Koheras ADJUSTIK
Low Noise Single Frequency Laser System

PRODUCT GUIDE
PRODUCT GUIDE
This guide includes the following NKT Photonics Lasers:

Koheras ADJUSTIK
Low Noise Single Frequency Laser System
This product guide is intended to provide functional, operational and installation information for the Koheras ADJUSTIK laser modules. The guide is divided into three sections:

- **Koheras Low Noise Single Frequency Laser System Description** - introduces the laser, its functionality, interfaces and chassis variants.

- **Operating the Laser** — provides information and procedures on how to connect, configure and manage the laser.

- **Installing the Laser** — includes the details on how to install the laser and connect optional interfaces.

**Warning:** Do not operate the laser before first reading and understanding all warnings, cautions and handling information stated within the document: *Koheras ADJUSTIK Safety, Handling and Regulatory Information*

**Note:** The paper copy of this document is included with your laser; however, it can also be downloaded from: https://www.nktphotonics.com/lasers-fibers/support/product-manuals/

**Terminology** This guide may refer to the Koheras ADJUSTIK as “the laser”. In specific cases where a distinction is required, this guide will use the actual laser model names.

**Target audience** This guide is for technical personnel involved in the selection, planning and deployment of lasers in laboratory and industrial settings. The guide assumes a reasonable knowledge level of lasers, photonic principles and electrical interface connectivity.

**Chapters inside** This guide includes the following chapters:

- **Chapter I “Laser Description”** — Describes the laser including its general operational principles, management and interfaces.

- **Chapter 2 “Modulation”** — Implementation information for wavelength and amplitude modulation.

- **Chapter 3 “Communicating with the Laser”** — Provides information and procedures on how to setup a PC with the laser’s management software and connect it to the laser.

- **Chapter 4 “Turning ON the Laser”** — Contains procedures on how to safely turn the laser emissions on and off using the management software.
• Chapter 5 “Using CONTROL” — Includes descriptions of all NKT CONTROL menu, settings, and panel items.

• Chapter 6 “Mechanical Installation” — Includes information and procedures on how to correctly install the laser chassis. Procedures within this chapter focus on providing adequate temperature regulation.

• Chapter 7 “Connecting the Laser” — This chapter provides the information on how to physically connect the safety interlock, power, the optical connections, and the .

• Appendices — The guide includes multiple appendices including laser specifications, support contact details, accessory descriptions and miscellaneous procedures supporting the laser operation and installation.

**Added information and safety notices**

Lasers are highly dangerous devices that can cause serious injury and property damage. This guide use the following symbols to either highlight important safety information or provide further information in relation to a specific topic.

- **Note:** Highlights additional information related to the associated topic and/or provides links or the name of the NKT guides describing the additional information.

- **Caution:** Alerts you to a potential hazard that could cause loss of data, or damage the system or equipment.

- **Warning:** The laser safety warning alerts you to potential serious injury that may be caused when using the laser.

**Revision**

The section records the document revision details.

January 2020 – First release - the document has been rewritten and overhauled from earlier releases.
Wavelength display ........................................................................................................... 47
W1 modulation ................................................................................................................... 47
W1 mod. Gain ..................................................................................................................... 47
W1 mod. source ................................................................................................................... 48
W1 mod. Coupling ............................................................................................................. 48
W1 mod. Range ................................................................................................................... 48
Power /current mode ....................................................................................................... 49
Power .................................................................................................................................. 49
Power unit .......................................................................................................................... 49
Watchdog timer ................................................................................................................ 50
Display backlight ............................................................................................................. 50
IP Address ........................................................................................................................ 50
Emission button ................................................................................................................ 50
3 Communicating with the Laser ........................................................................................ 53
CONTROL software ........................................................................................................ 53
Installing the software ..................................................................................................... 53
Connecting the laser to a PC with CONTROL ................................................................ 53
Ethernet connection ........................................................................................................ 54
4 Turning ON the Laser ...................................................................................................... 57
Safety .................................................................................................................................. 57
Preparation ........................................................................................................................ 57
Enabling and disabling emission ..................................................................................... 58
Enable emission (CONTROL) ............................................................................................ 58
Enable emission (front panel) ............................................................................................ 59
5 Using CONTROL ............................................................................................................. 63
CONTROL overview ......................................................................................................... 63
Relocating panels .............................................................................................................. 64
Toggling panels ................................................................................................................ 65
Connecting to the laser ..................................................................................................... 65
Status panel ...................................................................................................................... 65
Status indicators .............................................................................................................. 66
Section 3

