THORLABS

## Thorlabs Instrumentation

# PRO8000 Series Mainframes Operation Manual




## 2024

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**In the displays shown by the PRO8 you may find the name PROFILE. PROFILE was the name of the manufacturer before it was acquired by Thorlabs and renamed to Thorlabs.**

***Thorlabs GmbH***

**Warning**

**Sections marked by this symbol explain dangers that might result in personal injury or death. Always read the associated information carefully, before performing the indicated procedure.**

**Attention**

**Paragraphs preceeded by this symbol explain hazards that could damage the instrument and the connected equipment or may cause loss of data.**

**Note**

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

**Please read these advices carefully!**


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# 1 General Information

This part of the instruction manual contains specific information on how to operate the modular PRO8000 Series mainframe.

The descriptions of the modules are given in the individual module manuals.

The units of the PRO8000 Series are modular platforms for electro-optical test and control applications.

The high channel count and the wide variety of plug-in modules allow complex systems and solutions with a small footprint.

With the comfortable manual operation and the built-in RS232 and IEEE488.2 interfaces, the PRO8000 Series is the right choice for lab applications as well as for remote controlled test systems.

## 1.1 Safety

**Attention**

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

Prior to applying power to the PRO8000 Series, make sure that the protective conductor of the mains power cord is correctly connected to the protective earth ground contact of the socket outlet! Improper grounding can cause electric shock resulting in damage to your health or even death!

Also make sure that your line voltage agrees with the voltage given on the letterplate of the unit and that the right fuse has been inserted!

To avoid damage to the modules used or to the mainframe, modules must not be installed or removed when the mainframe is switched on.

All modules must be fixed using the screws provided for this purpose.

The PRO8000 Series must not be operated in explosion endangered environments!

Do not remove covers! Do not obstruct the air ventilation slots in the housing!

Refer servicing to qualified personnel!

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

This precision device is only serviceable if properly packed into the complete original packaging. If necessary, ask for a replacement package prior to return.

All connections to the load must be made using shielded cables, unless otherwise stated.

The PRO8000 Series laser modules can deliver up to several 100mW of possibly invisible laser radiation! Improper operation can cause severe eye and health damage!

Pay strict attention to the safety recommendations of the appropriate laser safety class! The laser safety class is marked on PRO8000 Series laser source module.

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**Attention**

The following statement applies to the products covered in this manual, unless otherwise specified herein. The statement for other products will appear in the accompanying documentation.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Thorlabs is not responsible for any radio television interference caused by modifications of this equipment or the substitution or attachment of connecting cables and equipment other than those specified by Thorlabs. The correction of interference caused by such unauthorized modification, substitution or attachment will be the responsibility of the user.

The use of shielded I/O cables is required when connecting this equipment to any and all optional peripheral or host devices. Failure to do so may violate FCC and ICES rules.

**Attention**

Mobile telephones, cellular phones or other radio transmitters are not to be used within the range of three meters of this unit since the electromagnetic field intensity may then exceed the maximum allowed disturbance values according to IEC 61326-1.

This product has been tested and found to comply with the limits according to IEC 61326-1 for using connection cables shorter than 3 meters (9.8 feet).

**Attention**

Mounting several PRO8000 (-4) in a rack, make sure to have 1 height-unit space between the different housings to ensure proper ventilation (ventilation slots are beneath the front panel!)

Use only the supplied mains cord with safety mains plug to connect the unit to the mains! The unit is grounded via the protective conductor of this cable. To avoid electric shocks the plug of the mains cable must be inserted in a correctly grounded socket.

Interruption of the protective grounding could lead to health damage or even death due to electric shock.

Please check prior to operation, if the line voltage indicated on the rear panel agrees with your local supply. If not please have a service technician change the line voltage and the appropriate fuse.

**Attention**

Changing the line voltage is a service operation and must be done only by qualified service personnel! (see chapter Changing the Line Voltage Setting).

**Attention**

Do not open the unit during operation. Internal adjustments as well as replacement of parts is only to be done by especially trained service personnel. Parts must not be exchanged while the unit is switched on. Dangerous voltages may also be present in the unit when switched off and with power cord removed.

Proper discharge of power components is advised.

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## 1.2 Ordering Codes and Accessories

| Ordering-Code | Short Description |
|---|---|
| | **Mainframes** |
| **PRO800** | Mainframe for up to 2 Modules, up to 4 A per Slot |
| **PRO8000** | Mainframe for up to 8 Modules, up to 4 A per Slot |
| **PRO8000-4** | Mainframe for up to 8 Modules, up to 4 A per Slot |
| | **Modules for the PRO8xxx Series** |
| **LDC8xxx** | Laser Diode Controllers, 7 Types, 100 mA to 8 A f.s. |
| **MLC8xxx** | 8 Channel Laser Diode Controllers, 8 Types, 25 mA to 200 mA f.s. |
| **TED8xxx** | Temperature controllers, 3 Rypes, 2 A to 8 A f.s. |
| **ITC8xxx** | Laser Diode and Temperature Controllers, 3 Types, 200 mA to 1 A f.s. Laser Current, 2 A TEC Current |
| **PDA8000** | Photo Diode Current Meter, 1 or 2 Channel, 7 Ranges, 10 nA to 10 mA f.s. |
| **WDM8xxx** | Laser Modules in the ITU Grid, C and L-Band |
| **OSW8xxx** | Optical Switches for the 1310 / 1550 nm Range, 1x2 to 1x8, 2x2 |
| | **Shielded Cable** |
| **CAB400** | Cable to Connect an LDC8xxx to a Laser Diode Mount |
| **CAB420-15** | Cable to Connect a TED8xxx to a Laser Diode Mount |
| **CAB430** | Cable to Connect an ITC8xxxDS15 to a Laser Diode Mount |

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# 2 Getting Started

## 2.1 Parts List

Inspect the shipping container for damage.

If the shipping container seems to be damaged, keep it until you have inspected the contents and you have inspected the PRO8000 Series mechanically and electrically.

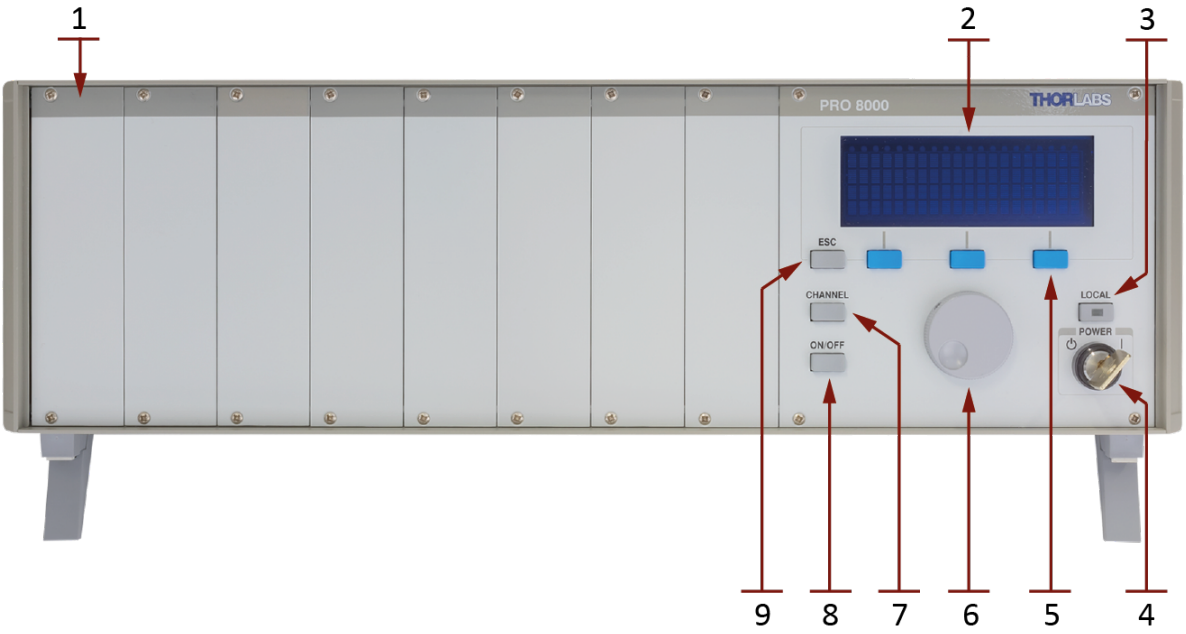
Verify that you have received the following items within the package:

1. PRO800 or PRO8000 or PRO8000-4
2. Power Cord, Connector According to Ordering Country
3. Operation Manual
4. Inserted Modules as Ordered with the Mainframe
5. Blind Plates in the Empty Slots


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## 2.2 Operating Elements

### Front Panel




1 **Module Slots:** The PRO8000 and PRO8000-4 can house up to 8 plug-in modules, the PRO800 two modules. All in - or outputs are accessible directly at the front of the modules.

2 **The Alphanumeric Vacuum-Fluorescence Display** enables interactive communication with the PRO8000 Series. Different menus allow a clearly structured representation of the relevant values.

3 **The LOCAL Key** switches to manual operation from remote control. The LED lights if in local mode. If a remote controller has given a “local lock-out” command **[LLO]**, this key is disabled for further operation until you switch off the unit or give the command **[GTL]**.

4 **The Main Switch** is a key-operated power control switch (On/Standby) to prevent accidental or non-authorized use.

5 **Three Blue Soft Keys** have different functions in the different menus. The respective function is shown in the bottom line of the display.

6 **Tuning Knob** allows to change numerical values can be changed. The respective value is selected with the cursor (▶) and to value to be changed.

**Example: ▶ 1550.83**

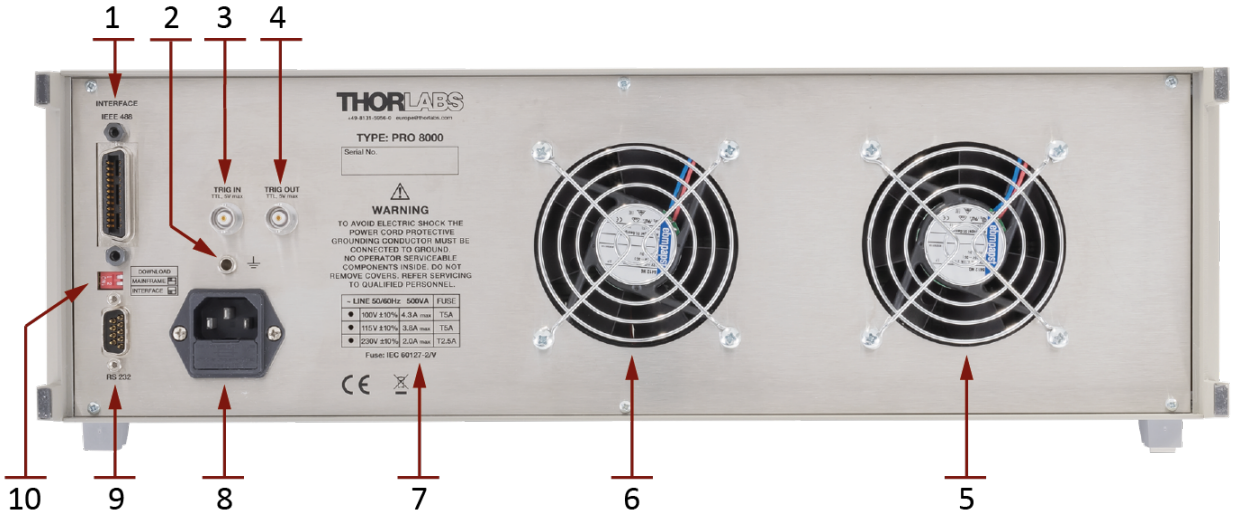
7 **The Channel Key** selects a module / a channel.

8 **The On/Off Key** switches a module / a channel on or off.

9 **The Escape Key** interrupts the actual procedure.

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**Rear Panel**




**1** IEEE488 Interface Connector

**2** GROUND Connector (4 mm Banana Jack)

**3** Trigger Input

**4** Trigger Output

**5** Fan and Air Outlet

**6** Fan and Air Outlet

**7** Fuse List with a Marker - Indicating the Line Voltage Setting

**8** Mains Connector with Fuse Holder

**9** RS232 Interface Connector

**10** Two-Pin DIP Switch - For Service Only! For normal operation, both switches must be in position "right".

## Notes

1. The DIP switches (2) must be set to the right position for normal operation of the PRO8000 Series.
2. The screw on the fuse list is just a marker that indicates the line voltage setting. See chapter Changing Line Voltage Setting for instructions.


