

Manual

DST Diode Laser Source

OsTech e. K.





Overview

The diode laser system DST11 series based on the OsTech DS11 laser driver and temperature controller series is a high precision, safe and cost effective solution for driving diode lasers and peltier elements. This series supports a consistent interface to control lasers and peltier elements. The driver's microcontroller based digital control unit offers a lot of options in the standard and can be customised fast and effectively. Standard interface is the RS232 port, analog control is also possible.

You can set arbitrary limits for currents, voltages and temperatures. The temperature controller realises a PID control loop. The device can modulate the laser internally using an on-board oscillator. Or it can be configured to modulate the laser externally. Multiple safety circuits monitor the laser operation to avoid any harm to the laser and the user.


Every device has passed our full power burn in and several safety tests for proving static discharge and transient protection.

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
- 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 (if available)

- 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 Safety Instructions

Your safe and effective use of this Laser Source is of utmost importance to us. Please read the following laser safety information before attempting to operate the laser. Note that OsTech bears absolutely no responsibility for the result of operation caused due to incorrect or inappropriate use of this product.

Do not open the laser system. There are no user-serviceable parts inside the unit. Unauthorized opening of the DST unit will void the warranty and may result in burns, electric shock and/or irreparable damage to the internal components.

2.1 Laser Safety

This is a class 4 Laser system. The laser radiation emitted from this unit is harmful. Reflexions may be as harmful as the original beam. Always follow these precautions:

1. Avoid exposure to the beam.
2. Always wear protective eyewear appropriate for working with laser light. Take care of the right protection level.
3. Avoid looking at the beam directly even with eyewear.
4. Be aware of the warning and safety labels (examples are shown in [figure 2.1](#) on [page 10](#)).
5. Define the laser area. Post warning labels around it. Limit access to that area.
6. Be aware of inflammable or explosive material inside the laser area.
7. Take care that only trained personnel is using the laser device.
8. Use a beam trap. Avoid reflective objects near the beam.

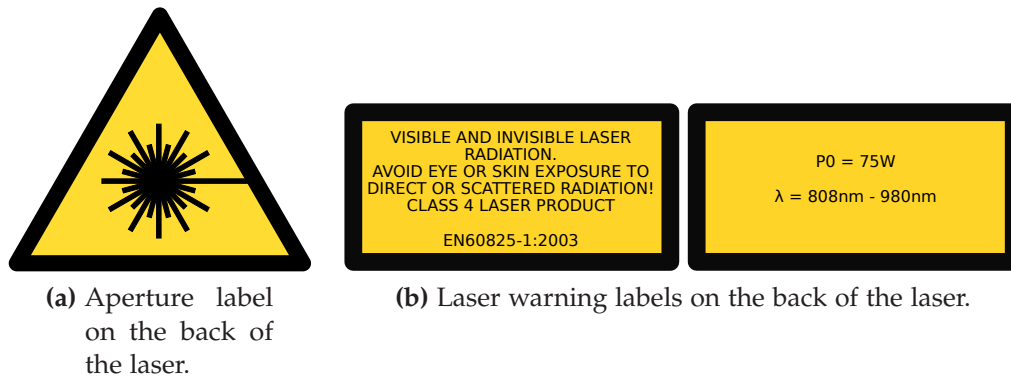


Figure 2.1: Examples for laser warning labels.

2.2 Label Identification

Figure 2.1 shows examples of the warning labels used in this product and where to find them. Please be aware of them and use caution when working with the laser.

Do not remove these labels. If you have any questions regarding warning labels, please contact us.

2.3 Environmental Concerns

To maximize the long-term performance of this instrument, the following environmental safeguards should be considered.

1. Avoid dust and direct sunlight.
2. Do not block fan ventilation. Ensure free air flow.
3. Avoid excess vibration that might compromise the mechanical integrity of the unit.
4. The recommended operating temperature is 10–35 °C.
5. Before switching on the main supply give the unit time for warming up if it comes from a cold environment.
6. Keep original packing material for transport or shipment.