INSTALLING THE LASER 77

6 Mechanical Installation ........................................................................................................ 79
   General ................................................................................................................................ 79
   Heat dissipation .................................................................................................................... 79
   Rack mounting the laser ....................................................................................................... 79
   Placing the laser on a table or shelf .................................................................................... 80
   Operating and storage environment .................................................................................. 81

7 Connecting the Laser ........................................................................................................... 83
   Connecting the safety interlock ......................................................................................... 83
   Interlock operation ............................................................................................................ 83
   Connecting an interlock switch ......................................................................................... 84
   Bus defeater ....................................................................................................................... 84
   Connecting power ............................................................................................................. 85
Connecting modulation signals ............................................................. 85
Connecting the trigger input or output ..................................................... 85
   Input trigger ....................................................................................... 85
   Output trigger ................................................................................... 86
Connecting the optical output ................................................................. 86

Appendices

A Specifications .......................................................................................... 91
B Service and support Information ............................................................. 95
   Servicing the laser .............................................................................. 95
   Opening the laser chassis ................................................................. 95
   WARRANTY VOID IF REMOVED Label ........................................... 95
   Support contact details ..................................................................... 96
      Support Email ............................................................................... 96
      Online support web-page ............................................................. 96
      Shipping address .......................................................................... 96
C Interface Pin Assignments ................................................................... 97
   Modulation input/output ................................................................. 97
   External bus ..................................................................................... 97
D CONTROL Software ......................................................................... 99
   Installing CONTROL ................................................................. 99
Table 1: ADJUSTIK variant specifications.................................................................20
Table 2: ADJUSTIK rear panel layout ................................................................. 23
Table 3: Recommended power modes ............................................................... 25
Table 4: Optical Interface Specifications ..........................................................28
Table 5: Status LEDs.............................................................................................29
Table 6: Module labels..........................................................................................31
Table 7: Wavelength modulation settings .........................................................34
Table 8: Narrow vs wide band wavelength modulation....................................38
Table 9: Front panel menu items ........................................................................45
Table 10: CONTROL panels and menu items ....................................................63
Table 11: Power specifications............................................................................85
Table 12: Optical ..................................................................................................91
Table 13: Mechanical dimensions .....................................................................91
Table 14: Operating and storage environment ..................................................91
Table 15: Electrical................................................................................................92
Table 16: Safety and regulatory compliances ...................................................92
Table 17: Mechanical dimensions.....................................................................93
Table 18: Modulation connector pin assignment .............................................97
Table 19: External bus pin assignment ..............................................................97
FIGURES

Figure 1: ADJUSTIK front panel ................................................................. 19
Figure 2: ADJUSTIK front panel layout .................................................. 22
Figure 3: Frequency response using wavelength modulation ................... 24
Figure 4: Top panel label locations ......................................................... 30
Figure 5: Rear panel label location .......................................................... 30
Figure 6: Differential input signal for wavelength modulation ............... 35
Figure 7: Single-ended to differential ..................................................... 35
Figure 8: Single-ended input signal with 2.5 V ....................................... 36
Figure 9: Single-ended input with 2.5 V on an unused branch ............... 36
Figure 10: Single-ended input signal with GND on an unused branch .... 37
Figure 11: Single-ended input connections with 0 V on an unused branch .. 37
Figure 12: Differential output signal ...................................................... 38
Figure 13: ADJUSTIK X15 wavelength modulation response .................. 39
Figure 14: ADJUSTIK E15/C15/Y10 wavelength modulation response .... 40
Figure 15: Differential input for amplitude modulation ......................... 41
Figure 16: Single-ended input for amplitude modulation ....................... 41
Figure 17: ADJUSTIK X15 in Pound-Drever-Hall configuration ............ 42
Figure 18: Top level menu ................................................................. 46
Figure 19: Wavelength setting menu ..................................................... 47
Figure 20: Wavelength display menu - set as Absolute ......................... 47
Figure 21: Wavelength modulation - ON ........................................ 47
Figure 22: Wavelength modulation gain setting menu ......................... 48
Figure 23: Wavelength modulation source signal set to internal ........... 48
Figure 24: Wavelength modulation signal coupling set to AC ................ 48
Figure 25: Wavelength modulation range set to Narrow ....................... 48
Figure 26: Operation mode set to constant power mode ....................... 49
Figure 27: Power tuning menu ............................................................. 49
Figure 28: Power unit menu - set to mW ........................................... 49
Figure 29: Watchdog timer setting ..................................................... 50
PROCEDURES

