# Life Test and Burn-In System for Butterfly Diodes

## User's Manual  (Rev01)



**LASER SAFETY: This product may contain laser diodes of different laser classes (not specified). To ensure continued safety, do not remove any covers or attempt to gain access to the inside of the product.**



DANGER

INVISIBLE LASER RADIATION*
AVOID DIRECT
EXPOSURE TO BEAM

* SEE MANUAL

# Safety precautions

**This manual contains a description of controls, adjustments and procedures for normal operation of the system and its plug-ins. The unit should only be operated by qualified personnel who reviewed this manual before installing and applying the system.**

**Caution: Electrostatic sensitive devices inside. Observe precautions for handling !**

# 1. Overview

The *Life Test and Burn-In System for Butterfly Diodes* (LTBIS) is a 19" case system with plug-ins to incorporate butterfly packaged laser diodes for burn-in procedures and testing. It allows for preselecting the laser current & temperature and to operate the lasers in either constant current or constant power mode. It allows for monitoring parameters like laser current & temperature, internal TEC current & voltage. The unit is commanded via an RS-232 serial interface (separate plug-in). Up to 10 plug-ins with one butterfly laser each can be installed per case.

# 2. Installation

2.1. General

At the rear panel of the 19" case the mains input is combined with a fuse housing and the mains switch. The case includes a power supply to provide up to 2A laser current and 3A TEC current for up to ten laser plug-in unit with one laser each. The system is provided with an interlock safety feature: A sub-D connector at the rear panel needs pins 1 and 2 to be shortened to operate the plug-in units.

One LTBIS master plug-in module per case is necessary to operate the system and to remotely control it.

**Caution: Switch the system off (mains switch on rear panel) before inserting or removing plug-in modules.**

2.2. Insertion of butterfly lasers into plug-in modules

The modules can only be used with pump lasers of a predefined pin assignment, see below.

**Caution: Inserting and operating lasers with pin designs different from the one described can damage the lasers! The system gives no indications if a wrong type of laser is inserted.**

## Connections

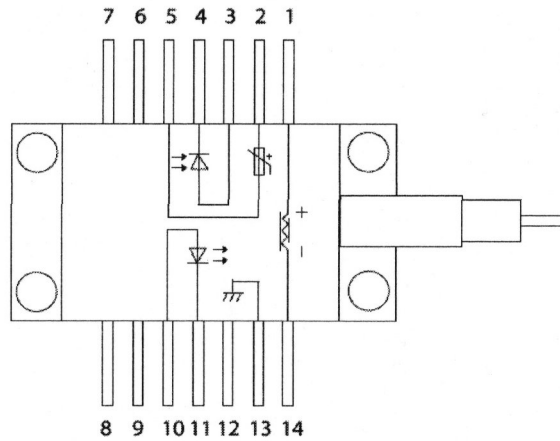| Pin # | Description | Pin# | Description |
|-------|-------------|------|-------------|
| 1 | Peltier cooler (+) | 8 | Not connected |
| 2 | Thermistor | 9 | Not connected |
| 3 | Monitor anode (-) | 10 | Laser anode (+) |
| 4 | Monitor cathode (+) | 11 | Laser cathode (-) |
| 5 | Thermistor | 12 | Not connected |
| 6 | Not connected | 13 | Case ground |
| 7 | Not connected | 14 | Peltier cooler (-) |