2.4 Optical Fiber Handling

The optical fiber or fiber cable is used to take the optical radiation (laser light) to the work piece. It is sensitive to dirt, dust and mechanical stress. To enhance the lifetime of the optical fiber and ensure a safe operation of the laser device please follow the recommendations below. Otherwise it is possible that a failure like fiber tip burning or damaged optics inside the laser module or at the application side of the cable occurs. Such a kind of failure is excluded from warranty.

1. Inspect the optical connectors before every connection and clean them if necessary.
2. Periodic inspection of the fiber tip for scratching or pits is important for safe operation of the laser diode. If the fiber surface is damaged replace it. OsTech offers the repair as a service.
3. If you need help with fiber handling or fiber cleaning equipment please contact OsTech.
4. Before inspecting the fiber surface shut off the laser device every time. Unplug the main power supply.
5. Do not connect or disconnect the fiber cable with enabled laser radiation.
6. Take care of the bending radius of the fiber cable. As a rule of thumb please use the following equations:
Minimal radius of fiber cable handling without laser operation = 150 times fiber cladding diameter (e. g. for 500 μm cladding diameter the minimal bending radius is 75 mm).
Minimal bending radius with laser operation = 300 times fiber cladding diameter (e. g. for 500 μm cladding diameter the minimal bending radius is 150 mm).
7. Avoid mechanical stress like pulling or excessive bending/buckling.
8. Direct back reflexions from the workpiece into the connector can trigger damage if the light is absorbed beneath the glass fiber (e. g. glue or dirt)
9. Connector temperatures exceeding 50 °C ages the epoxy used inside the connector and reduces its lifetime.



3 Hardware setup

3.1 Unpacking

Inspect the shipping box for damages immediately after receiving it. If something seems to be damaged inform the shipping company for insurance issues. Please keep the shipping box until the whole device is tested. While unpacking check the part list and the delivery note.

3.2 Connecting the fiber

Almost all DST systems have a detachable FSMA fiber connector. Use a metal armoured fiber cable if possible. Use a fiber cable with a centricity of $\leq 10 \mu\text{m}$ (up to $400 \mu\text{m}$ fiber core diameter). Use fiber connectors appropriate to the laser power (standard ferrule up to 50 W, copper ferrule and air cooling up to 250 W, copper ferrule with mode stripper and water cooling up to 500 W). Use fiber cables with same or larger core diameter as specified with the laser device. Check the fiber surfaces. Connect the fiber connectors only with clean surfaces. Tighten the cap nut thoroughly. If your device has fiber connector temperature and fiber breakage detection connect the D-sub 9-pin connector coming from the fiber cable to the device.

In some configurations you may have a direct fiber output without metal armoring. Pay attention to fiber bending. As a rule of thumb you can use a bending diameter of 300 times the fiber core diameter under working conditions and 150 times the fiber core diameter under storage conditions. A fiber break may induce hazardous laser radiation in unwanted directions immediately. Some fiber configurations may need additional instructions that are available separately.

3.3 Connecting an external water cooling

If you purchased a laser device with an external water cooling you have to connect an appropriate water chiller.

- In standard configuration OsTech provides G $\frac{1}{4}$ " inner threads with mounted 8 mm or 12 mm quick fit connectors. 8 mm and 12 mm means an calibrated outer diameter of the water hose of 8 mm and 12 mm respectively.
- A maximum pressure of 4 bar is allowed in the water circuit.
- There is an overtemperature shutdown of the laser diode (normally at 33 °C or 35 °C). The water temperature and flow has to be adjusted to get the laser temperature well below that (normally to 25 °C).
- Use tap water as liquid coolant. DI water is not required and will damage metal parts inside the cooling circuit over time. High percentage of glycol should also be avoided.
- Connect the alarm output of the chiller to the laser device. It will be handled as an interlock signal.
- Some devices have integrated water flow monitoring. Ensure a proper water flow (normally between 2.5 l/min and 4 l/min). Otherwise the laser output will be disabled.

