. Then increase $xTCCK$ slowly by 1 as long as the circuit stays stable. When it becomes unstable halve the $xTCCK$ value. Here the controller nearly runs as P controller. After this try to find the value for $xTCCN$ in the same way. However, you may increase it by bigger steps. Now the controller behaves like a PI controller. Finally, you may increase $xTCCV$ by steps of 0.3 until you find an optimum value for response time and overshooting.

Note that you have to stop and start the temperature controller after changing those values to make sure that the controller is initialized with the new values.

6.2 Temperature sensor

The temperature sensor is connected over three pins of the laser & peltier interface: GND, SINP and SSUP. The schematic in [figure 6.1](#) shows the internal part of the driver on the left hand side and a typical NTC thermistor connected to it on the right hand side. In newer versions SSUP and SINP are connected internally. Only the pins SINP and GND are available externally.

As you can see there the temperature is calculated by measuring the voltage over a simple voltage divider. After a 24 bit AD conversion the temperature T is calculated from the measured voltage V . For this purpose the Steinhart-Hart equation is used by default.

$$T(R_{NTC}) = \frac{1}{c_1 + c_2 \cdot \ln(R_{NTC}) + c_3 \cdot (\ln(R_{NTC}))^3} + c_0 \quad (\text{TSM1})$$

The default coefficients c_0 , c_1 , c_2 and c_3 of this polynomial correspond to an NTC with 10 k Ω at 25 °C which is a wide spread standard. You may adjust these coefficients to a different sensor by the commands $xTSC$ [0..3].

Additionally, the driver can be set to calculate the temperature using the following third-order polynomial:

$$T(V) = c_3 \cdot V^3 + c_2 \cdot V^2 + c_1 \cdot V + c_0 \quad (\text{TSM0})$$

The model switching is done with the $xTSM$ command. Here, $xTSM0$ causes the polynomial model to be used and $xTSM1$ switches to the Steinhart-Hart equation.

The coefficients for some common sensors are given in the table below.

The settings for a PT100 or PT1000 sensor can be calculated from its resistance using the following formulas:

$$R_0 = 100 \Omega \quad (\text{at } 0^\circ\text{C})$$

$$R(T) = R_0 \cdot (1 + A \cdot T - B \cdot T^2) \quad (T: \text{temperature in } ^\circ\text{C})$$

As B is commonly neglected you can calculate them using

$$R(T) = R_0 \cdot (1 + A \cdot T)$$

and using the divider network which leads to the coefficients shown in the following table:

	$xTSC0$	$xTSC1$	$xTSC2$	$xTSC3$
<i>polynomial model ($xTSM0$)</i>				
NTC 10 k Ω B3980	135.83	-63.2256	15.3332	-1.80043
NTC 10 k Ω B3450	156.089	-74.4317	17.5466	-1.99111
PT100 TK3850	-266.475	2330.44	0	0
PT1000 TK3850	-327.084	344.924	0	0
AD590 (1 μ A/K)	-897.065	-234.043	0	0
<i>Steinhart-Hart equation ($xTSM1$)</i>				
NTC 10 k Ω B3980	-273.15	$1.0832 \cdot 10^{-3}$	$2.4141 \cdot 10^{-4}$	$6.505 \cdot 10^{-8}$
NTC 10 k Ω B3450	-273.15	$1.1293 \cdot 10^{-3}$	$2.3411 \cdot 10^{-4}$	$8.7755 \cdot 10^{-8}$

The settings for the AD590 (1 μ A/K) sensor can be calculated using

$$U(T) = U_{\text{ref}} - (4272.72 \cdot 10^{-6} \cdot T) \quad (T: \text{temperature in } ^\circ\text{C})$$

For tolerances of real sensors you may need to calibrate the setup point of your sensor by adding the difference between the real temperature and the shown temperature to the absolute part $xTSC0$.

If you need assistance in connecting your sensors or you want to assemble any other sensor to the driver we would be pleased to assist you in finding the appropriate coefficients.

7 Remote control

All OsTech modules may be controlled over a serial interface. The transfer parameters of the serial interface are fixed to 9600 baud 8N1.

7.1 Standard mode

In *standard mode* you can send commands and parameters to the device in text format and the device answers in the same way. The answer of the device always contains comments and the parameters and values are given back. This mode is optimal for working at a PC using any terminal program.