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## 2.3 First Steps

Prior to starting operation of the PRO8000 Series, check if the line voltage specified on the letter plate agrees with your local supply and if the appropriate fuse is inserted. To change the line voltage see chapter Changing Line Voltage Setting.

Connect the unit to the line with the provided mains cable. Turn the unit on by means of the mains switch.

The 4 mm banana jack allows to connect the chassis ground to the ground of the external setup.

The display lights up several seconds after switching on the unit. The system boot process may take around 15 sec. If no display is shown after this time, please check line voltage and line fuse.

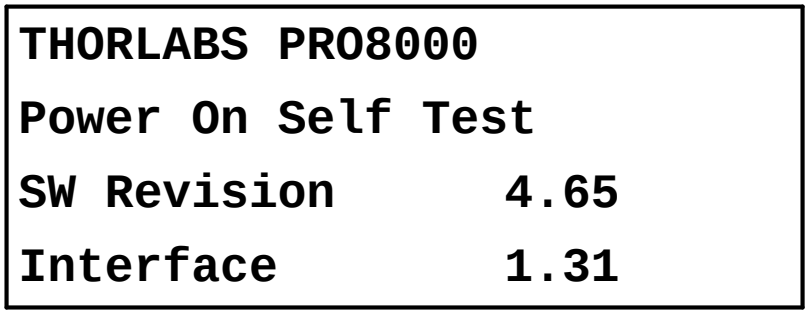
The PRO8000 Series mainframe is ready to use immediately after turning on. However, a warm-up time is required in order to reach the specified accuracy of the plugged-in modules. Please refer to the manuals of the installed modules for closer information.

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# 3 Operating Instruction

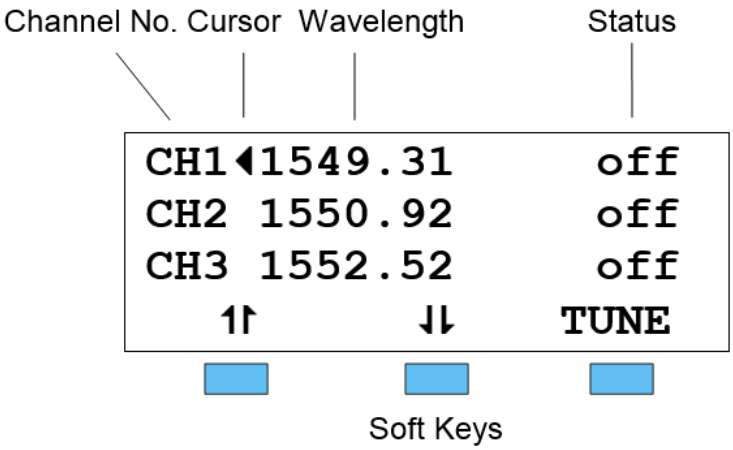
## 3.1 After Power-On

After turning on your PRO8000 Series the main processor executes a self test program for several seconds.




The display shows the actual software and interface revision number. After a few seconds the program enters the main menu screen.

## 3.2 Main Menu




*PRO8000 Series Main Menu with WDM Laser Sources*

The first three lines show the contents of the respective menu. In this example "Main Menu" the wavelengths of the inserted WDM modules of the channels CH1 to CH3 are displayed.

The fourth line describes the functions of the three soft keys (here up (↑), down (↓) and TUNE).

## 3.3 The Cursor

The cursor of the display can be placed at different positions in the display. It can point to values to the left ( ◂ ) or to the right ( ▸ ).

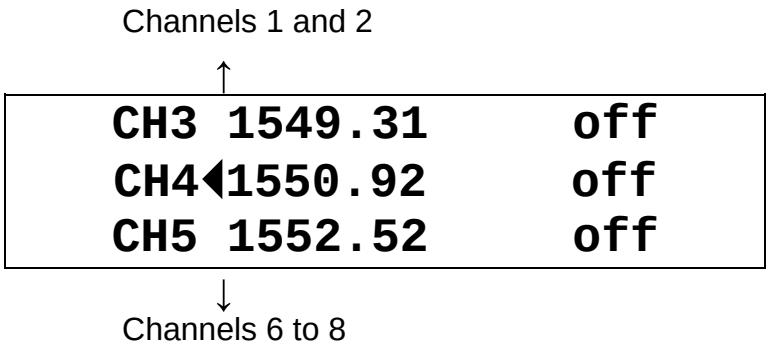
The cursor can be moved up with the soft key or down with the soft key.

With the cursor leaving the upper or lower edge of the display you can scroll through the whole content of the corresponding screen.

With the cursor in the third line, the next line will appear from below when pressing.

Example in the main menu with 8 lines for the channels:


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## 3.4 Selecting a Module

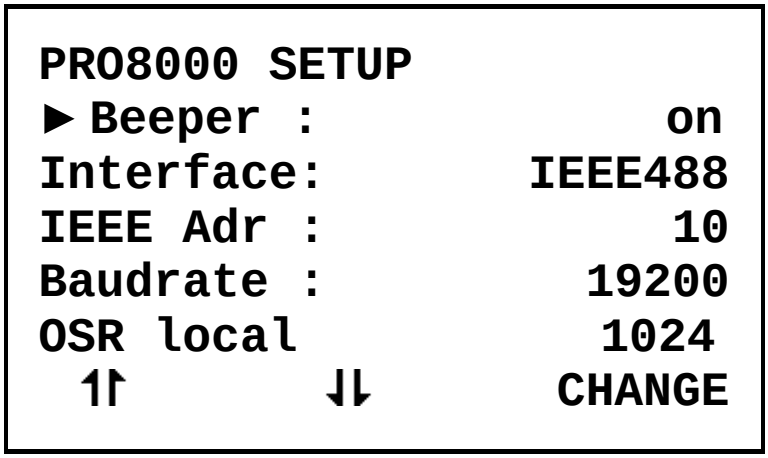
A module is selected for further input by placing the cursor beside the respective channel number.

**CH4◀**

Pressing CHANNEL will lead to the channel menu of the selected module. Please refer to the operation manual of the individual module.

## 3.5 Setup Menu

The Setup Menu can be entered from the main menu by pressing ESC :




In above sample the first line "Beeper" is marked by the cursor, so pushing the “CHANGE” button toggles the beeper (signal for occurring errors and input confirmation) on and off.

The second line allows to select the IEEE488 Interface the terminal mode via RS232 Interface.

In the third line the IEEE-address can be set, default value is 10.

The appropriate baud rate for the RS232 interface can be selected in line 4 (default = 19200 Baud).

**OSR local** allows to select the averaging rate for displayed values, i.e. how many measured values are averaged to reduce noise. The higher the value, the longer it takes to actualize the measured values on the screen. This item does not affect the remotely transferred measurement values. (‘Normal’ value = 16).

Pushing ESC again brings you back to main menu.

# 4 Communication with a PC

**Note**

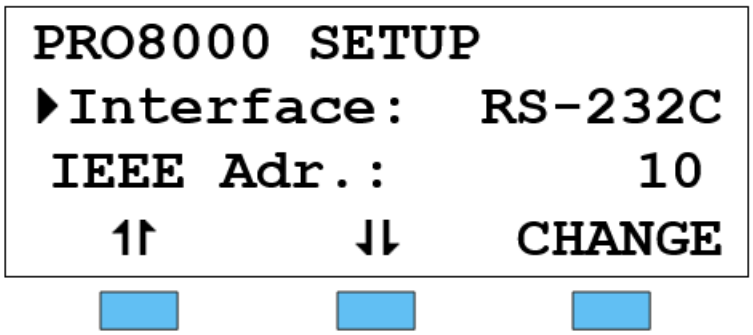
When remote control is active, the following operating elements are still enabled:

- The "Go To Local" Key 

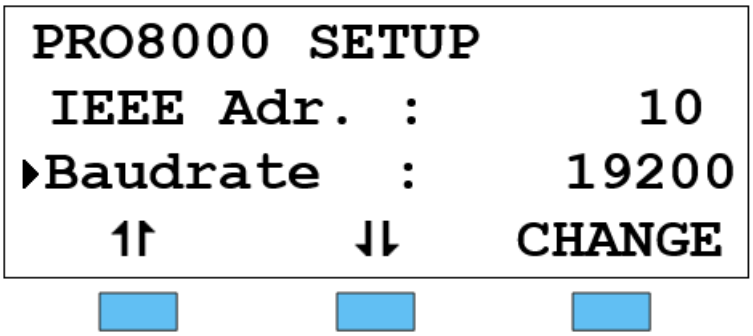
- The LEDs SEL, ERR and On and all Potentiometers on the Installed Modules

## 4.1 Hardware Standard RS232C

The RS232C interface complies with the IEEE1174 standard for programmable instruments. To use the implemented RS232C interface, first select this option in the setup menu.



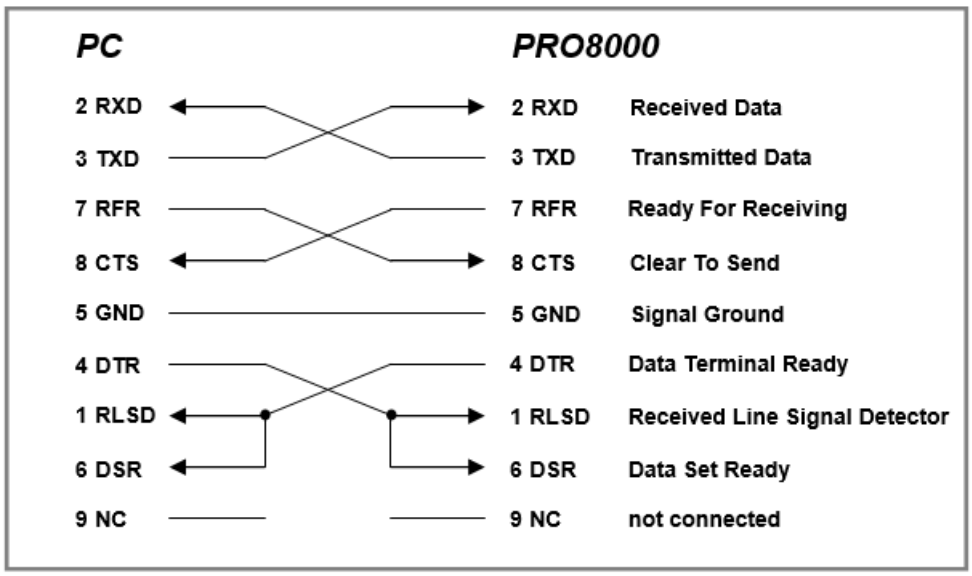

Then select the desired baud rate (default is 19200 Baud).



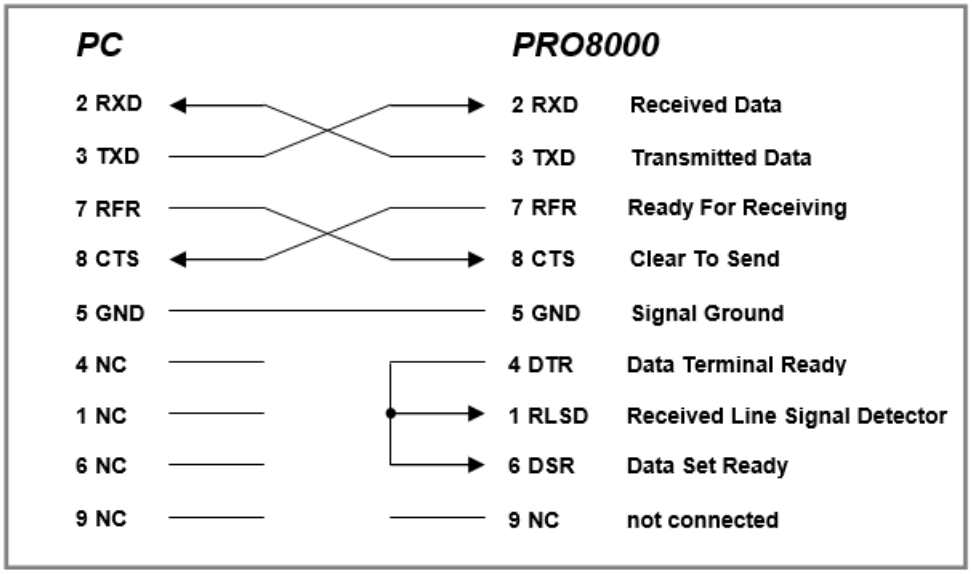

If you use an **older** PRO8xxx series system that has a **female** 9-pin D-SUB connector at the rear panel. In this case, a 1:1 serial connection cable between mainframe and PC must be used.