Procedure 1: Connecting a PC to the laser using a USB cable ............................... 53
Procedure 2: Connecting a PC to the laser using Ethernet ..................................... 55
Procedure 3: Turning on the laser using CONTROL .................................................. 58
Procedure 4: Turning on the laser using CONTRO4 ............................................... 60
Procedure 5: Relocating panels ............................................................................... 64
Procedure 6: Connecting the door interlock circuit ............................................... 84
Procedure 7: Installing CONTROL ........................................................................ 99
This section provides a description of the laser and its chassis types. It includes the following topics:

- “Laser Description” on page 19
- “Module variants” on page 20
- “Laser features” on page 24
- “Miscellaneous” on page 27
- “Optical interface” on page 27
- “Laser Control” on page 28
- “Status LEDs” on page 29
- “Chassis labels” on page 30
Laser Description

The Koheras ADJUSTIK is a single frequency distributed feedback (DFB) fiber laser with passive vibration reduction. The laser system is housed within a rack mount control chassis which includes a front panel operational interface. The laser’s optical output is defined by an ultra-narrow line width in the Hertz range and exceptionally low frequency and intensity noise. These characteristics make the laser suitable for laser interferometry, coherent communication, microwave generation, spectroscopic, and scientific applications.

**Figure 1** ADJUSTIK front panel

A total of four variants of the laser are available with additional options that can be specified. The variants are all designed with distributed feedback fiber laser technology and center wavelengths can be specified from either 1535 to 1580 nanometers or 1030 to 1120 nanometers. All laser variants support a wide tuning range of approximately 1 nm from the specified center wavelength.

### Features and Options

The laser series includes the following features and options:

- **Thermal Tuning** – can vary the wavelength through coarse thermal control of the laser substrate.
- **Piezo Tuning** – provides fast wavelength modulation with finer control
- **Standard or Polarization Maintaining (PM) fiber** – PM fiber is available if the application requires that the polarization is preserved.
- **Wavelength modulation** – the wavelength can be modulated using either an external or internal signal.
- **Power or Current modes** – the lasers can operate in either constant power or constant current mode.
- **Adjustable output power (X15 variant only)** – using an optional Variable Optical Attenuator
- **Emission features** – multiple features that control emission availability from the laser.
Tuning
Tuning is accomplished by either manual thermal tuning or using an external signal applied at the laser’s fast wavelength modulation input pins. A varying external signal applied to the pins, modulates the output wavelength. Modulating the output wavelength can obtain improved stabilization when compared with the free-running wavelength specification.

Output fiber
The standard output of the laser utilizes either standard single mode fiber or optional polarization-maintaining fiber to improve the linear characteristics. Improved polarization linearity is usually required when the laser output is either externally modulated or frequency converted.

Theory of operation
The ADJUSTIK is a fiber laser that uses a fiber Bragg grating cavity to produce an output beam operating in single mode. The center wavelength of the laser is configurable using either thermal substrate control or optional Piezo components. Due to the special Bragg grating, the single mode operation is constantly maintained and is stable over the entire operating frequency band of the laser.

Module variants
The Koheras ADJUSTIK is available in four variants. The variants are mainly classified by their wavelength and output power. Table 1 describes the primary technical differences between the variants.