After sending a character you will receive an echo of your input, i. e. all sent characters return immediately. All characters are changed to upper case. All inputs have to be finished by `(CR)` to process the input; `(CR)` is also returned. If a command returns a value, the answer is also finished by `(CR)`. No linefeed `(LF)` is added after the `(CR)`, but most terminals are able to generate this automatically. You may invalidate any sequence by sending `(Esc)`. Single characters may be deleted from the buffer by backspace `(←)`. Between commands and their parameters you can insert as many spaces as you want (no space is also okay). But note that the whole command line must not be longer than 14 characters.

```
sent command:   LCT222.3 (CR)                every character is returned
received answer: Laser Current Target:  222.3 mA (CR)    verbose answer
```

7.2 Reduced mode

The *reduced mode* works similarly to the standard mode. The difference is that you merely receive the values and numbers without any comment or unit.

```
sent command:   LCT222.3 (CR)                every character is returned
received answer: 222.3 (CR)                  short answer
```

For a single command this mode can be reached by simply adding the prefix R. So LCT222.3 would become RLCT222.3. To switch to this mode permanently use the command GMS32768. The command GMC32768 switches back to standard mode.

7.3 Binary mode

In *binary mode* no comments are returned and values are sent binary coded (MSB first) with a checksum following. This mode is optimal if you want to control the device automatically by a master computer. The checksum is computed by adding every single byte of a word or float value to the fixed value 0x55 (ignoring the overflow). For e. g. a float value whose four bytes are all 0x00 (= 0.0) the checksum is 0x55. If all bytes are 0x01 then the checksum would be 0x59 and so on.

sent command: LCT222.3 CR every character is returned
 received answer: *MSB...LSB,checksum* binary coded answer

There are four data types with the following return structure:

- float 4 bytes + checksum
- short or word 2 bytes + checksum
- string 0...255 bytes + 0x00
- boolean 1 byte:
 - 0xAA for *run* or *on*
 - 0x55 for *stop* or *off*

The device always starts in standard mode. Binary mode is initialized by setting a bit in the general mode variable of the device as follows:

sent command: GMS8 CR set bit 0x08 of mode variable

To return to standard mode this bit has to be cleared:

sent command: GMC8 CR clear bit 0x08 of mode variable

7.4 Software

At <http://www.ostech.de> you may download software to interact with OsTech devices.

- the terminal program *OSTERM*
- LabVIEW™ VIs, including a runtime version

Sample routines in C and C++ are also available on request.



8 Error codes

When an error occurs, the driver generates an error code. The error code can be determined by the GE command. Furthermore, the error is shown on the display. A list of error codes and their causes follows:

error code	cause
0	no error, everything ok
1	interlock open
2	laser compliance voltage not OK or no laser connected
3	internal supply voltage not OK
4	laser temperature sensor open
5	crystal temperature sensor open
6	laser temperature exceeds upper limit
7	laser temperature lower than lower limit
8	laser short-circuit or no laser connected
9	device temperature (GT) too high
10	laser temperature exceeds maximum laser temperature (LTM)
11	crystal temperature exceeds upper limit
12	crystal temperature lower than lower limit
16	laser current greater than maximum current limit (LCLM)
17	current error
18	total power limit exceeded

9 Command reference

9.1 Laser commands (L)

cmd	type	min	max	default	unit	description
L	bool	S	R	S		laser stop/run
LTM	float	-99	200	35	°C	laser temperature maximum
LG	bool	S	R	S		gate option

9.1.1 Laser current commands (LC)

cmd	type	min	max	default	unit	description
LCL	float	0	$I_{\max} + 5\%$	$I_{\max} + 5\%$	mA	current limit
LCT	float	0	I_{\max}	0	mA	current target
LCA	float	— no parameter —			mA	actual current
LCB	float	0	I_{\max}	0	mA	base or bias current

9.1.2 Laser voltage commands (LV)

cmd	type	min	max	default	unit	description
LVA	float	— no parameter —			V	actual laser voltage
LVC	float	1.3	6	3	V	compliance voltage

9.1.3 Laser photo current (LPC) and power (LP) commands

cmd	type	min	max	default	unit	description
LPCA	float	— no parameter —			μA	laser photo current actual
LPCT	float	0	20	0	μA	laser photo current target
LPCC	bool	S	R	S		laser photo current control
LPA	float	— no parameter —			W	laser power actual
LPT	float	0		0	W	laser power target
LPF	bool	— no parameter —				laser power fix procedure