If you have a **newer** version with a 9-pin **male** connector a Null Modem serial cable with a pin-to-pin connection as shown below is required:


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If your control PC does not support DSR/DTR signaling the connections of the Null Modem cable must be modified as shown below:




### 4.1.1 Interface Specification

| | |
|---|---|
| Electrical characteristics | EIA RS232C |
| Connector | 9-Pin D-SUB (Male) |
| Communication | Full Duplex |
| Baud Rate | 1200, 2400, 4800, 9600, 19200, 38400 |
| Start Bit | 1 Bit |
| Stop Bit | 1 Bit |
| Data Length | 8 Bit |
| Parity | No Parity |
| Handshaking | RTS / CTS |
| Receive Buffer Length | 256 Bytes |
| Termination Character | CR LF (ASCII 0DH0AH) |

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### 4.1.2 Emulating the IEEE488 Bus Commands

As the RS232 interface does not offer hardware control lines like the IEEE488 bus, the according IEEE488 bus command are emulated by specials commands.

(Please refer to chapter Hardware Standard IEEE 488.1)

**Device CLear**

Syntax: "**&DCL**"

Description: Clears the input buffer and output queue. Resets the parser unit and the execution unit

**Go To Local**

Syntax: "**&GTL**"

Description: Switches the PRO8000 into LOCAL mode (manual operation). Previously set values for laser current, laser power, temperature etc. remain valid.

**Local LockOut**

Syntax: "**&LLO**"

Description: Disables the 

button. Return to LOCAL mode (manual operation) is only possible with the command "**&GTL**".

**Poll Status-byte**

Syntax: "**&POL**"

Description: Reads the status byte and clears bit 6 (MSS). This command is used to emulate a service request.

### 4.1.3 Service Request Emulation

To get the instrument status byte asynchronously, the service request sequence is used:

- In case the device needs a service request it sends [&SRQ] to the PC.
- Now the PC should query the status byte with "&POL".
- The device will then answer with [&nnn] where nnn represents the status byte in decimal notation.

See chapter Service Request Enable Register (SRE)

### 4.1.4 Operating Commands

For the RS232C communication, all operating commands as described in the following IEEE488 section and in the individual module manuals are valid.

## 4.2 Hardware Standard IEEE 488.1

The IEEE488 interface of the PRO8000 Series is based on the IEEE 488.2 standard. This includes the IEEE 488.1 standard for the hardware settings. There is a standard 24-pin IEEE488 jack on the rear panel. The address of the PRO8000 Series mainframe must differ from that of other devices using the same IEEE488 bus.

You can select it in the setup menu , see chapter Setup Menu.


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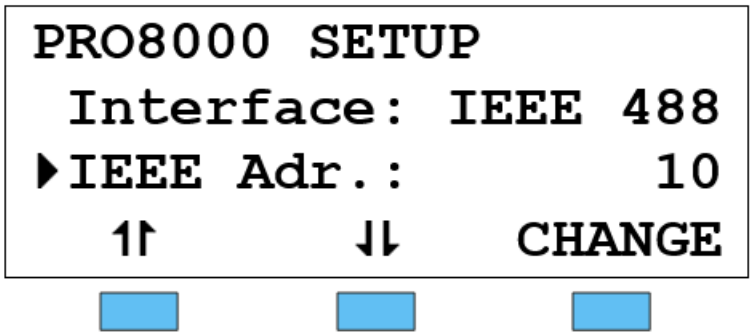
### 4.2.1 IEEE 488.1 Subsets Of The PRO8000 Series

| Function | Part set |
|---|---|
| Source Handshake | SH1 |
| Acceptor Handshake | AH1 |
| Talker | T6 |
| Listener | L4 |
| Service Request | SR1 |
| Remote/Local | RL1 |
| Parallel Poll | PP0 |
| Device Clear | DC1 |
| Device Trigger | DT0 |
| Electrical Interface | E1 |

### 4.2.2 Device Address and String Terminator

#### Address

The device address of the PRO8000 Series can be changed by pressing ESC in the main menu. The display shows:




Pressing the key (**CHANGE**), soft keys ← ..... → appear, enabling the address to be changed. The device address can be selected between 0 and 30.

Pressing ESC saves the new setting and return to the main screen.

**Note**

The default device address is 10.

#### String Terminator

The string terminator of the PRO8000 Series is preset to <LF><EOI>. This is fixed and cannot be changed. The PRO8000 Series accepts any combination of <LF> and <EOI> as string terminator.

### 4.2.3 Starting The IEEE488 Interface

1. Connect the PRO8000 Series and the PC with shielded IEEE488 cables.
2. Connect the units to the mains.
3. Switch on both units.

In order to ensure a safe data transmission, the length of the IEEE488 cable between two units should not exceed 2 meters and the total cable length of the IEEE488 bus should not exceed 20 meters.

The PRO8000 Series will automatically enter the REMOTE mode when the first command is received from the PC.

**Note**

Programming of the control software will vary with the type of computer, the user interface, the programming language, the interface card used as well as with the driver software and the correspondingly supplied software interfaces. Please refer to the documentation of these components.

Also, please refer to the chapter Hints for Setting Up Control Programs.

### 4.2.4 IEEE488 Bus Commands

To communicate via the IEEE488 bus the standard control signals [MLA], [MTA], [UNL], [UNT], [ATN], [REN], [SPE], [SPD] are used.

If the control program for the PRO8000 Series system is written in a language as e.g. BASIC, then these IEEE488 control signals are automatically transmitted to the mainframe according to the used driver software and do not have to be explicitly produced in the control program.

These functions are already implemented in the Thorlabs LabView® or LabWindows® drivers.

When receiving the IEEE488 bus commands [GET], [LLO], [GTL], [DCL] and [SDC], the PRO8000 Series will execute the following functions:

#### [LLO] Local LockOut

The command [LLO] once sent will disable the key 

throughout further operation. A return to the LOCAL mode (manual operation) is possible only with the command **[GTL]** (see below).

#### [GTL] Go To Local

The command **[GTL]** returns the PRO8000 Series to LOCAL mode (manual operation). Values, previously set for laser current, laser power, temperature etc., remain valid.

#### [DCL] Device Clear

The command **[DCL]** clears the output queue, the error queue and resets the registers. It affects only the IEEE488 bus electronic (see System Reset).

Normal operation of the modules is not interrupted.

**Note**

The command **[DCL]** resets all IEEE488 units connected to the bus.

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#### [SDC] Selected Device Clear

The command **[SDC]** resembles the command **[DCL]** but refers only to the IEEE488 part of the selected unit (see System Reset).

Normal operation of the unit is not interrupted.

**Note**

In contrast to the command **[DCL]**, the command **[SDC]** resets only the IEEE488 of the addressed device.

#### [GET] Group Execution Trigger

Due to the interface specification “DT0” (see chapter IEEE 488.1 Subsets Of The PRO8000 Series), the command **[GET]** is not implemented.

## 4.3 Software Standard IEEE488.2

### 4.3.1 Nomenclature

| | |
|---|---|
| Program Messages (PC to PRO8000) are Written in Inverted Commas | **"*IDN?"** |
| Response Messages (PRO8000 to PC) are Written in Brackets | **[:SLOT 1]** |
| Decimal Point | **1.234** |
| Subsequent Parameters are Separated with Commas | **"PLOT 2,0"** |
| Subsequent Commands are Separated with Semicolons | **"*IDN?;*STB?"** |

### 4.3.2 Program and Response Messages

Messages are transferred in two directions between the PRO8000 Series and the PC. Prior to sending a message from the PRO8000 Series to the PC, the PC must send a status read query (a command ending with a quotation mark) to specify, what information shall be transferred.

With the next read command, this information is transferred from the PRO8000 Series to the controller.

#### Program Messages

Messages from the PC to the PRO8000 Series are called **program messages**. Program messages are used to affect settings of the PRO8000 Series ("command") and response messages are selected ("status read query").

Examples:

**":SLOT 2"**: This command selects a slot (here: slot # 2).
**"*IDN?"**: This is a status read query - it requests the identification.

**Response Messages**

Messages from the PRO8000 Series to the PC are called **response messages**. Response messages transfer measurement values and status information to the PC.

Example:

> **[:ILD:ACT 7.12345678E-005]** measures the actual laser current of a current controller module.

### 4.3.3 Data Format

According to the IEEE 488.2 specifications all data variables are divided into 4 different data formats:

**Character response data (<CRD>)**

is a single character or a string. Examples:

**A** or **ABGRS** or **A125TG** or **A1.23456A**

(See IEE488.2, chapter 8.7.1)

**Numeric response data Type 1 (<NR1>)**

is a numerical value with sign in integer notation. Examples:

**1** or **+1** or **-22** or **14356789432**

(See IEE488.2, chapter 8.7.2)

**Numeric response data Type 2 (<NR2>)**

is a numerical value with or without sign in floating point notation without exponent. Examples:

**1.1** or **+1.1** or **-22.1** or **14356.789432**

(See IEE488.2, chapter 8.7.3)

**Numeric response data Type 3 (<NR3>)**

is a numerical value with or without sign in floating point notation with exponent with sign . Examples:

**1.1E+1** or **+1.1E-1** or **-22.1E+1** or **143.56789432E+306**

(See IEE488.2, chapter 8.7.4)

### 4.3.4 Common Commands and Queries

The IEEE 488.2 standard requires a set of commands, that every device must support. These commands are called mandatory commands.

All commands can be single or "compound" having a tree structure. Those with compounds are called compound or group commands.

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### IEEE 488.2 Mandatory Commands

| **Command**<br>Explanation | **Response Example** |
|---|---|
| ***IDN?**<br>Identification Query | **[THORLABS PRO8000 Ver.4.64-1.31<LF>]** |
| ***RST**<br>Resets the PRO8000 Series:<br>• All Outputs of all Modules are switched Off<br>• All Macros are Deactivated (Not Deleted)<br>• Unit Stays in 'Ready' Status i.e. Bit 0 (FIN) of the Status Byte Register is Set<br>• All Set Parameters (Current, Power Values etc. Remain valid!) | |
| ***TST?**<br>Executes a Self Test and Queries the Result | **[0<LF>]** |
| ***OPC**<br>Operation Completed and Active Mode Started | |
| ***OPC?**<br>Operation Completed Query | **[1<LF>]** |
| ***WAI**<br>Waiting Until the Last Operation is Completed | |
| ***CLS**<br>Clears all Event Registers (ESR, DEE1...DEE8) and the Error Queue. Due to the cleared event registers, also DESR is 0, bit 0 (FIN) of the STB is set. | |
| ***ESE <NR1>**<br>Sets the Value for the Standard Event Status Enable Register (ESE) | |
| ***ESE?**<br>Queries the Current Value of the Standard Event Status Enable Register (ESE)<br>The content of the register is not changed. | **[<NR1><LF>]** |
| ***ESR?**<br>Queries the Current Value of the Standard Event Status Register (ESR) and Clears it the Same Time | **[<NR1><LF>]** |
| ***SRE <NR1>**<br>Sets the Value of the Service Request Enable Register (SRE) | |
| ***SRE?**<br>Queries the Current Value of the Service Request Enable Register (SRE) | **[<NR1><LF>]** |
| ***STB?**<br>Queries the Value of the Status Byte Register (STB).<br>Bit 6 is reset to 0, the other bits kept unchanged. | **[<NR1><LF>]** |
| ***SAV 0**<br>Immediately Saves all Set Values as Default Values to be Loaded on the Next Power Up | |

### Mainframe Commands

For special macro commands 'ELCH', see chapter PRO8000 Series 'ELCH' Macro Functions.

| **Command**<br>Explanation | **Response Example** |
|---|---|
| **":CONFIG:PLUG?"**<br>Shows the configuration of the plug-in modules, always 16 values, module type and subtype for every slot, e.g.:.<br>**[:CONFIG:PLUG  223,0,191,0,247,0,159,0,107,1,243,2,47,0,0,0]** | |
| **":SLOT <NR1>"**<br>Selects a slot for further programming | |
| **":SLOT?"**<br>Queries the selected slot | **[:SLOT <NR1><LF>]** |
| **":STAT:xxx?"**<br>XXX stands for one of the additional IEEE 488 registers implemented (BFC, BFR, BFE, DESR or DESE) It returns the binary content of the register | **[:STAT:xxx <NR1><LF>]** |
| **":STAT:xxx <NR1>"**<br>Sets the content of the enable register (BFE, EDE and DESE). Refer to chapter Status Reporting. | |
| **":PORT?"**<br>Queries the chosen port of a multidevice controller as MLC8xxx or PDA8xxxx. | **[:PORT <NR1><LF>]** |
| **":PORT <NR1>"**<br>Selects a port of a multidevice controller as MLC8xxx or PDA8xxx. | |
| **":SYST:ERR?"**<br>Queries the error queue | **[0,"No error"<LF>]** |
| **":SYST:ANSW?"**<br>Query the answering format of the PRO8. | **[:SYST:ANSW FULL]** |
| **":SYST:ANSW VALUE"**<br>PRO8000 Series will send only the requested parameter without designator. Example: When requesting the slot number with **":SLOT?"** the mainframe will send only **[2<LF>]** instead of **[:SLOT 2<LF>].**<br>This is **not compliant** to the IEEE 488.2 standard but useful under point of increasing speed. | |
| **":SYST:ANSW FULL"**<br>PRO8000 Series will stop the function started with ":SYST:ANSW VALUE" and respond again according to the IEEE488.2 standard. | |
| **":TYPE:ID?"**<br>Queries information about the selected module<br>See also operation manuals of the appropriate modules. | Possible answers:<br>ITC8xxx: 159<br>LDC8xxx: 191<br>PDA8xxx: 107<br>TED8xxx: 223<br>MLC8xxx: 47<br>WDM-B: 249. |
| **":TYPE:SUB?"**<br>Queries a possible sub type of a module. | |
| **":TYPE:TXT?"**<br>Module ID in text form. | |
| **":TYPE:OPT?"**<br>Returns 10 figures (0...255) depending on the installed options (mainly for service purposes) | |
| **":TYPE:SN?"**<br>Query the serial number of the mainframe. | |


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### 4.3.5 Module Specific Commands and Queries

See the operating manual of the corresponding module.