3.4 Putting an integrated chiller unit into operation

For laser devices with an integrated water chiller unit please refer to its documentation that is available separately.

3.5 Turning on the device

- Install the laser device in a safe environment. Take care about safety regulations especially laser safety.
- Initial start-up of the device should always be done by trained staff.
- Make sure that you connect everything necessary to the support connector (described in [section 10.2](#))
- Make sure that all interlock connectors are closed. There is a 4-pin M8 connector providing a dual circuit interlock, pin 1 and pin 14 at the 25-pin support connector, fiber connector detection sensor and water chiller alarm if applicable.
- Make sure that the emergency button (the large red button at the front side) is unbolted.
- Please note the laser safety regulations!

- For water-cooled devices check that the water chiller is working and water flow is appropriate for the laser diode.
- For devices with integrated water chiller the water reservoir has to be filled.
- Turn the key switch on.
- For air-cooled lasers the cooling fan and temperature controller will start.
- Before enabling the laser radiation, all interlocks have to be closed and the laser temperature has to be within the limits. Devices with a detachable fiber output must have a connected fiber cable.
- Use a beam dump to terminate the laser beam.
- After turning on the device CW mode is enabled by default.
- Check the laser operation with a current value near the laser threshold.

4 Technical parameters

4.1 General parameters

input voltage	DST11: 110–220 V AC
ambient temperature	0–35 °C
humidity	< 95 %
<i>housing size</i>	<i>width × height × depth (depth without connectors)</i>
19 in, 2 HU	483 mm × 88 mm × 260 mm (19 in × 3.5 in × 10.2 in)
19 in, 3 HU	483 mm × 132 mm × 340 mm (19 in × 5.2 in × 13.4 in) or 483 mm × 132 mm × 400 mm (19 in × 5.2 in × 15.75 in)
19 in, 4 HU	483 mm × 177 mm × 340 mm (19 in × 6.7 in × 13.4 in)
19 in, 5 HU	483 mm × 221.5 mm × 340 mm (19 in × 8.7 in × 13.4 in)
remote control	PC serial interface RS232, analog voltage control

4.2 Laser module

laser diode power	2 HU air-cooled	up to 50 W optical
	3 HU air-cooled	up to 90 W optical
	4 HU air-cooled	up to 130 W optical
	water-cooled	up to 500 W optical
current noise		1 %... 0.1 % of I_{\max} rms, better on request

<i>internal pulse mode</i>		
pulse width	range	1 μ s ... >48 h
pulse period	range	(pulse width + 1 μ s) ... >48 h
time base	accuracy	± 1 %
pulse to pulse	accuracy	300 ns
rise/fall time	max.	30 μ s
	typ.	20 μ s
	on request	< 5 μ s to < 1 μ s

4.2.1 Safety breakdown conditions

- interlock open
- internal supply failure
- abnormal transients
- laser output open circuit
- laser output short circuit
- laser diode overtemperature
- internal overtemperature
- power dissipation
- fiber connector detection
- fiber cable connector temperature, fiber break (if applicable)
- water flow (if applicable)
- laser warning lamps (if applicable)



5 Keypad and display menus

Operation of the device using keypad and display is enabled by default. To avoid unauthorised input it is possible to disable the keypad via RS232 (send GM2S4 to disable and GM2C4 to enable the keypad and the LASER ON/OFF switch).

5.1 Keypad

<input type="checkbox"/> ▲ UP	<ul style="list-style-type: none">• increases the digit under the cursor
<input type="checkbox"/> ▼ DOWN	<ul style="list-style-type: none">• decreases the digit under the cursor
<input type="checkbox"/> ◀ LEFT	<ul style="list-style-type: none">• moves to the previous input field, unsaved changes are discarded
<input type="checkbox"/> ▶ RIGHT	<ul style="list-style-type: none">• moves to the next input field, unsaved changes are discarded
<input type="checkbox"/> ● OK or Enter	<ul style="list-style-type: none">• triggers actions• toggles checkboxes• saves a changed value• moves the cursor position if pressed on an unchanged or already saved value

5.2 Display Menus

The display always shows one of two menus. 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 first menu shown after power-on is the main menu. The second menu is the laser and device menu.