9.1.4 Laser modulation commands (LM)

cmd	type	min	max	default	unit	description
LMDI	bool	S	R	S		internal digital modulation
LMDX	bool	S	R	S		external digital modulation
LMAX	bool	S	R	S		external analog modulation
LMW	float	1	> 48 h	1000	μ s	pulse width
LMP	float	LMW + 1	> 48 h	2000	μ s	pulse period
LMDIC	word	0	65534	0		number of pulses
LMDXN	bool	R	S	S		negate modulation input

9.1.5 Laser sequencer commands (LZ)

The LZTR command is available in every laser driver:

cmd	type	min	max	default	unit	description
LZTR	float	300	34000	300	ms	ramp time (refers to I_{max})

The following commands are optionally available on request:

cmd	type	min	max	default	unit	description
LZR	bool	— no parameter —			ms	sequencer run (stop with LS)
LZP	word				ms	sequencer point select
LZPT	word				ms	subsequence time (duration)
LZPC	float				ms	subsequence current (end)

9.1.6 Pilot laser commands (P)

cmd	type	min	max	default	unit	description
PL	bool	S	R	S		pilot laser stop/run
PP	word	0	16	0		pilot laser modulation

9.2 Temperature sensor and TEC commands (xT)

In these commands x has to be replaced by a digit (or letter) to select the temperature sensor or TEC. The first temperature sensor or TEC corresponds to 1, the second to 2, the third to 3 and so on.

As the first temperature sensor or TEC is usually used for a laser and the second

for a crystal, a deprecated option for selecting them is the use of the letters L and C, respectively.

9.2.1 Temperature sensor commands

In new firmware versions the sensor commands are also available with prefix nS instead of xT where n corresponds to the number of the temperature sensor.

cmd	type	min	max	default	unit	description
xTA	float	— no parameter —			°C	actual temperature
xTLU	float	−99	200	40	°C	upper temperature limit
xTLL	float	−99	200	0	°C	lower temperature Limit
xTSCk	float			NTC B3980		sensor coefficients, $k = 0 \dots 3$
xTSM	word	0	1	0		sensor approximation model <ul style="list-style-type: none"> ▪ 0: polynomial model ▪ 1: Steinhart-Hart equation

9.2.2 TEC commands

cmd	type	min	max	default	unit	description
xTC	bool	S	R	S		temperature controller stop/run
xTT	float	−99	200	20	°C	temperature target
xTCA	float	— no parameter —				actual current
xTCL	float	0	$I_{P_{max}}$	$I_{P_{max}}$	mA	current limit
xTVA	float	— no parameter —			V	actual voltage
xTCCK	float	0	255	2		PID parameter: gain factor
xTCCN	float	0	255	60	s	PID parameter: reset time
xTCCV	float	0	99	1	s	PID parameter: rate time

9.3 General commands

cmd	type	min	max	default	unit	description
GD	bool	— no parameter —				set defaults
GF	float	1.2	24	5	V	fan voltage (max. 300 mA)
GFD	float	1.2	24	5	V	default fan voltage

cmd	type	min	max	default	unit	description
GX	bool	S	R	S		external control stop/run
GT	float	— no parameter —			°C	device temperature (head)
GVS	word	— no parameter —				software version
GVN	word	— no parameter —				serial number

9.3.1 Status command

cmd	type	min	max	default	unit	description
GS	word	— no parameter —				get status

The status bits have the following meanings:

0x0001	interlock OK					
0x0004	driver supply OK			0x0400		LT sensor OK
0x0008	driver temperature OK			0x0800		CT sensor OK
0x0010	LTLU not OK					
0x0020	LTLI not OK			0x2000		LTM not OK
0x0040	CTLU not OK			0x4000		LC ON
0x0080	CTLI not OK			0x8000		LC error

9.3.2 Mode commands

cmd	type	min	max	default	unit	description
GM	word	— no parameter —				get mode
GMC	word					clear mode bit(s)
GMS	word					set mode bit(s)
GMT	word					toggle mode bit(s)

The mode bits have the following meanings:

0x0001	laser current ON			0x0100		first TEC (laser) ON
0x0002	input echo OFF			0x0200		second TEC (crystal) ON
				0x0400		pilot laser ON
0x0008	binary mode			0x0800		laser current control (LCC) OFF
0x0010	laser voltage control OFF			0x1000		use external interface after startup
0x0020	LMDI ON			0x2000		LMDX OFF
0x0040	LMDX ON			0x4000		gate option

0x0080	LMAX ON	0x8000	reduced mode
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