## 4.4 Error Messages

Following the IEEE488.2 standard, devices provide an error queue storing errors one by one. Every query **":SYST:ERR?"** will fetch one single error from the error queue.

Repeated use of **":SYST:ERR?"** is necessary until the error queue is empty.

If the queue is empty, the error message **[0, "No error"]** is sent to the PC.

Error messages are organized in groups:

| Error Number | Error Type |
|---|---|
| 0 | No Errors |
| 100 ... 199 | Command Errors |
| 200 ... 299 | Execution Errors |
| 300 ... 399 | System Errors |
| 400 ... 499 | Query Errors |
| 1000 ... 9999 | Module Specific Errors |

The module specific error messages are described in the operation manual of the appropriate module.

### 4.4.1 Empty Error Queue

**[0,"No errors"]**
Error queue is empty.

### 4.4.2 100 ... 199 Command Error Messages

**[100,"Unknown command"]**
Possible reason: The string **":HELLO WORLD"**. was sent to the mainframe and could not recognized as valid command.
The command **":ILD:SET? 1.1"** does not require a numerical parameter.

**[101,"Invalid character"]**
Possible reason: The character **Hex 09** sent to the mainframe does not belong to the allowed set of characters.

**[102,"Invalid numeric parameter"]**
Possible reasons: **":ILD:SET 1.1."** The second decimal point is not allowed.
**":ILD:SET 12E+12E"**. The second "E" is not allowed.

**[103,"Invalid text parameter"]**
Possible reasons: **":SENSOR CG"**. This parameter is not valid for a temperature sensor.
**":MODE THH"**. This parameter is not valid for this command.

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**[104,"Missing parameter"]**
Possible reason: **":ILD:SET"**. This command requires a numerical parameter.

**[105,"Invalid separator"]**
Possible reason: **":ILD:SE"**. This command was not complete.

**[107,"Empty slot"]**
Possible reason: **":SLOT 3"** selected an empty slot.

**[108,"Parameter can not be set"]**
Possible reason: **":ILD:ACT 2.3E-3"**. This is only a read query but no set command.

**[109,"Wrong compound"]**
Possible reason: **":ILD:ERR?"**. This combination is not allowed.

**[110,"Unknown compound"]**
Possible reason: **":ILD:ERM?"**. This is a wrong compound (**ERM**).

**[111,"Wrong parameter"]**
Possible reason: **":ILD:ERM!"**. This is a wrong parameter (**!**).

**[112,"Wrong command for the selected port"]**
Possible reason: e.g. PDA, setting forward current on channel 2.

**[190, "Parser buffer overflow"]**
Possible reason: Transmitted string was longer than the parser input buffer.

### 4.4.3 200 ... 299 Execution Error Messages

**[200,"Data out of range"]**
Possible reason: **":ILD:SET 10E+30"** was sent to the mainframe, but this current set value is far out of range.

### 4.4.4 300 ... 399 System Error Messages

**[300,"Hardware error"]**
Possible reason: Service is requested.

**[301,"Software error"]**
Possible reason: Unfixed bug. Please report to Thorlabs.

**[304,"Update required"]**
Possible reason: The firmware of the mainframe is not compatible (too old) with the modules firmware. A firmware update of the PRO8000 Series mainframe must be made at factory - please contact Thorlabs for return instructions.

**[310,"ELCH set value initialization not complete"]**
Possible reason: Attempt to start a macro function while not all required parameters are set.

**[311,"ELCH read value(s) initialization not complete"]**
Possible reason: Attempt to start a macro function while read parameters are not set.

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### 4.4.5 400 ... 499 Query Error Messages

**[400,"Too many errors"]**
Possible reason: More than 30 errors in the error queue.

**[410,"Query interrupted"]**
Possible reason: More than one query sent to the mainframe before the read command.

**[420,"Query unterminated"]**
Possible reason: No query sent to the mainframe before the read command.

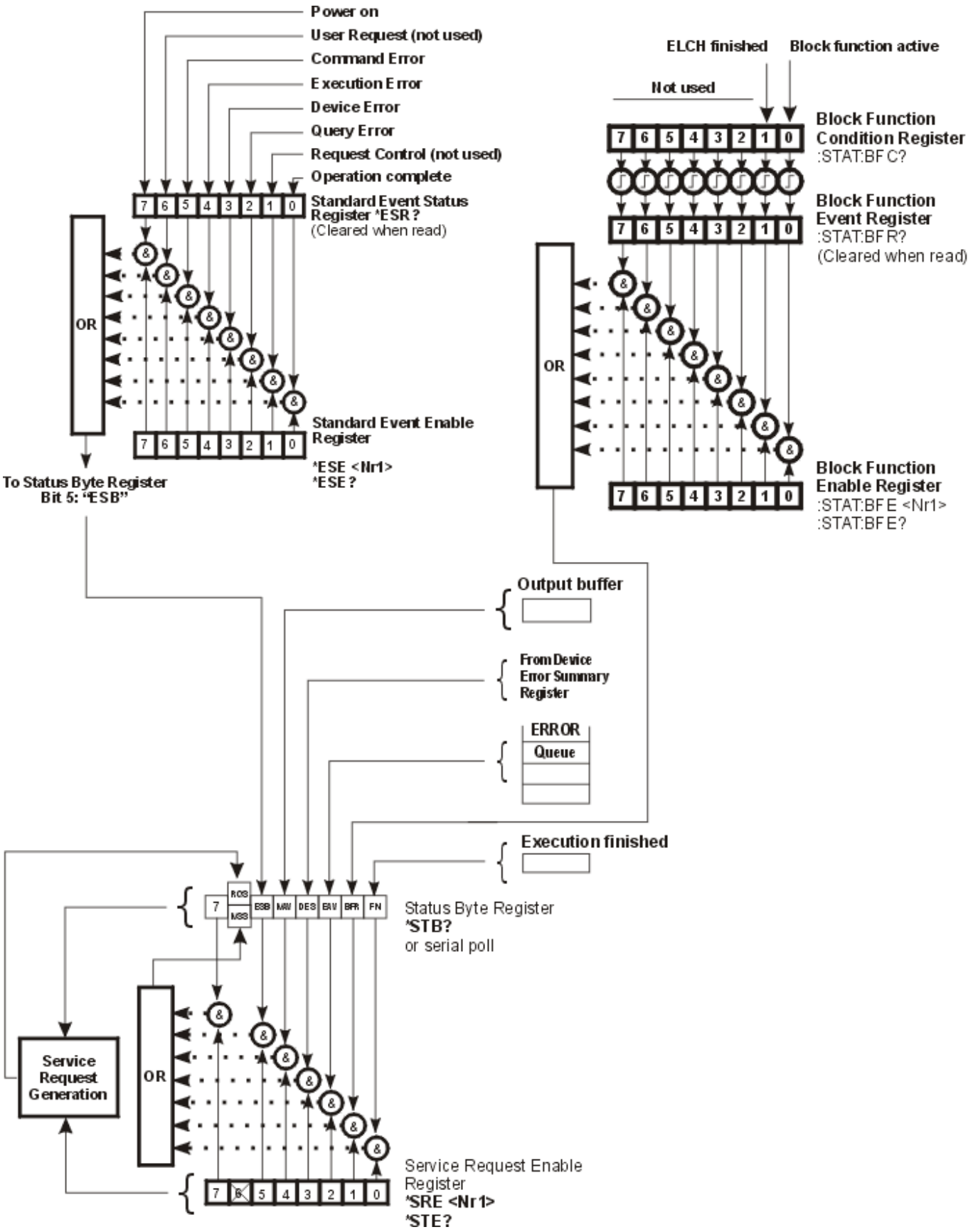
## 4.5 Status Reporting

The PRO8000 Series provides the following 9 8-bit registers to program various service request functions: ESR, ESE, STB, SRE, BFC, BFE, BFR and DESR, DESE

| | |
|---|---|
| ESR | Standard Event Status Register |
| ESE | Standard Event Status Enable Register |
| STB | Status Byte Register |
| SRE | Service Request Enable Register |
| BFC | Block Function Condition Register |
| BFR | Block Function Event Register |
| BFE | Block Function Enable Register |
| DESR | Device Error Summary Register |
| DESE | Device Error Summary Enable Register |

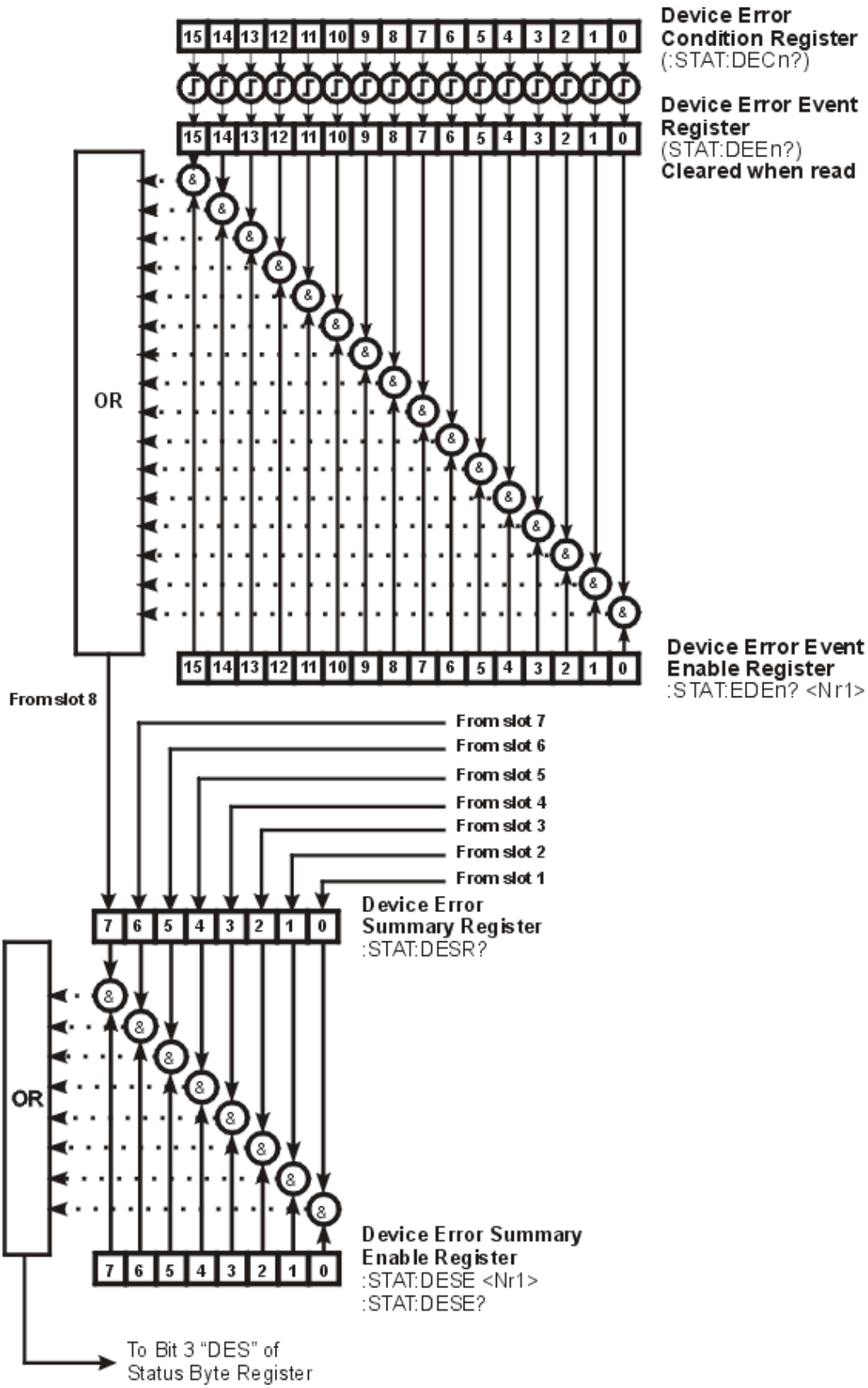
(See IEE488.2, chapter 4.4)

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*Structure of the registers ESR, ESE STB, SRE, BFC, BFR and BFE*


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*Structure of the registers DESR and DESE, including the device error registers of the plug-in modules.*

### 4.5.1 Standard Event Status Register (ESR)

The ESR can be read directly with the command **"*ESR?"**. Reading the ESR clears it at the same time. The content of the ESR can not be set.