5.2.1 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 is shown in [figure 5.1](#). The big number shows the actual laser current. The following fields are available in the main menu:

Laser On	shows if the laser is on or off
LCT	laser current target
CW Mode, ... Mod.	modulation mode
TEC On	shows if the TEC controller is on or off
TT	target temperature
TA	temperature actual
Error#	error number (0 = no error)
Interlock	if the interlock is closed
Estimated Laser Power	Estimation of the current laser power based on laser current (LCA), laser threshold (LCH) and laser slope (LCS)

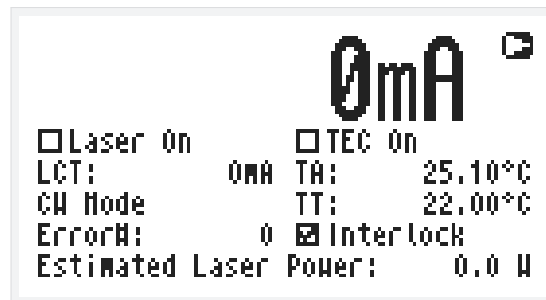


Figure 5.1: Main menu layout

5.2.2 Laser and Device Menu

The laser menu is shown in [figure 5.2](#). Here you can change laser and general settings and find out the type and serial number of your device. The following fields are included:

CW Mode	no modulation
LMAX	external analog modulation
LMDX	external digital modulation
LMDI	internal digital modulation
LMW	laser modulation width
LMP	laser modulation period
LCB	laser current bias (for modulation)

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
LCH	Laser Current Threshold
LCS	Laser Current Slope
Error#	error number (0 = no error)
Service	Show type, serial number and software version of the device.
Restore Default Settings	Reset all settings in the device to their default values.
Pilot laser (optional)	Switch the pilot laser on and off.
Intensity (optional)	pilot laser intensity (0..16)

```

Laser and Device Menu
⊗ CW      ⊗ LMDX  LMA:   1.000ms
⊗ LMAX    ⊗ LMDI  LMP:   2.000ms
LCB:      0MA   PC:    0  ⊗ LG
LCH:     5.090 A  LCS:   0.9000
Error#:    0  Service
Restore Default Settings
⊗ Pilot Laser - Intensity:  0
  
```

Figure 5.2: Laser and Device Menu



6 Laser control

6.1 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.

6.1.1 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 maximum operating current of your laser module. Activate the laser by throwing the laser switch near the display. The LED on the front panel will start blinking and the actual current will be displayed. When you turn off the laser the LED on the front panel will 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.

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

6.1.2 Ramp on laser switching

In CW mode the ramp on laser run 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. The laser stop ramp is disabled by default and can be enabled by the command LAM2S256 and disabled by LAM2C256. 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 6.1](#) shows how LZTR works. For a list of other commands see [chapter 9](#).

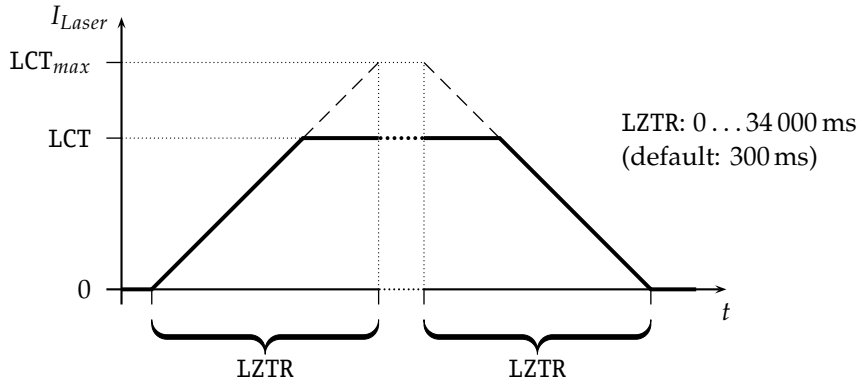


Figure 6.1: Laser current on-off ramp in CW mode. The ramp is active at any change of laser current.