Fig.2: Pin assignment for lasers accepted by the plug-in modules (pump lasers)
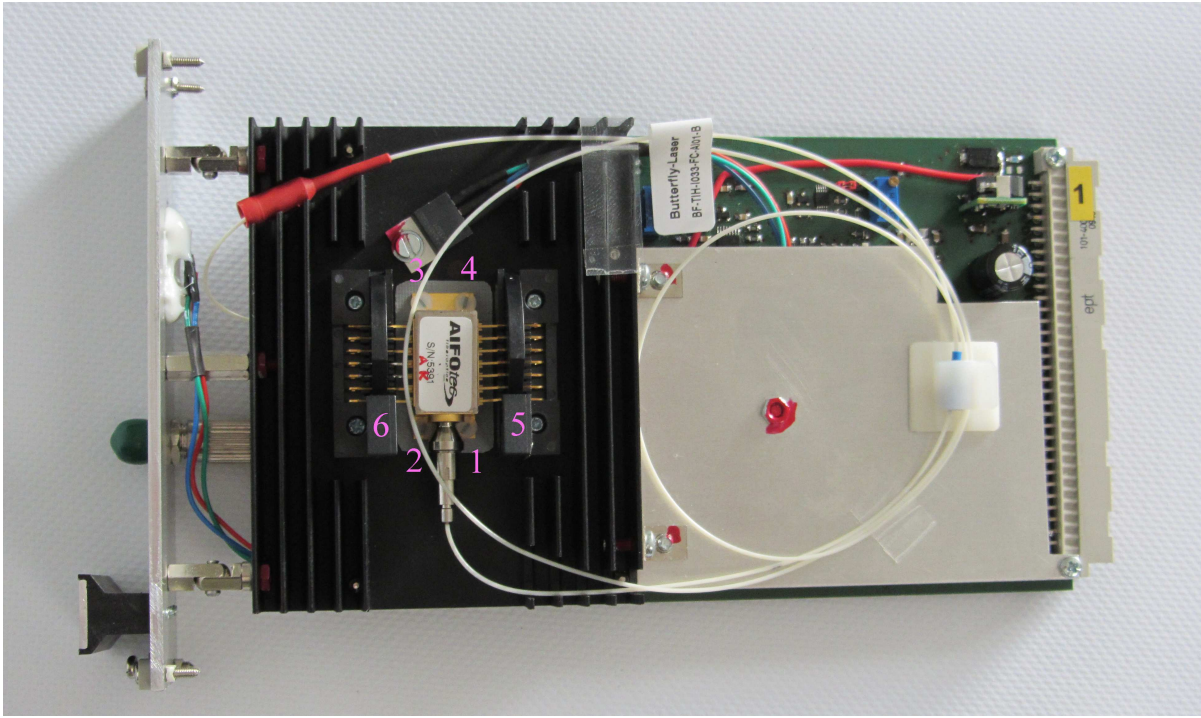


Fig.3: Single plug-in module, front view

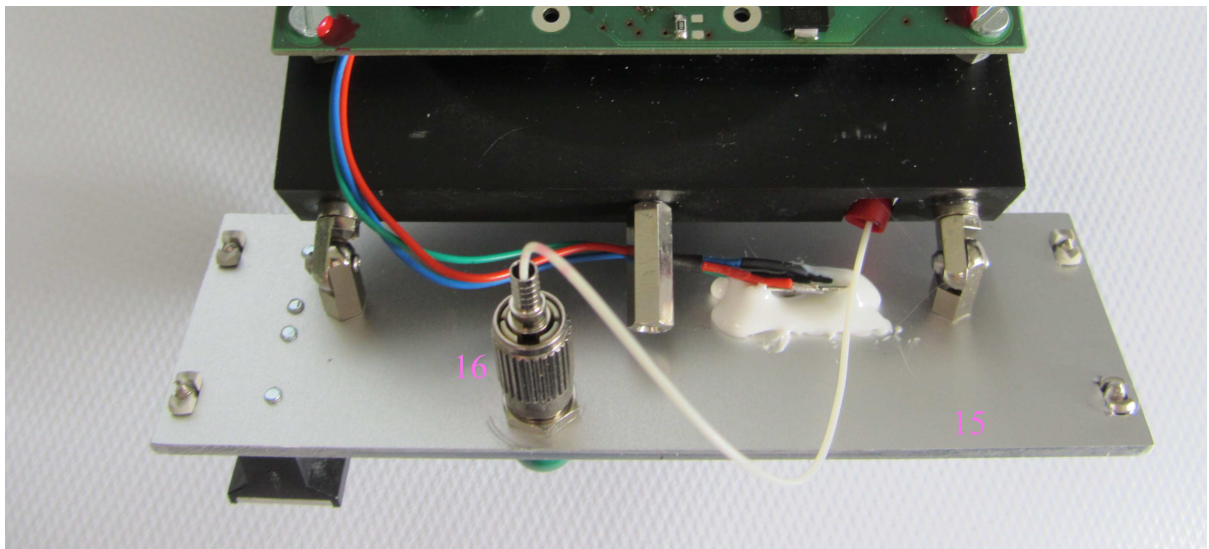Fig. 4: Single plug-in module removed from system case, side view