The bits are active high.

**Power On**

This bit indicates the off to on state of the power supply. State = HIGH after switching on the device for the first time.

**User Request (Not Used here)**

A local control has been activated.

**Command Error**

A command error occurred.

**Execution Error**

An execution error occurred.

**Device Dependent Error**

A device dependent error (module error) occurred.

**Query Error**

A error occurred trying to query a value.

**Request Control**

The mainframe is requesting to become the system controller.

**Operation Complete**

All started operations have been completed. System is in idle mode.

### 4.5.2 Standard Event Status Enable Register (ESE)

The bits of the ESE are used to select which bits of the ESR shall influence bit 5 (ESB) of the Status Byte Register (STB).

The 8 bits of the ESE are connected by logical "AND" with the according 8 bits of the ESR. These 8 results are connected by logical "OR", so that any "hit" leads to a logical 1 of bit 5 (ESB) of the STB.

As any bit of the STB can assert an SRQ, every event (bit of the ESR) can be used to assert an SRQ.

### 4.5.3 Status Byte Register (STB)

The bits of this register show the status of the PRO8000 Series mainframe. The register can be read out using ***STB?**. The content of the STB can not be set. The bits are active high.

**RQS/MSS**

RQS: Request service message: Shows that this device has asserted SRQ.

MSS: Master summary status: Shows that this device requests a service.


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**ESB (Event Status Byte)**

Shows if any event has occurred in the Standard Event Status Register, enabled by the Standard Event Status Enable Register.

**MAV (Message Available)**

This bit is high after a query, as a result "waits" in the output queue to be fetched. It is low, if the output queue is empty.

**DES (Device Error Summary Register Bit)**

Indicates whether any of the plug-in modules has send an error message through its Device Error Event Register.

**EAV (Error Available)**

Shows the error queue not to be empty yet.

**BFR (Block Function Register-Bit)**

Indicates whether the block functions are active or the 'ELCH' function (ELectrical CHaracterization) is completed.

**FIN (Command Finished)**

This bit is high, after a command has finished and all bits of the STB have been set.

All bits except bit 6 of the STB can be used to assert a service request (SRQ). Alternatively the SRQ can be recognized using the command "*STB?".

### 4.5.4 Service Request Enable Register (SRE)

The bits of the SRE are used to select, which bits of the STB shall assert an SRQ.

Bit 0, 1, 2, 3, 4, 5 and 7 of the STB are combined by logical "AND" with the according 7 bits of the SRE. These 7 results are combined by logical "OR", so that any "hit" leads to a logical 1 in bit 6 of the STB and asserts an SRQ.

### 4.5.5 Device Error Summary Register (DESR)

Bit 0.....7 indicate if any plug-in module in the slots 1...8 (1...2) has asserted an error message via it's Device Error Event Register.

### 4.5.6 Device Error Summary Enable Register (DESE)

The DESE enables via “AND” functions which module in which slot is allowed to create an error message, i.e. set bit “DES” in the Status Byte Register.

### 4.5.7 Device Error Condition Register (DEC)

The bits of this register show the errors, that occur during operation (operation errors). The bits are active high.

The function of the Device Error Condition register depends on the module in the corresponding slot. Please refer to the individual operation manual of the plug in module.

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### 4.5.8 Device Error Event Register (DEE)

The bits of this register hold the errors, that occurred during operation (operation errors). So each bits of the DEC sets the according bit of the DEE.

The DEE can be read but not set.

Reading out clears the DEE.

### 4.5.9 Device Error Event Enable Register (EDE)

The bits of the EDE are used to select, which bits of the DEE shall influence bit 3 (DES) of the STB.

The 8 bits of the EDE are related by logical "AND" to the according 8 bits of the DEE. These 8 results are combined by logical "OR" so that any "hit" leads to a logical 1 in bit 3 (DES) of the STB.

As any bit of the STB can assert an SRQ, every error (bit of the DEE) can be used to assert an SRQ.

### 4.5.10 Block Function Condition Register (BFC)

Presently, only bit 0 and 1 of the BFC are functional:

- Bit 0 indicates if the block function mode is active.
- Bit 1 shows if the programmed 'ELCH' function has been completed (= HIGH).

### 4.5.11 Block Function Event Register (BFR)

The bits of this register hold the status changes that occurred during operation. So each bit of the BFC sets the according bit of the BFR.

The BFR can be read but not set.

Reading out clears the BFR.

### 4.5.12 Block Function Enable Register (BFE)

The BFE enables via “AND” functions which block message is allowed to set the bit “BFR” in the Status Byte Register.

### 4.5.13 Service Request by Detecting SRQ

If an SRQ is asserted, bit 6 of the STB is set to logical 1, so that the controller can detect by serial polling, which device asserted the SRQ.

### 4.5.14 Service Request by *STB? Command

If the controller does not "listen" to SRQs at all, the service request can be detected by reading the status byte with the command **"*STB?"**.

If bit 6 is logical 1, a service request was asserted.


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### 4.5.15 Hints for Setting Up Control Programs

During the test phase of control programs all program messages should be transmitted separately. Each command should be followed by a status request (response message) so that possible errors are read out directly after the command that might have caused it.

Manufacturers of interface cards that are used in the control computer provide drivers for the bidirectional communication between the PC and the PRO8000 Series mainframe for all common software packages. We recommend building these write and read back commands into separate functions and then using these functions for the data transfer.

These functions should use an additional global flag that determines whether the write or read back communication is to be stored in a data file together with the talker and listener address of the IEEE488 system or printed out additionally. Problems that occurred on the bus or error messages that cannot be explained immediately can be investigated later by analyzing the data transfer file between the PRO8000 Series mainframe and the control computer.

The same procedure is useful for the RS232 communication.

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## 4.6 System Reset

There 5 different types of PRO8000 Series or its installed modules:

- Power-On Reset
- Reset by Device Clear
- Reset by Clear Status
- Reset by Software
- Reset by Interface Clear

The differences are explained in the chapters subsequent.

### 4.6.1 Power-On Reset

Resetting after switching on the power supply has the following effects:

- Sets the Power on Bit in the Event Status Register (ESR)
- Deletes the Output Queue and Sets Bit 4 (MAV) of the Status Byte to 0
- Clears the Error Queue is Cleared and Sets Bit 2 (EAV) of the Status Byte to 0
- Clears the Execution Unit and the Command Queue
- Resets the Command Cecoder (Parser)
- Clears all Event Registers
- Sets the Device Error Summary Register to 0
- Sets the System to 'Ready' State and Sets the Bit 0 (FIN) of the Status Byte
- Discards all 'ELCH' Macro Functions
- Switches off (Disables) the Outputs of all Installed Modules
- Resets all Set Values of the Modules to the most Recent Entered Manually Responsible to their Defaults

### 4.6.2 Reset by Device Clear

This reset is called by the IEEE bus commands Device CLear **[DCL]** or Selected Device Clear **[SDC]**and hast the following effects.

- Deletes the Output Queue and Sets Bit 4 (MAV) of the Status Byte to 0
- Clears the Error Queue is Cleared and Sets Bit 2 (EAV) of the Status Byte to 0
- Clears the Execution Unit and the Command Queue
- Resets the Command Decoder (Parser)
- Sets the System to 'Ready' State and Sets the Bit 0 (FIN) of the Status Byte
- Discards all 'ELCH' Macro Functions
- Switches off (Disables) the Outputs of all Installed Modules
- Resets all Set Values of the Modules to the Most Recent Entered Manually Responsible to their defaults

All module outputs and set values remain **unchanged**.


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### 4.6.3 Reset by the Clear Status Command

The CLear Status command ***CLS** has the follwing effects:

- Clears the Error Queue is Cleared and Sets Bit 2 (EAV) of the Status Byte to 0
- Clears all Event Registers
- Sets the Device Error Summary Register to 0
- Sets the System to 'Ready' State and Sets the Bit 0 (FIN) of the Status Byte

### 4.6.4 Reset by the Reset Command

The Reset command ***RST** resets all device functions.

- Eventually Activated Macro Functions are Deactivated (Not Deleted)
- The Outputs of all Modules are Switched Off
- System Enters the 'Ready' State and Bit 0 (FIN) of the Status Byte is Set

All set values and module assignments remain **unchanged**.

### 4.6.5 Reset by Interface Clear

The IFC is a separate line of the IEEE488 bus connection.

The PRO8000 Series is NOT RESPONDING to the activation of this signal line by the control computer.

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# 4.7 PRO8000 Series "ELCH" Macro Functions

## 4.7.1 What Is ELCH ?

The abbreviation **ELCH** stands for **EL**ectrical **CH**aracterization of laser components.'ELCH' is comprised of a group of embedded macro functions (block commands) that allow the acceleration of standard measurements, for example the LIV curve determination of laser diodes etc.

The advantages of 'ELCH' are a low IEEE488 bus traffic and and increased measurement speed.

## 4.7.2 Basic Settings

In order to use the 'ELCH' macro functions, the following basic settings are required:

1. Select the desired module.
2. Set the polarities of the laser diode and the monitor diode.
3. Set the desired operating mode (constant current or constant power).
4. Set the parameters of the temperature controller and switch it on.

## 4.7.3 Individual Settings for a Measurement

Prior to start a measurement:

1. Define the parameter that shall be changed during measurement (e.g. laser current).
2. Set the start and stop value for this parameter.
3. Set the number of measurement steps within the span between start and stop value.
4. Define how many dependent values (parameters) shall be measured at every single step?
5. Define the mode (continuous or triggered) the 'ELCH' should run.
6. Define which parameter from which module shall be read out.
7. Define the sequence of the parameter values in the answer string.

### 4.7.3.1 Start and Stop Values for the Chosen Parameter

Depending on the selected module and operating mode, different parameters can be chosen for the automated measurement:

- The laser diode current $I_{LD}$
- The monitor diode current $I_{MD}$
- every value that also uses the compound **":ACT"**

Enter the start and stop values by appending the compound **"START"** or**" STOP"** to the desired parameter.

**Examples**

Programming:

e.g. **":ILD:START 1e-3"** (Start Value 1 mA)

**":ILD:STOP 100e-3"** (Stop Value 100 mA)


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Reading:

**":ILD:START?"** or

**":ILD:STOP?"**

#### 4.7.3.2 Number of Steps for the Chosen Interval

Set the desired number of steps for the appropriate start - stop interval:

Programming:

**":ELCH:STEPS n"** with $2 \leq n \leq 1000$

Reading:

**":ELCH:STEPS?"**

#### 4.7.3.3 Number of Measured Values for Every Step

This defines how many different values depending on the chosen variable are to be registered.

Example:

For measuring the dependency of the laser power vs. laser current (P-I characteristic), one dependent value (the parameter P - power) needs to be measured and thus n is set to1.

**Note**

The default setting for n is 1. A maximum of 8 dependent values can be registered.

Programming:

**":ELCH:MEAS n"** with $1 \leq n \leq 8$

Reading:

**":ELCH:MEAS?"**

### 4.7.4 Cascading Several ELCH Runs

It's not necessary to read out the measured data immediately after an 'ELCH' run. In certain cases it might be useful to cascade several runs, e.g. to allow for a zoomed scale spreading of certain regions in the measured characteristic.

Just start the next 'ELCH' run with changed parameters after the previous run has finished.