6.2 Estimated Laser Power

An estimation for the Laser Power is shown in the display. You can also get this value by the LPE command. The estimated laser power is calculated as follows:

$$LPE = (LCA - LCH) \times LCS \quad (6.1)$$

Here LCA is the actual laser current, LCH is the laser threshold current and LCS is the laser slope. If LCA is below LCH then LPE shows 0. Make sure to set LCH and LCS according to the laser and adjust it from time to time as the laser degrades.

Please note that this is just a power estimation calculated from the actual laser current. Temperature and other influences are not considered. You can not rely on it being the actual laser power!

It is not possible to control optical power. The device acts as a current source. Optical monitor value (voltage or current) is only for information. It may vary with fiber bending and back reflexions (20% is possible).

6.3 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.

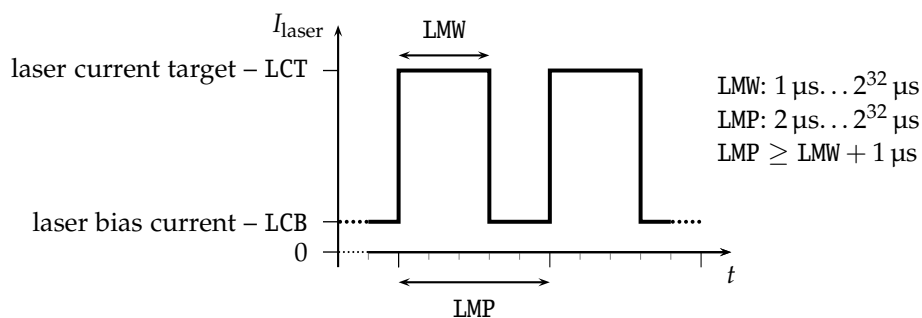


Figure 6.2: continuous pulse mode

6.4 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.

In modulation modes the measured currents and voltages displayed in the main 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.

6.4.1 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 6.2](#). 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.

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 6.3](#)—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

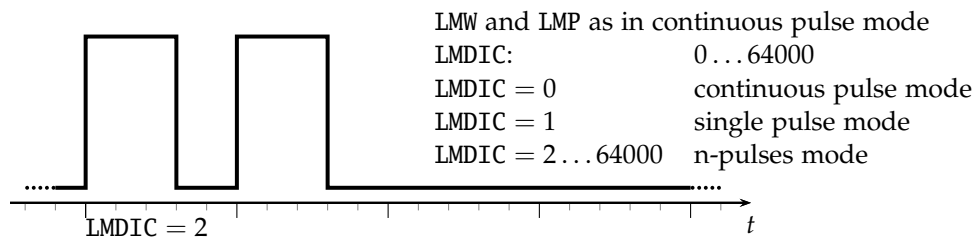


Figure 6.3: single pulse mode, n-pulses mode

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.

External trigger mode

To switch to this mode activate the gate option in single pulse mode/n-pulses mode. The gate option (see [section 6.3](#)) 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.

6.4.2 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).

6.4.3 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/10 V corresponds to I_{\max} of the current source. The current will be limited by the laser current limit that can be changed by the LCL command. 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 /25 k Ω . If you have a 4 V input and want to connect e. g. a 10 V signal, you should use a 15 k Ω resistor in series externally.