Fig.5: single plug-in module removed from system case, top view with fiber adapter

To remove/replace a laser execute the following steps:

- Loose four front panel screws of the plug-in module [Fig 3: 10, 11, 12, 13]
- Two front panel screws need to be kept in place
- Carefully pull the plug-in module out of the 19" case
- Disconnect all laser fiber connections from rear of front panel adapter [Fig 5: 16]
- Unclamp the two wings of the laser socket [Fig. 4: 5, 6]
- Remove the four plastic screws holding the laser package [Fig. 4: 1, 2, 3, 4]
- The laser can now be removed
- Don't remove the thermal pad below the laser
- A replacement laser can be inserted

Assemble in reverse order

**Caution: When positioning a laser butterfly package into the socket make sure that the contact pins are in the appropriate slots in the socket before closing the wings!**

**Caution: Don't remove or properly replace the thermally conducting and electrically isolating pad below the laser!**

## 2.3. Computer control (RS232-interface)

The interface is a three-wire type (Tx, RX, gnd). Any ASCII terminal program (e.g. Windows OS "Hyperterminal") can be used for line-oriented communication.

Serial Interface initial settings:  115200 baud, 8N1, no handshake

# 3. Operation

## 3.1. Power up

After switching the mains switch on the rear panel to "1", two green front panel LEDs "Power" on the master module indicate proper operation of the internal power supplies. A blue LED "Interlock" indicates that the interlock safety circuit (sub-D connector rear panel) is closed.

After power up and after the interlock circuit being opened and closed again during operation all laser currents and TEC currents of all modules are reset to zero values. The default value for the laser's NTC resistor voltage feedback to control the laser diode temperature is $U_{ntc} = 1,25V$ corresponding to 25°C.

## 3.2. Plug-in modules

On the front panel of each module a green LED "Power" indicates that it is connected to the case. A red "Emission" LED indicates laser emission from the optical connector. All operational parameters of the lasers can only be controlled remotely. After power up all laser and TEC currents are set to zero and laser emission is disabled. Each module owns a channel number from 0 to 9 to send commands to the corresponding laser.

## 3.3. Computer control (RS232-interface)

The system is controlled by sending line-oriented commands based on the ASCII character set. A colon ($3A) at the beginning of a new line indicates, that the system is ready to receive a command („prompt"). Commands are case sensitive and are processed after sending carriage return ($0D) and line feed ($0A). In response to a command either requested data are sent or the command is echoed, both followed by a new prompt. In case of misspelling a command or in case of sending an unknown command, an error message (":ERROR") is the response. Numbers are always hexadecimal and can be either upper or lowercase. Do not omit leading zeroes, i.e. type "000A" instead of "A".
A list of all commands and its documentation are given in the next chapter.

## 3.4. Serial Commands

### 3.4.1 General commands

| | |
|---|---|
| **help** | show this help |
| **fwinfo** | display version number |
| **sernb** | display serial number |

### 3.4.2. Commands to set target parameters

Commands for preselection or readout of parameter values are a combination of "set/get", channel number X (0-9) and a hexadecimal value YYY.

| | |
|---|---|
| **set chX &lt;param&gt;YYY** | set parameter for channel X (1-4) |
| **get chX &lt;param&gt;** | get parameter from channel X (1-4) |

&lt;param&gt; =

| | |
|---|---|
| **pow** | set/get power YYY (000-FFF) of laser X |
| **max** | set/get maximum laser current YYY (000-FFF) |
| **ntc** | set/get ntc reference voltage YYY (000-FFF) |
| **tec** | set/get maximum tec current YYY (000-FFF) |

### 3.4.3. Commands for laser control

| | |
|---|---|
| **set chX on** | enable emission laser X |
| **set chX off** | disable emission laser X |
| **set chX regZ** | change the laser operating mode Z of laser X to E, C, I |
| **get chX reg** | get the laser operating mode Z (C, I) of laser X |
| **get chX status** | get the emission status ("on"/"off") of laser X |

### 3.4.4. Commands to retrieve actual data

| | |
|---|---|
| **get chX &lt;param&gt;** | get parameter from channel X (1-4) |