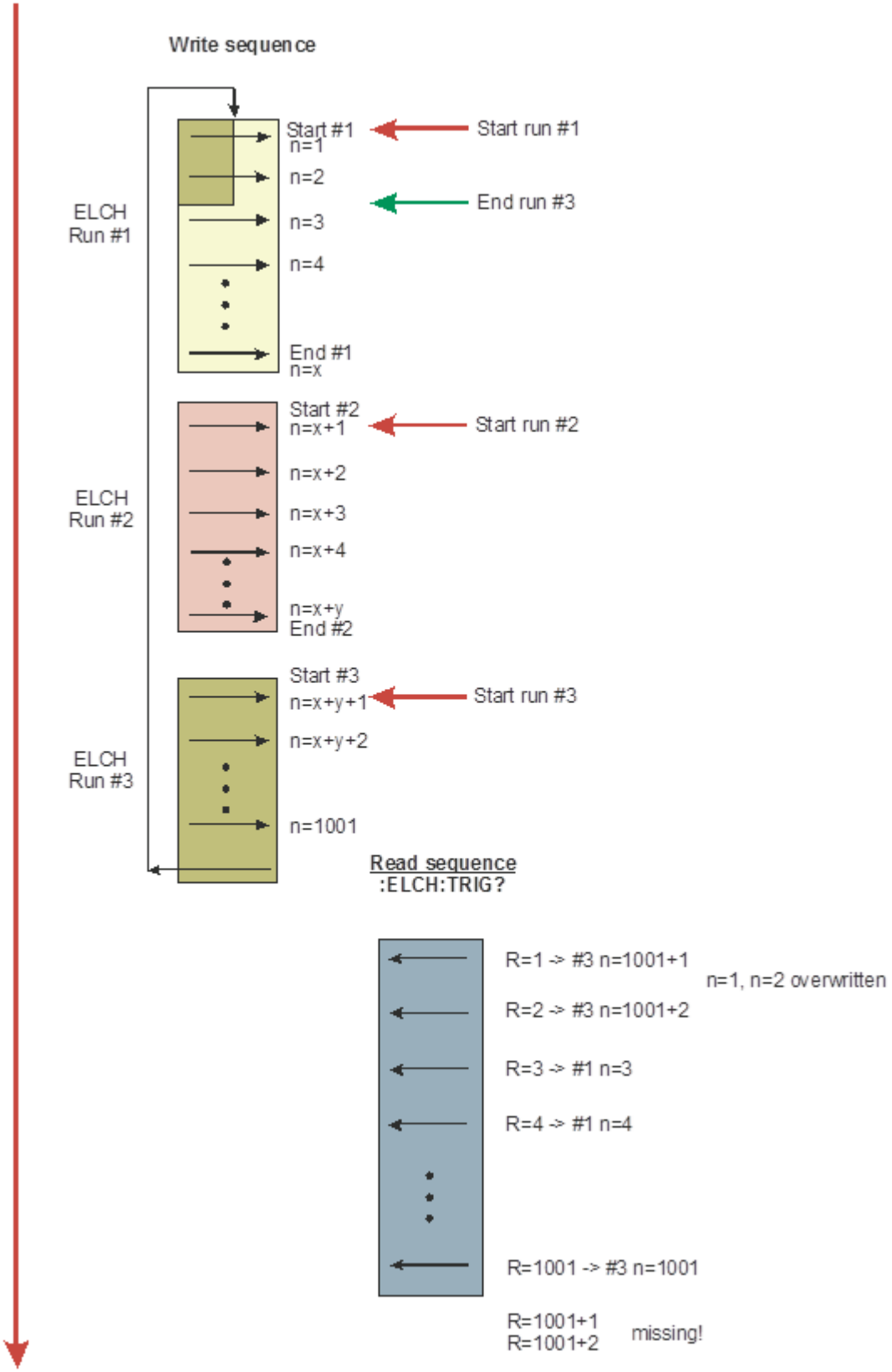
**Note**

Make sure to not exceed a maximum of 1001 measurement steps (each with a maximum of 9 data, 1 independent and 8 dependent values), as n = 1001 is the maximum number of measurement steps that can be stored in the PRO8000 Series.

If the total number of measurement steps exceeds 1001, the subsequent measurements will overwrite the values measured at the beginning due to the ring architecture of the memory!

In the diagram below such an example is shown.

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Here the number of steps exceeds the maximum by two steps. In the subsequent read procedure, the first two values of measurement #1 would be wrong and the last two values of run #3 missing.

Of course, the data read out can be started prior to starting the next measurement. If doing so, the first two measurements would be correct, however the last two of measurement #3 would still be missing.


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If you want to discard run#1, the command **":ELCH:RESET 0"** should be sent prior to starting run #2. This resets the read pointer to position 1.

### 4.7.5 Values to be Measured

1. Select the desired module using the **":SLOT n"** command.
2. Enter the value to be measured (e.g. $I_{LD}$, $V_{LD}$ etc.) using the compound **":MEAS"**

   e.g.**":ILD:MEAS n"** , where **n** stands for the position of the measured value in the output string ( n = 1 to 8).

**Note**

You cannot select fixed parameters (e.g. a hardware limit $I_{LIM}$ etc. or values that are calculated from others). Trying to do so will result in an error message **"310: ELCH set value initialization not complete"** when starting the 'ELCH' measurement.

Defining less values to be measured than set with the **":ELCH:MEAS n"** command, the error message **"311: ELCH read value(s) initialization not complete"** occurs when starting 'ELCH'.

The variable parameter always shows up at the first position of the output string by default and must not be programmed explicitly.

In the answer string the values are separated by commas.

### 4.7.6 Setting the Desired Measurement Mode

The 'ELCH' measurement can be carried out in continuous or triggered mode.

In continuous mode, the PRO8000 Series measures all values as fast as possible. Data are not transferred automatically to the PC, but the PC can query all results measured until then.

Programming:

Start the 'ELCH' measurement in continuous mode:

**":ELCH:RUN 1"**

Reading:

**":ELCH:RUN?"**

In triggered mode, a new measurement on the next step is started by the next query of a measured value. This way the measurement speed can be affected by the read frequency of measured values, and also can stop the measurement interactively if limits of measured values are reached.

Programming:

**":ELCH:RUN 2"**

Reading:

**":ELCH:RUN?"**

If the 'ELCH' function is running in continuous mode at that moment, this command of course triggers a short interruption in the measurement sequence.

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Command:

**":ELCH:TRIG?"**

starts the measurement for the next step and reads the measured value.

Command:

**":ELCH:RUN 0"**

terminates the measurement and the 'ELCH' function.

### 4.7.7 Reading the ELCH Status

There are several methods to see whether the 'ELCH' measurement sequence is still running or not:

- Query the 'ELCH' status directly: ":ELCH:RUN?". This method is time consuming, particularly if the 'ELCH' sequence is still running.
- Read the Block Function Event Register: ":STAT:BFR?" If the 'ELCH' run is finished, bit 1 is set to 1
- If enabled via the Block Function Enable Register, read bit 2 of the Status byte "*STB?" which is faster.
- If enabled via the Service Request Register, trigger a service request - this takes no additional time.
- Poll the status byte using low level IEEE488 messages Serial Poll Sequence SPE and SPD (see IEE488.2, section 2.5.1).

### 4.7.8 Reading the Measured Values

The command

**":ELCH:TRIG?"**

allows to step through the list of measured values.

If using this command more often than measurement steps were defined, the last answer string will be repeatedly read out.

Example of an answer string:

**7.12345678E-003,6.94673825E-002,1.00453298E+000<LF>**

The command:

**":ELCH:GETALL?"**

retrieves all measured data of the 'ELCH' run at once. Depending on the number of measurement values, this can take a considerable time.

Example:

1001 measurement values with 8 readout values results in
1001 * (1 set + 8 read) * 17 Byte / value + 2 ...3 Byte string terminator = max. **153156 Byte!**

For this reason, make sure that the input buffer is of a sufficient size and that the IEEE timeout is set in order to avoid a timeout error. So if refer to above example, the read-out of 1001 measurements with 9 values takes around 40 seconds.

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Example of answer string (measured values separated by comma, measurement points - by semicolon):

**1.00000005E-003,9.79492208E-004;3.25000030E-003,**
**3.23242205E-003;5.50000044E-003,5.47656277E-003;**
**7.75000080E-003,7.73339858E-003;1.00000007E-002,**
**9.98535194E-003;**

**Note**

Please keep in mind, that the IEEE488 bus traffic of all connected hosts is suspended as long as the data transfer from the PRO8000 Series to the control PC running. In order to allow IEEE488 traffic in between, your program needs to interrupt the data transfer.
Make sure, that the size of the input buffer is sufficient.

If using the **":ELCH:GETALL?"** command while the 'ELCH' routine is still running, only measured data up to this point are transmitted. The **":ELCH:GETALL?"** command can be used then again to retrieve the rested data, or proceed with the **":ELCH:TRIG?"** command.

The command:

**":ELCH:RESET?"**

returns the remaining number of measurement values.

The command

**":ELCH:RESET 0"**

resets the internal 'ELCH' counters to zero. Recorded but not read-out yet prior to that data are being overwritten by the next 'ELCH' run.

### 4.7.9 Example of an ELCH Measurement Procedure

The following example of an 'ELCH' sequence measures the photo current of the monitor diode of a laser and the current of an external photo diode, dependent on the laser current.

The Laser Diode Current controller (LDC8xxx) is in slot 2, the external photodiode is connected to input 1 of the PDA8000-2 Photodiode Amplifier in slot 3.

| Command | Explanation |
|---|---|
| **":SLOT 2"** | Select the LDC8xxx Module in Slot 2. |
| **":ILD:START 10e-3"** | Start Value for ILD = 10 mA |
| **":ILD:STOP 100e-3"** | Stop Value for ILD = 100 mA |
| **":ELCH:STEPS 101"** | The LD current range is divided in 101 steps. |
| **":ELCH:MEAS 3"** | 3 measurements for every step. |
| **":VLD:MEAS 1"** | Select the VLD (measured) to be on position 1 in the output string. |
| **":IMD:MEAS 2"** | Select the IMD to be on position 2. |
| **":SLOT 3"** | Select the module in slot 3. |
| **":PORT 1"** | Select the input port 1 of the photo-amplifier module. |
| **":IPD:MEAS 3"** | Select the measured photocurrent of module 3 on position 3. |
| **":SLOT 2"** | Return to the slot 2 to the module that generates the independent parameter, i.e., the value that is stepped through. Mandatory when starting 'ELCH'. |
| **":LASER ON"** | Switch on the laser. |

Remark: As Thorlabs laser diode controllers use a soft start function in order to protect the laser diode, a wait time of 1 to 2 seconds needs to be inserted in order to settle the laser current.

| | |
|---|---|
| **":ELCH:RESET 0"** | Resets the 'ELCH' data pointers. |
| **":ELCH:RUN 1"** | Starts the 'ELCH' measurement in continuous mode. |
| **":ELCH:TRIG?"** | Requests the first measurement string. |

| | $I_{LD}$ (Set) | $V_{LD}$ (Read) | $I_{MD}$ (Read) | $I_{PD}$ (Read) |
|---|---|---|---|---|
| Position | 0 | 1 | 2 | 3 |
| | **7.12500000E-003,** | **7.12345678E-001,** | **3.34673825E-004,** | **1.00453298E-003<LF>** |

| | |
|---|---|
| **":ELCH:TRIG?"** | Requests the next measurement string. |
| **":ELCH:RESET?"** | Shows the number of remaining values. |

Repeat until all values are read or use the single command

**":ELCH:GETALL?"**

to retrieve **all** data measured in a single step.

**Attention**

If using this command make sure, that the input buffer is of a sufficient size (up to 160kB) and that the IEEE488 timeout is set to an appropriate value (up to 50 sec.).


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If using the **":ELCH:GETALL?"** command during the running measurement, only the data that were acquired up to then are retrieved. Use this command again to retrieve the remaining data.

**":ELCH:RUN 0"** Stops the 'ELCH' function.

### 4.7.10 Possible ELCH Error Sources

➢ "**310, 'ELCH' set value initialization not complete**"

- The value that was selected as the independent variable is not allowed for this purpose, e.g. values which are calculated from others. Please refer to the operation manual of the individual module. Any command that offers the compound **":MEAS n"** can be used.
- The given START and STOP values either belong to different commands or / and to different modules.
- The selected modules initialization is not completed yet.
- The selected module is not switched on.
- The module that provides the independent variable was not selected when starting 'ELCH' (Missing command **":SLOT n"**).