6.5 Pilot laser control

The device supports controlling a pilot laser. This function is only available if a pilot laser function is included in the laser. 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:

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

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 (sensor 1) open
5	crystal temperature sensor (sensor 2) open
6	laser temperature (sensor 1) exceeds upper limit
7	laser temperature (sensor 1) 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 (sensor 2) exceeds upper limit
12	crystal temperature (sensor 2) lower than lower limit
16	laser current greater than maximum current limit (LCLM)
17	current error
18	total power limit exceeded
21	temperature sensor 3 exceeds upper limit
22	temperature sensor 3 lower than lower limit
23	temperature sensor 3 open
31	temperature sensor 4 exceeds upper limit
32	temperature sensor 4 lower than lower limit
33	temperature sensor 4 open
41	temperature sensor 5 exceeds upper limit
42	temperature sensor 5 lower than lower limit

error code	cause
43	temperature sensor 5 open
51	necessary TECs don't run
61	temparature of necessary TECs outside of temperature window
71	temperature sensor 6 exceeds upper limit
72	temperature sensor 6 lower than lower limit
73	temperature sensor 6 open
81	temperature sensor 7 exceeds upper limit
82	temperature sensor 7 lower than lower limit
83	temperature sensor 7 open

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
LCH	float	0	I_{\max}	0	mA	laser threshold current
LCS	float	0	100	1	W/A	laser slope
LPE	float	— no parameter —			W	laser power estimated

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	μs	pulse width
LMP	float	LMW + 1	> 48 h	2000	μs	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

9.2.2 TEC commands

cmd	type	min	max	default	unit	description
xTT	float	-99	200	20	°C	temperature target

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
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)

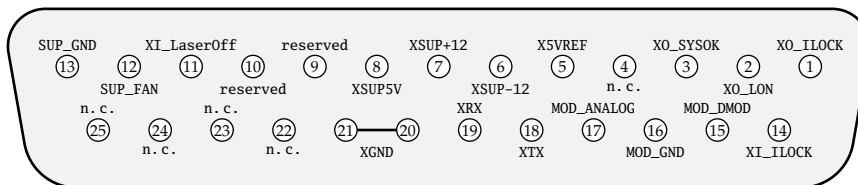
The mode bits have the following meanings:

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

10 Hardware Interface Description

10.1 Support connector 1st version

The support connector is an isolated industrial interface. It is a female D-sub 25-pin connector.

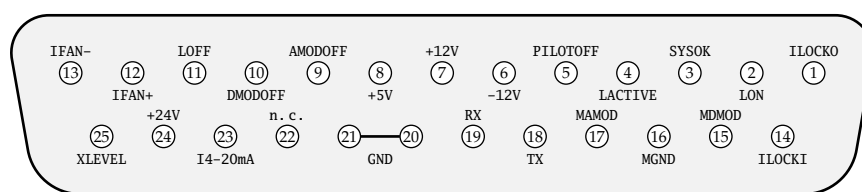


pin no.	abbr.	description
1	XO_ILOCK	interlock output, max. 12 V 100 mA
2	XO_LON	laser on – TTL output, high=laser on (pull-up resistor at 5 V with 270 Ω for e. g. LED)
3	XO_SYSOK	system ok – TTL output, high=laser temperature and system ok (pull-up resistor at 5 V with 270 Ω)
5	X5VREF	external reference 5 V±1 %, max. 20 mA, e. g. potentiometer supply
6	XSUP-12	external supply –12 V, max. 250 mA
7	XSUP+12	external supply 12 V, max. 250 mA
8	XSUP5V	external supply 5 V, max. 250 mA
11	XI_LaserOff	laser on/off – TTL input, low=laser on, internally pulled up
12	SUP_FAN (optional)	universal supply 2–22 V for external fan (not isolated)
13	SUP_GND (optional)	universal supply GND (not isolated)
14	XI_ILOCK	interlock input – has to be closed to XO_ILOCK
15	MOD_DMOD	modulation digital input, TTL
16	MOD_GND	modulation GND

17	MOD_ANALOG	modulation analog input 0–4 V → 0 A– I_{max} ($R_i = 10\text{ k}\Omega$, for 0–10 V signal put 15 k Ω in series)
18	XTX	RS232 – TX
19	XRX	RS232 – RX
20, 21	XGND	external GND
9, 10	reserved	reserved
4, 22-25	n. c.	reserved