&lt;param&gt; =

| | |
|---|---|
| **curL** | get the measured current of laser X |
| **volL** | get the measured voltage of laser X |
| **monI** | get the measured current of internal laser monitor diode of laser X |
| **curT** | get the measured TEC current of laser X |
| **volT** | get the measured TEC voltage of laser X |
| **volN** | get the measured NTC voltage of laser X |
| **tp** | get the measured butterfly case temperature of laser X |

**Caution: Always disable laser emission (**"set chX off"**) before changing the laser current or the APC/ACC modes!**

## 3.5. Setting a module's laser current

A laser can be operated in ACC mode (automatic current control) or in APC mode (automatic power control). In APC mode two different ways of controlling laser emission power can be selected: One is by using the internal photodiode of the laser; another by using an external photodiode connected to the laser's output fiber via an external coupler.

In all cases a maximum laser current must be chosen, which is never exceeded in any operation mode or condition.

The sequence to control the laser current is as follows:
- Use "set chX maxYYY" to select the laser's absolute maximum current
- Use "set chX regC/E/I" to select ACC or APC modes
- Refer to the table below for the proportionality factor of Bit value to current
- Use "set chX powYYY" to preselect the laser or photodiode current value

To get information about the actual values of voltage and current applied to the inserted laser by the module use the commands "get chX volL" and "get chX curL" (see chapter 3.4.4).

**set chX regZ**   change the laser operating mode Z

> Z = „C": ACC mode – preselect laser current with „set chX powYYY"
>
> Z = „I": APC mode with internal laser diode – preselect photodiode current with „set chX powYYY"

### 3.5.1. ACC mode (automatic current control)

In this mode the laser current is preselected with the command "set chX powYYY" and a Bit value = YYY in hexadecimal numbers. Via a proportionality factor (given in the table below) the requested laser current can be converted to the Bit value to be sent by the command. An internal feedback loop keeps the current constant.

### 3.5.2. APC modes (automatic power control)

In these modes a feedback loop controls the laser current to keep the measured photodiode current at a level of preselected photodiode current set by the command "set chX powYYY" and a Bit value = YYY in hexadecimal numbers. Via a proportionality factor (given in the table below) the requested photodiode current can be converted to the Bit value to be sent by the command. The relationship between the selected photodiode current, the corresponding laser emission power and the resulting laser current has to be taken from the data sheet of the inserted laser by the user.

**Caution: The user is responsible for always checking for the maximum allowed currents (laser diode and TEC) of the lasers installed into the modules. Commanding the adjustment of wrong parameters will destroy the inserted laser.**
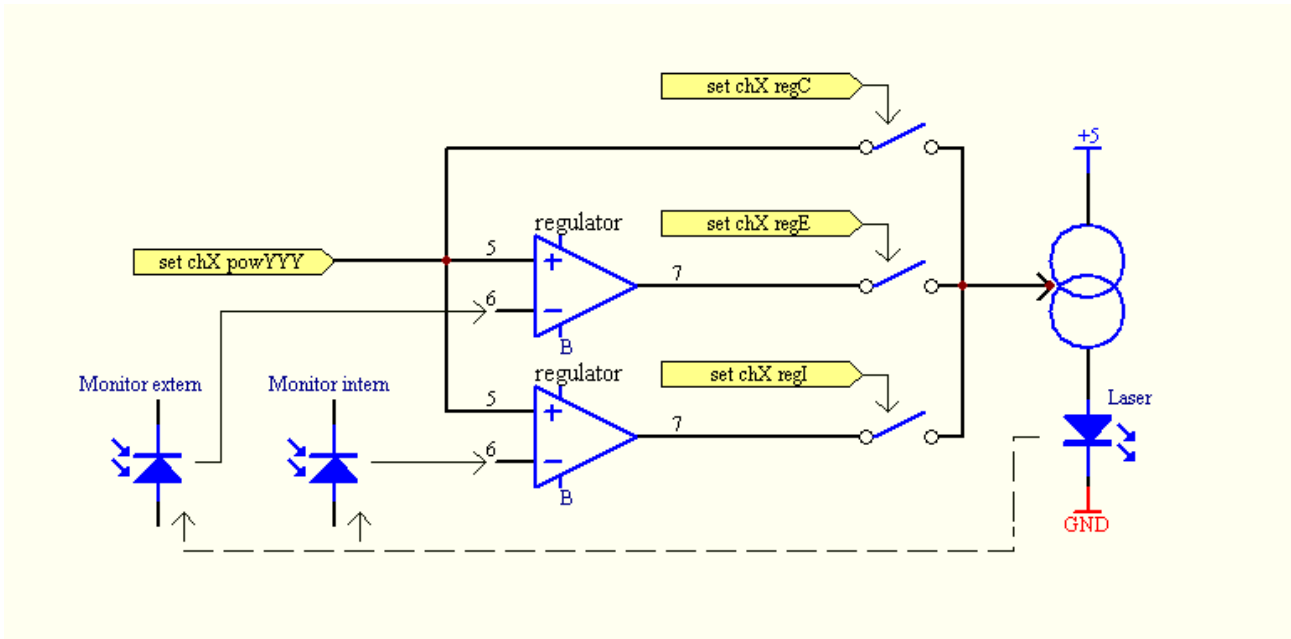
Fig. 6: Schematic of the laser current control feedback circuit