➢ "**311, 'ELCH' read value(s) initialization not complete**"

- A value that is not a measurement value (e.g. P share) was assigned as a read value. Any command that offers the compound **":ACT?"** can be used.
- The selected module was not correctly initialized. For example from a TED8xxx module the resistance of a thermistor temperature sensor was attempted to read while the TED module was set to an AD590 temperature sensor.
- Wrong number of dependent values. For example, 3 dependent values were specified by **":ELCH:MEAS 3"** but only 2 dependent values are set by **":ILD:MEAS 1;:TEMP:MEAS 2"**.

➢ "**312, 'ELCH' was stopped**"

- ELCH was stopped by use.
- An error has occurred in a module (e.g. interlock open).

➢ Errors while using the data read-out commands **:"ELCH:GETALL?"** or **":ELCH:TRIG?"** e.g.
**"Timeout expired before operation completed"** or **"The number of bytes transferred is equal to the input count"**

- Insufficient Timeout
- Insufficient Input Buffer Size
- Not all measured data could be retrieved: Perhaps, the measurement is still in progress. Either check the 'ELCH' Status or use the **":ELCH:GETALL?"** command again to retrieve the rest of the data.
- The retrieved data do not start with the expected first set value: Possibly, the data of a previous 'ELCH' run were not read out. Use the **":ELCH:RESET 0"** command in order to discard previously measured values.

# 5 Maintenance and Service

Protect the PRO8000 Series from adverse weather conditions. The PRO8000 Series is not water resistant.

**Attention**

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

The unit does not need a regular maintenance by the user. It does not contain any modules and/or components that could be repaired by the user himself. If a malfunction occurs, please contact Thorlabs for return instructions.

Do not remove covers!

### General care

Protect the PRO8xxx series from adverse weather conditions. The PRO8xxx series is not water resistant.

**Attention**

To avoid damage to the PRO8xxx series, do not expose it to spray, liquids or solvents!

### Cleaning

The unit and the display window can be cleaned with a cloth dampened with water. You can use a mild 75% Isopropyl Alcohol solution for more efficient cleaning.

### Line voltage

The PRO8000 Series mainframes operate at fixed line voltages of 90 to 110 V, 104 to 127 V and 207 to 253 V. Prior to starting the operation, check that the line voltage as specified on the letter plate matches your local supply voltage. A qualified service person is required to change the operating line voltage. See chapter Changing Line Voltage Setting for instructions.

## 5.1 Installing and Uninstalling Modules

**Attention**

PRO8000 Series module(s) **must not** be installed or uninstalled when the mainframe is switched on. Otherwise, severe damages may occur to the module(s) and/or the mainframe!

The PRO8000 Series has a modular design and can be operated with a variety of different modules. The change of modules or retro-fitting of modules can be done by the user himself.

It is not necessary to re-adjust the modules after installation.

The number of modules that can be used simultaneously is limited by the number of slots. Modules can be installed to any of the slots.

After switching on the PRO8000 Series will recognize each new configuration automatically.

### Uninstalling a module

1. Switch off the mainframe and remove the mains cable from the mains jack. The modules are uninstalled from the front of the unit.
2. Modules of standard width are fixed with two screws, modules with double width - with four screws.
3. Pull out the modules using the handle.


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4. Unused slots must be covered using a blind plate.

**Installing a module**

1. Depending on the required width of the module a sufficient number of slots must be free; uninstall modules (see above) or remove blind plates.
2. Insert the module into the guide rail of the slot and push until it locks in.
3. Fix the modules with the appropriate number of screws.
4. Check the function of the modules by switching on the mainframe. All installed modules must be recognized correctly in the setup menu.

**Note**

In case a new module has been installed, it will be initialized using it's default settings. When switching off the PRO8xxx series mainframe, any settings that were made to the module(s) are saved and are restored after power-on, as long as the module was not moved to another slot. If relocating a module, it will be recognized after power-on with its default settings; any settings that were made previously, are lost.

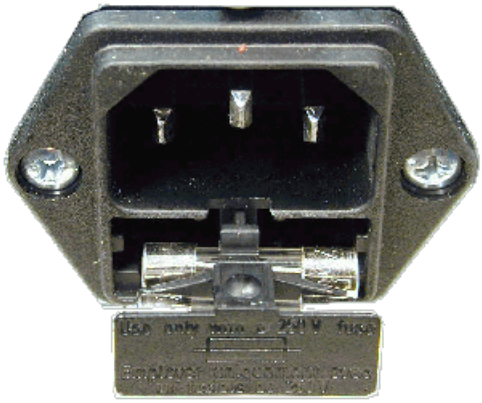
## 5.2 Exchanging the Mains Fuse

The line fuse is located on the rear panel, in a small compartment of the mains connector. It can be exchanged easily without opening the cabinet.

**Attention**

Use only the fuse value corresponding to the line voltage!

- Switch off the mainframe and remove the mains cable from the mains jack.
- Use a screwdriver to remove the lid of the fuse holder. A small drawer opens. The replacement fuse becomes visible, if provided. The active fuse is in the back of the drawer.



- Remove the fuse holder completely and exchange the blown fuse. Use an IEC 60127-2/V, 5 x 20 mm, 250 V fuse with slow response and high breaking capacity according to the table below:

| Line Voltage | PRO8000 | PRO8000-4 | PRO800 |
|---|---|---|---|
| 100 V ±10% | T5H250V | T8H250V | T2.5H250V |
| 115 V ±10% | T5H250V | T8H250V | T2.5H250V |
| 230 V ±10% | T2.5H250V | T4H250V | T1.25H250V |

- Place back the fuse holder.

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- Switch on the mainframe. If the unit cannot be switched on even with the correct fuse inserted, please contact Thorlabs.

## 5.3 Changing the Line Voltage Setting

**Warning**

Dangerous or even lethal voltages inside the unit!
Any service procedure, e.g. changing of the line voltage setting or replacement of the internal fuses, must be done only by qualified service personnel!

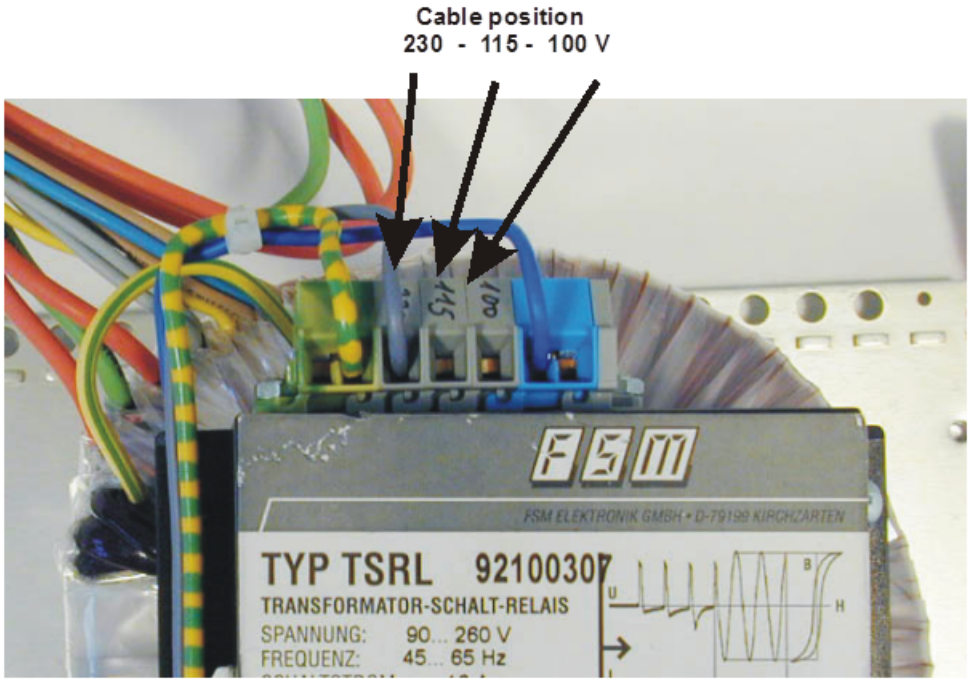
**Attention**

Remove the power cord prior to opening the mainframe  housing!
Even after disconnecting the mains cable, dangerous voltages may be present inside the unit!

The PRO8000 Series operates with line voltages of 100 V ±10%, 115 V ±10% or 230 V ±10%.

Prior to switching on the unit make sure that the voltage stated on the letter plate is in accordance with the locally supplied line voltage.

The setting of the line voltage is determined by the wiring of the transformer connector terminal at the left side panel inside the unit.




After changing the line voltage, make sure to change also the appropriate line fuse (see section Exchanging the Mains Fuse).

**Procedure**

1. Switch off the mainframe and disconnect the power cord.
2. Remove the upper two plastic feet by unscrewing the hex screws on the rear panel and remove the upper housing cover.
3. Install the gray cable to the corresponding clamp, as marked on the terminal. The cable is released from the clamp by pressing and holding down the clamp spring with a screwdriver.
4. Place back the upper housing cover and screw on the plastic feet.


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5. Check the mains fuse and its replacement for corresponding to the set line voltage; exchange them if necessary.
6. Finally, place the marker screw on the rear panel to the right position, according to the set line voltage.

| ~ LINE 50/60Hz 500VA | | | FUSE |
|---|---|---|---|
| ○ | 100V±10% | 4.3 A max | T5 A |
| ○ | 115V±10% | 3.8 A max | T5 A |
| ⊗ | 230V±10% | 2.0 A max | T2.5 A |

*PRO8000 - Marker Screw for 230 V*

## 5.4 Replacement of Internal Fuses

**Warning**

Dangerous or even lethal voltages inside the unit!
Any service procedure, e.g. changing of the line voltage setting or replacement of the internal fuses, must be done only by qualified service personnel!

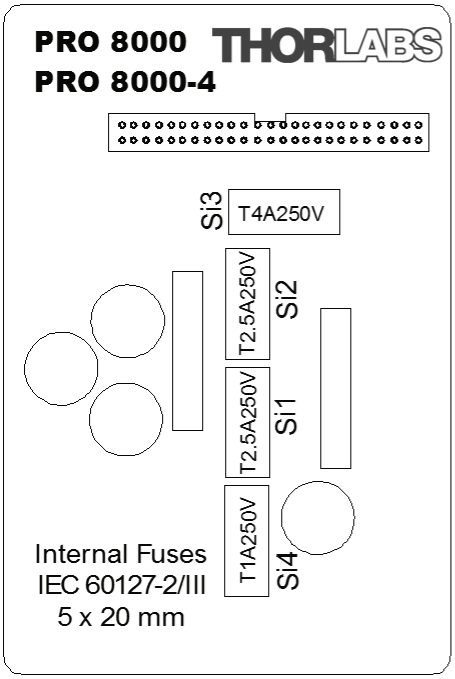
**Attention**

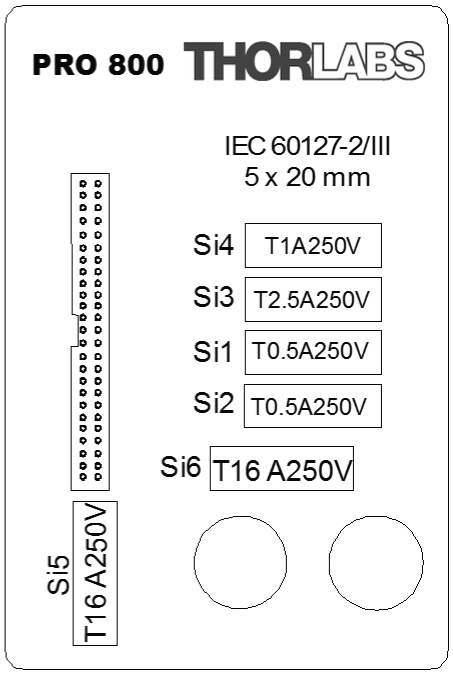
Remove the power cord prior to opening the mainframe housing!
Even after disconnecting the mains cable, dangerous voltages may be present inside the unit!

**Procedure**

- Switch off the mainframe and disconnect the power cord.
- Remove the upper two plastic feet by unscrewing the hex screws on the rear panel and remove the upper housing cover.
- Name, type and location of the internal fuses are given on the adhesive labels.
- Replace the defective fuse.
- Place back the upper housing cover and screw on the plastic feet.

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## 5.5 Troubleshooting

In case that your PRO8000 Series system shows malfunction please check the following items:

**The mainframe does not work at all (no display on the mainframe).**

1. Is the mainframe connected properly to the mains power supply?
   ➤ Connect the mainframe to the power line, take care of the correct voltage setting and grounding of the mainframe.
2. Is the mainframe turned on?
   ➤ Turn on the power key switch.
3. Check the fuse at the rear panel of the mainframe.
   ➤ If blown, replace the fuse with the correct type (one spare fuse is inserted in the fuse holder). Please refer to chapter Exchanging the Mains Fuse.