10.2 Support connector 2nd version

The support connector is an isolated industrial interface. It is a female D-sub 25-pin connector.



pin no.	abbr.	description
1	ILOCKO	output – interlock output, max. 12 V 10 mA (connect to pin 14 to close interlock)
2	LON	output – laser ON, high = laser is in ON state ^{1) 2)}
3	SYSOK	output – system ok – high = system ok – laser ready for operation ^{1) 3)}
4	LACTIVE	output – laser active – high = laser is emitting ^{1) 2) 8)}
5	PILOTOFF	input – if your laser has a pointer device it is switched ON when low ^{2) 3)}
6	-12V	supply output –12 V, max. 250 mA for free usage ²⁾
7	+12V	supply output 12 V, max. 250 mA for free usage ²⁾
8	+5V	supply output 5 V \pm 1 %, max. 250 mA for free usage ²⁾
9	AMODOFF	input – low = switch external analogue modulation ON ^{2) 3)}
10	DMODOFF	input – low = switch external digital modulation ON ^{2) 3)}
11	LOFF	input – laser OFF – low = laser is on ^{2) 3)}
12	IFAN+	optional (fan) supply – 2–22 V up to 1 A for external fan vs. IFAN– ⁷⁾
13	IFAN–	optional (fan) supply vs. IFAN+ ⁷⁾

14	ILOCKI	interlock input – has to be connected to ILOCKO (pin 1) to close interlock
15	MDMOD	input – digital modulation ⁴⁾
16	MGND	modulation GND
17	MAMOD	input – analogue modulation ^{4) 5)}
18	TX	RS232 – TX ²⁾
19	RX	RS232 – RX ²⁾
20, 21	GND	external GND
22	n . c .	reserved
23	I4–20 mA	optional additional 4–20 mA analogue modulation input, only if requested
24	+24V	supply output 24 V max. 80 mA for free usage ²⁾
25	XLEVEL	input for logical output level ⁶⁾

- 1) logic output, high level = XLEVEL (default 5 V), low level < 1 V, see ⁶⁾
- 2) to GND
- 3) input internally pulled up, input is tolerant up to 24 V for high level
- 4) to MGND
- 5) 0–4 V → 0 A– I_{max} ($R_i = 10\text{ k}\Omega$)
optionally: 0–10 V → 0 A– I_{max} ($R_i = 25\text{ k}\Omega$)
- 6) XLEVEL is 5 V (TTL level) by default
to change output high level to 12 V connect XLEVEL (pin 25) to +12V (pin 7) or
to change output high level to 24 V connect XLEVEL (pin 25) to +24V (pin 24)
- 7) signals are not isolated, take care!
- 8) active, if the laser current is > 0.5 % of I_{max}

10.3 AMOD/DMOD connector

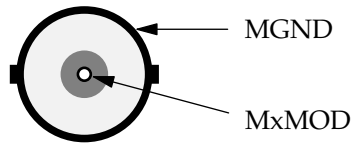
In devices with a 1st version support connector, this is a BNC connector for digital modulation with TTL level and for analog modulation with 0–4 V.

In devices with a 2nd version support connector, there are optionally two modulation inputs: a BNC connector for digital modulation and an SMB male connector for

analog modulation. The MxMOD pins are internally connected to pin 15 and 17 of the support connector.

In digital modulation TTL/XLEVEL low turns the laser off and TTL/XLEVEL high turns the laser on. The command LMDXN can be used to invert the meaning of these levels.

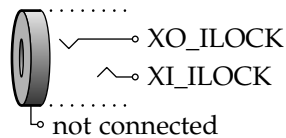
In analog modulation 0–4 V or 0–10 V corresponds to 0 A– I_{max} . The input impedance is 10 k Ω or 25 k Ω respectively.



10.4 Interlock connector 1st version

This connector was used in older devices. Please refer to the type specific data sheet.