## 3.6. Setting a module's laser diode temperature

The temperature of the inserted laser's diode is managed by a TEC (thermo electric coupler) inside the laser package. It is measured by an NTC resistor inside the laser package. The module includes a feedback loop to control the TEC current for keeping the laser diode at a fixed temperature. This temperature can be preselected as follows:

- Refer to the laser data sheet for the proportionality NTC resistance vs diode temperature
- Refer to the formula below for the proportionality NTC resistance vs NTC readout voltage
- Refer to the table below for the proportionality factor of Bit value to voltage
- Use "set chX volNYYY" to preselect the NTC voltage value calculated above

The following formula gives the proportionality between the NTC resistance $R_{ntc}$ and the NTC voltage $U_{ntc}$ needed to program the laser diode temperature:

$$U_{ntc} = (2,5V \times R_{ntc}) / (10kOhm + R_{ntc})$$

Typical values are:  12,5kOhm @ 20°C: $U_{ntc}$ = 1,38V
10,0kOhm @ 25°C: $U_{ntc}$ = 1,25V
8,06kOhm @ 30°C: $U_{ntc}$ = 1,11V

To get information about the actual values of voltage and current applied to the inserted laser's TEC by the module use the commands "get chX volT" and "get chX curT". For reading the NTC voltage use "get chX volN".

Table of units for calculating data to preselect:

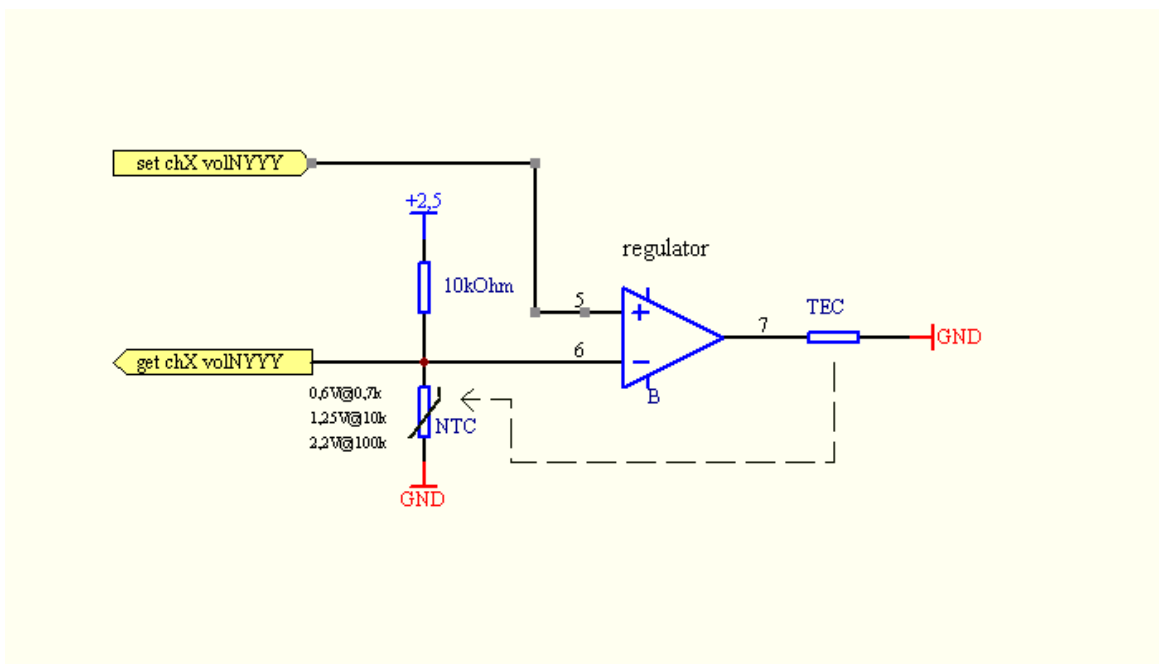| Command | Parameter | A/D Sensitivity | Example |
|---------|-----------|-----------------|---------|
| pow | Laser diode current | 0,5 mA/Bit | 300h = 768d<br>768Bit x 0,5 mA/Bit = 0,384A |
| max | Maximum laser diode current | 0,5 mA/Bit | 300h = 768d<br>768Bit x 0,5 mA/Bit = 0,384A |
| tec | Maximum TEC current | 1,0 mA/Bit | D00h = -768d<br>-768Bit x 2,441 mA/Bit = -1,874A |
| ntc | NTC voltage | 1,0 mV/Bit | 300h = 768d<br>768Bit x 1,0 mV/Bit = 0,768V |