**The display works, but not the module.**

1. Is the module inserted correctly and are all mounting screws tightened?
   ➤ Insert the module in the desired slot and tighten all mounting screws properly.
   ➤ See the individual manual of the module for further troubleshooting.

**The installed IEEE488 interface does not respond to the connected computer.**

1. Is the option “Interface: IEEE488” selected in the setup menu?
   ➤ Press “ESC” until entering the setup menu. Use the arrow soft keys to select the interface line, press the change button and select IEEE488 interface. See chapter Setup Menu.
2. Is the correct type of IEEE488 connecting cable used?
   ➤ Install the appropriate cable.
3. Was the cable installed after turning on the mainframe or the PC?
   ➤ Turn off both units and turn them on again.
4. Does the mainframe's device address match with the address in the control software?


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➤ Refer to chapter Setup Menu to see the present IEEE488 bus address of the mainframe and make sure that it matches with the control software (default address is 10). Alternatively, you may change the actual IEEE address of the mainframe corresponding to the software.

5. Is there an address conflict on the IEEE488 bus interface? Check if there is another device using the same address?
   ➤ Make sure that each of the present devices has its individual address.

**The installed RS232 interface does not respond to the connected computer**

1. Is the option “Interface:  RS232” selected in the setup menu?
   ➤ Press “ESC” until entering the setup menu. Use the arrow soft keys to select the interface line, press the change button and select RS232 interface. See chapter Setup Menu.
2. Is the correct type of serial cable used?
   ➤ Install the appropriate cable, see chapter Hardware Standard RS232C.

**With the first RS232 command, the mainframe enters the remote mode, but does not respond further.**

1. Check the selected baud rate.
   ➤ The baud rates in the PRO8000 Series setup menu and in the control software must match.

**The LOCAL key of the mainframe is not responding.**

1. The "**LLO**" (Local Lockout) command might have been sent to mainframe, this way disabling the **LOCAL** key.
   ➤ In order to return to local mode, from the PC the command "**GTL**" (Go To Local) must be sent.
   ➤ The **LOCAL** key is enabled when turning off and on again the mainframe.

**The displayed measured values seem to react only very slowly.**

➤ Adjust the over sampling rate (OSR) in the setup menu to a lower value.

If above hints could not resolve the malfunction, please contact Thorlabs for technical support and/or return instructions.

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# 6 Appendix

## 6.1 Technical Data

| Common | PRO800 | PRO8000 | PRO8000-4 |
|---|---|---|---|
| Number of Slots | 2 | 8 | 8 |
| Mains Switch | Key Operated | | |
| Remote Control | Via IEEE488 and RS232C | | |
| **Power Supply** | | | |
| Mains Voltage | 100 V, 115 V, 230 V ±10%, Fixed | | |
| Mains Frequency | 50 to 60 Hz | | |
| Maximum Power Consumption | 220 VA | 500 VA | 800 VA |
| Supply Mains Overvoltage | Category II (Cat II) | | |
| Maximum Output Current per Slot | 4 A | 4 A | 4 A |
| Maximum Output Current, all Slots | 8 A | 16 A | 32 A |
| **Display and Operating Elements** | | | |
| Display | 4 x 20 Characters Alphanumeric Vacuum-Fluorescence-Display | | |
| User Interface | Interactive Menus | | |
| Keypad | 7 Micro-Switch Keys | | |
| Main Tuning Knob | Rotation Encoder | | |
| Acoustic Messages | Internal Beeper:<br>Short Tone as Confirmation, Long Tone as Warning | | |
| **Connectors On Rear Panel** | | | |
| Ground | 4 mm Banana Jack | | |
| Power Line | Line 3 Pin IEC 320 with Fuse | | |
| Remote Control | IEEE488 (24 Pin)<br>RS232C (9 Pin) D-SUB | | |
| Auxiliary Jack | 9-Pin D-Sub. for Extensions | | |
| TRIG IN (Max. 5 V, TTL) | BNC | | |
| TRIG OUT (Max. 5 V, TTL) | BNC | | |
| **Protections** | | | |
| • Key Operated Power Control Switch (ON / STANDBY)<br>• Interlock Connector<br>• Over Temperature Protection of the Mainframe<br>• Over Temperature Protection of the PRO8000 Series Modules<br>• Protection Against Transients<br>• Protection Against Interrupted Wiring (OPEN)<br>• Protection Against Too High Laser or TEC Current (Hardware and Software Limit)<br>• Protection Against Too High Optical Power (Current Limit of the Monitor Diode) | | | |
| **General** | | | |
| Warm-Up Time for Rated Accuracy | 10 min | | |
| Operating Temperature Range[1)] | 0 °C to 40 °C | | |
| Storage Temperature Range | -40 °C to 70 °C | | |
| Relative Humidity | Max. 80% up to 31 °C, Decreasing to 50% at 40 °C | | |
| Pollution Degree (Indoor Use Only) | 2 | | |
| Operation Altitude | <2000 m | | |
| Dimensions (W x H x D) | (232 x 147 x 396) mm | (449 x 147 x 400) mm | (449 x 177 x 456) mm |
| Weight | <9 kg | <17 kg | <21 kg |

[1)] non-condensing

All technical data are valid at 23 ± 5 °C and 45 ± 15% rel. humidity (non-condensing)


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## 6.2 Certifications and Compliances

THORLABS

CE

# Konformitätserklärung
# Declaration of Conformity
# Déclaration de Conformité

**Thorlabs GmbH**
**Münchner Weg 1**
**D-85232 Bergkirchen**
**Germany**

erklärt in alleiniger Verantwortung, dass das Produkt:
declares under its own responsibility that the product:
déclare sous notre seule responsabilité que le produit:

**Series 8000**
**PRO800, PRO8000, PRO8000-4 including Modules (TED8*, ITC8*, PDA8*, WDM8*)**

mit den Anforderungen der Normen
fulfills the requirements of the standards
satisfait aux exigences des normes

| | |
|---|---|
| 2014/35/EU<br>EN 61010-1:2010 | Low Voltage directive<br>Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements |
| 2014/30/EU<br>EN 61326-1:2013 | Electromagnetic compatibility directive<br>Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements |
| 2011/65/EU<br>EN 50581:2012 | RoHS directive<br>Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous Substances |

übereinstimmt und damit den Bestimmungen entspricht.
and therefore corresponds to the regulations of the directives.
et répond ainsi aux dispositions des directives.

Dachau, 11. December 2019 .....

| | |
|---|---|
| Ort und Datum der Ausstellung<br>Place and date of issue<br>Lieu et date d'établissement | Name und Unterschrift des Befugten<br>Name and signature of authorized person<br>Nom et signature de la personne autorisée |

## 6.3 Letter of Volatility

| Model | Memory Size | Memory Type, Purpose | Volatility | User Data | Method of Clearing |
|---|---|---|---|---|---|
| PRO800, PRO8000, PRO8000-4 | Up to1MB | RAM, Runtime Data | No, Battery Buffered | No* | Cannot be Cleared by User |
| PRO800, PRO8000, PRO8000-4 | Up to 4MB | Flash, Firmware | No | No | Cannot be Cleared by User |
| LDC8000 Series | 256 B | EEPROM, Calibration Data | No | No | Cannot be Cleared by User |
| TED8000 Series | 256 B | EEPROM, Calibration Data | No | No | Cannot be Cleared by User |
| ITC8000 Series | 256 B | EEPROM, Calibration Data | No | No | Cannot be Cleared by User |
| PDA8000 Series | 256 B | EEPROM, Calibration Data | No | No | Cannot be Cleared by User |
| MLC8000 Series | 256 B | EEPROM, Calibration Data | No | No | Cannot be Cleared by User |
| OSW8000 Series | 256 B | EEPROM, Calibration Data | No | No | Cannot be Cleared by User |
| WDM8000 Series | 2 KB | EEPROM, Calibration Data | No | No | Cannot be Cleared by User |

(*) device settings like ‘selected channel’ or ‘set current’ are stored here, user cannot enter arbitrary data

## 6.4 Literature

[1] IEEE488.2-1992 - IEEE Standard Codes, Formats, Protocols, and Common Commands for Use With IEEE Std 488.1-1987, IEEE Standard Digital Interface for Programmable Instrumentation

Available at http://www.ieee.org/publications_standards/index.html .

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## 6.5 Warranty

Thorlabs GmbH GmbH warrants material and production of the PRO8000 Series for a period of 24 months starting with the date of shipment. During this warranty period Thorlabs GmbH will see to defaults by repair or by exchange if these are entitled to warranty.

For warranty repairs or service the unit must be sent back to Thorlabs GmbH GmbH. The customer will carry the shipping costs to Thorlabs GmbH GmbH, in case of warranty repairs Thorlabs GmbH GmbH will carry the shipping costs back to the customer.

If no warranty repair is applicable the customer also has to carry the costs for back shipment.

In case of shipment from outside EU duties, taxes etc. which should arise have to be carried by the customer.

Thorlabs GmbH GmbH warrants the hard- and/or software determined by Thorlabs GmbH GmbH for this unit to operate fault-free provided that they are handled according to our requirements. However, Thorlabs GmbH GmbH does not warrant a fault free and uninterrupted operation of the unit, of the software or firmware for special applications nor this instruction manual to be error free. Thorlabs GmbH GmbH is not liable for consequential damages.

**Restriction of Warranty**

The warranty mentioned before does not cover errors and defects being the result of improper treatment, software or interface not supplied by us, modification, misuse or operation outside the defined ambient stated by us or unauthorized maintenance.

Further claims will not be consented to and will not be acknowledged. Thorlabs GmbH GmbH does explicitly not warrant the usability or the economical use for certain cases of application.

Thorlabs GmbH GmbH reserves the right to change this instruction manual or the technical data of the described unit at any time.

## 6.6 Copyright and Exclusion of Liability

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

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## 6.7 Thorlabs 'End of Life' Policy

**Thorlabs GmbH 'End of Life' Policy (WEEE)**



Thorlabs verifies our compliance with the WEEE (Waste Electrical and Electronic Equipment) directive of the European Community and the corresponding national laws. Accordingly, all end users in the EC may return “end of life” Annex I category electrical and electronic equipment sold after August 13, 2005 to Thorlabs, without incurring disposal charges. Eligible units are marked with the crossed out “wheelie bin” logo (see right), were sold to and are currently owned by a company or institute within the EC, and are not dissembled or contaminated. Contact Thorlabs for more information. Waste treatment is your own responsibility. “End of life” units must be returned to Thorlabs or handed to a company specializing in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site. It is the users responsibility to delete all private data stored on the device prior to disposal.


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## 6.8 List of Acronyms

| | |
|---|---|
| AG | Anode Ground |
| BFC | Block Function Condition Register |
| BFE | Block Function Enable Register |
| BFR | Event Register |
| CG | Cathode Ground |
| CRD | Character Response Data |
| DBR | Distributed Bragg Reflector |
| DCL | Device Clear |
| DEC | Device Error Condition Register |
| DEE | Device Error Event Register |
| DES | Device Error Status |
| DESE | Device Error Summary Enable Register |
| DESR | Device Error Summary Register |
| EAV | Error AVailable |
| EDE | Enable Device Error Event Register |
| ELCH | ELectrical Characterization |
| EOI | End Of Information |
| ESB | Error Status Byte |
| ESE | Standard Event Status Enable register |
| ESR | Event Status Register |
| FIN | Command FINished |
| GET | Group Execute Trigger |
| GTL | Go To Local |
| GPIB | General Purpose Interface Bus |
| IEEE | Institute for Electrical and Electronic Engineering |
| ITU | International Telephone and Telegraph Union |
| LF | Line Feed |
| LLO | Local Lockout |
| LS | Laser Source Module |
| NR1 | Numeric Response data of type 1 |
| NR2 | Numeric Response data of type 2 |
| NR3 | Numeric Response data of type 3 |
| MAV | Message AVailable) |
| MSS | Master Summary Status |
| PC | Personal Computer |
| PD | Photo Diode |
| RQS | ReQuest Service Message |
| SDC | Selected Device Clear |
| SEL | SELect |
| SRE | Service Request Enable Register |

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| | |
|---|---|
| SRQ | Service ReQuest |
| STB | STatus Byte Register |
| SW | Soft Ware |
| TEC | ThermoElectric Cooler (Peltier Element) |
| TRG | TRiGger |
| TTL | Transistor-Transistor Logic |
| WDM | Wavelength Division Multiplex |


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## 6.9 Thorlabs Worldwide Contacts

For technical support or sales inquiries, please visit us at www.thorlabs.com/contact for our most up-to-date contact information.



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