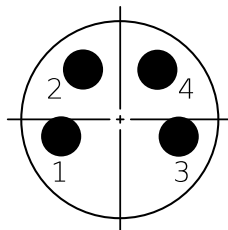
The interlock connector is a female 3.5 mm ($\frac{1}{8}$ in) TS connector (jack socket). The laser can only run when interlock is closed, i. e. XO_ILOCK pin and XI_ILOCK pin have to be connected. These pins are internally connected to their respective pins on the support connector.



10.5 Interlock connector 2nd version

The interlock connector is a M8-round connector. It provides two separate interlock circuits. The laser can only run when both interlocks are closed, i.e. IL1+ pin and IL1- pin have to be connected and IL2+ pin and IL2- have to be connected.

This interlock connector is independent from the ILOCK pins of the support connector.



pin no.	abbr.	description
1	IL1+	
2	IL1-	
3	IL2+	
4	IL2-	

safety function: interlock

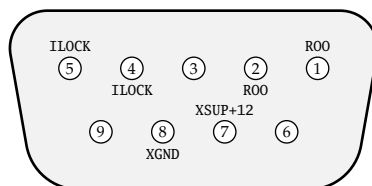
- ISO 13849-1:2006 category 3 PL e
- the safety function does simultaneity monitoring
- 2-channel connection to interlock connector M8
- after triggering the safety function, the laser will be turned off within 1ms with an interlock error
- The laser has to be restarted by the operator with one exception: activating the laser by a fixed voltage level at pin 11 (LOFF, support connector) will start the laser immediately when the cause of the failure disappears.

safety function: fiber plug detection

- ISO 13849-1:2006 category 1 PL c
- the fiber must be firmly connected to the laser, otherwise the safety function is activated
- after triggering the safety function, the laser will be turned off within 1ms with an interlock error

10.6 Water Chiller connector

This D-sub 9-pin female connector can be used to connect the water chiller. The ILOCK pins (pin 4 and 5) have to be connected to operate the laser.



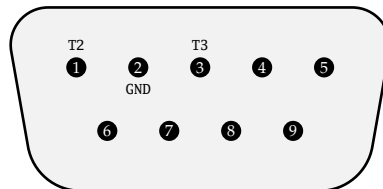
pin no.	abbr.	description
1	R00	output – remote on/off (optional)
2	R00	output – remote on/off (optional)
4	ILOCK	input – level/flow/temperature alarm, integrated into interlock circuit
5	ILOCK	input – level/flow/temperature alarm, integrated into interlock circuit
7	XSUP+12	external supply output 12 V max. 250 mA, internally connected to pin 7 of the support connector
8	XGND	external GND

10.7 Fiber breakage detection

This D-sub 9-pin male connector can be used to monitor the integrity of the optical fiber and the temperatures of the fiber connectors.

T2 measures the temperature of the laser-facing connector. T3 measures the temperature of the application-facing connector and is used for fiber breakage detection. An open or shorted sensor is detected as a broken fiber.

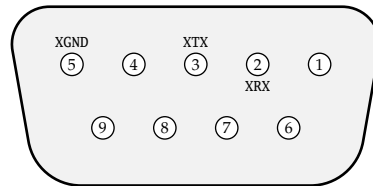
If a sensor failure is detected or the temperature is not between 5 °C and 85 °C, the laser will be stopped with an error code.



pin no.	abbr.	description
1	T2	input – temperature of fiber connector (laser end)
2	GND	ground
3	T3	input – temperature of fiber connector (application end) and fiber breakage detection

10.8 RS232 connector

This D-sub 9-pin female connector can be used to control the driver over a serial interface as described in [chapter 7](#).



pin no.	abbr.	description
2	XRX	receive data, the same as pin 19 on the support connector
3	XTX	transmit data, the same as pin 18 on the support connector
5	XGND	ground, the same as pins 20 and 21 on the support connector

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Version 1.5 2021-07

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