Fig. 7: Schematic of the lasers NTC resistor voltage measurement circuit

## 3.7. Retrieving actual laser data

The four commands set chX maxYYY/powYYY/ntcYYY/tecYYY are used to preselect the laser's parameters as target data. The corresponding get-commands only retrieve the values YYY being sent. Actual parameters of the lasers are retrieved by different commands (see chapter 3.4.4), which control the measurement of these and include an A/D conversion.

All these commands give a three digit result YYY in hexadecimal numbers but of different unit depending on the data, see below.

All A/D converters of the system are adjusted to a sensitivity of 2,441 units/Bit with unit = mA, µA, mV, 0.1°C , corresponding to the following table. All measurement results are given in complements on two in order to allow for negative results.

Range of values YYY in complements on two:

max. +:    7FFh
     0:    000h
   -1:    FFFh
max. -:    800h


Table of units for calculating retrieved laser status data:

| Command | Parameter | A/D Sensitivity | Example |
|---------|-----------|-----------------|---------|
| curL | Laser diode current | 2,441 mA/Bit | 300h = 768d<br>768Bit x 2,441mA/Bit = 1,874A |
| curT | TEC current | 2,441 mA/Bit | |
| volL | Laser diode voltage | 2,441 mV/Bit | 300h = 768d<br>768Bit x 2,441mV/Bit = 1,874V |
| volT | TEC voltage | 2,441 mV/Bit | D00h = -768d<br>-768Bit x 2,441mV/Bit = -1,874V |
| volN | NTC voltage | 2,441 mV/Bit | 300h = 768d<br>768Bit x 2,441mV/Bit = 1,874V |
| tp | Butterfly case temperature | 0,2441 °C/Bit | 068h = 104d<br>104Bit x 0,2441°C/Bit = 20,8°C |
| monL | Photodiode current | 2,441 µA/Bit | 334h = 820d<br>820Bit x 2,441µA/Bit = 2,00mA |


## 3.8. Command examples


Enable laser Ch1

Set ACC mode:                     set ch1 regC

Maximum TEC current 2A ($\rightarrow$ 819 bit):    set ch1 tec333
Maximum laser current 2.2A ($\rightarrow$ 901 bit):  set chX max385

Target laser current 1A ($\rightarrow$ 409 bit):     set ch1 pow199
Target laser temperature 25°C:       --- (default)
Enable laser emission:              set ch1 on


Change temperature laser Ch1

Target laser temperature 20°C
($\rightarrow U_{ntc}$ = 1,38V $\rightarrow$ 1380 bit):      set ch1 ntc564


Disable laser Ch1

Disable laser emission:             set ch1 off