<table>
<thead>
<tr>
<th>Module Type</th>
<th>Standard λ</th>
<th>Other λs</th>
<th>Output Power</th>
<th>Polarization Maintaining</th>
<th>Fast Modulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>X15</td>
<td>1550.12</td>
<td>1535 - 1580 nm</td>
<td>30 mW (fixed)²</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>E15</td>
<td>1550.12</td>
<td>1535 - 1580 nm</td>
<td>40 mW (max.)³</td>
<td>Optional</td>
<td>Yes</td>
</tr>
<tr>
<td>C15</td>
<td>1550.12</td>
<td>1535 - 1580 nm</td>
<td>&gt;10 mW (fixed)²</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Y10</td>
<td>1064.00</td>
<td>1030 - 1120 nm</td>
<td>&gt;10 mW (fixed)²</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

1. Fixed
2. Actual value depends on the factory calibration
3. Min. output ~30% of the maximum

Center wavelength
The center wavelength of ADJUSTIK lasers is set to 1550.12 nm (ITU DWDM C-BAND Channel 34) or 1064.00 nm. The lasers can also be specially ordered from the factory with other center wavelengths ranging from 1535 to 1580 nm or 1030 to 1120 nm.

Output power
Depending on the module type, the output power varies between greater than 10 mW and up to and including 40 mW. The output power is fixed for the lasers. however, a Variable Optical Attenuator (VOA) can be specified with the laser to adjust the output power over a large dynamic range.
**Tuning types**

The laser's variants can be further specified with different tuning options. The options include narrow and wide thermal tuning for coarse adjustment, Piezo tuning for finer adjustment and output power tuning. The tuning options must be specified when the laser is ordered from the factory.

**Thermal tuning**

Thermal tuning options available are:

- **Narrow thermal tuning** – provides narrow thermal tuning suitable for systems where a wide tuning range is not required but vibration immunity is vital.

- **Wide thermal tuning** – provides a wider thermal tuning range at the expense of reduced immunity to vibration and acoustic pickup.

*Note:* Wide thermal tuning is the default option for Koheras ADJUSTIK lasers.

**Piezo tuning**

The laser modules support fine fast wavelength modulation using Piezo tuning. For further information see “Fast wavelength modulation” on page 24).

*Note:* Koheras ADJUSTIK lasers are fitted with Piezo tuning by default. If Piezo tuning is not required it must be specified when ordering the laser.

**Output power tuning**

Output power tuning is determined by the variant type:

- **C15 and Y10 variants** – No power tuning, output power is fixed at the factory.

- **E15 variant** – Limited power tuning from approximately 30 to 100% of the maximum output power.

- **X15 variant** – Full range power tuning from 0 to 100% of it's maximum output power. (A VOA is fitted to its output.)

---

**Front and rear panels**

**Front panel**

Figure 2 shows the front panel of the laser. The laser has two optical outputs A and B. The outputs are assigned at the factory as either the main output, monitor output or blank. The front panel also includes controls to operate the laser without using a CONTROL PC. The controls include:

- **LCD display panel** - displays operational parameters and a menu system where the laser’s parameters can be set.

- **Menu and return buttons** – use to enter into menu levels, select parameter digits, confirm the setting and return to a higher menu level.
• Selection dial – use the dial to move the selection pointer among the menu items and modify parameter values.

• Emission button – enables and disables emission (enables emission only if the system meets safety and operational parameters.)

• Key switch – the key switch must be ON to enable emission. Remove the key to prevent unauthorized laser operation.

• AC mains switch – powers the laser ON or OFF.

See “Optical specifications” on page 23 for more information on the optical outputs and their connector configuration.

Status LEDs on the front panel indicate the following states:

• Power – the supply voltage status

• Interlock – interlock circuit open/closed (not OK/OK)

• Emission – the laser emission status

• Status – the module stability status

For more information see “Status LEDs” on page 29.

**Figure 2** ADJUSTIK front panel layout

Rack mounting
There is a flange on each side of the front panel for mounting the laser in a standard 19 inch rack. The flanges include plastic finger-grips to facilitate installing and removing the laser from a rack. For more information on installing the laser, see “Mechanical Installation” on page 79.
Rear panel  Figure 2 shows the rear panel which includes the following connectors:

- AC inlet - standard IEC C-14 mains inlet connector
- LEMO connector - 2 pin door interlock circuit
- Modulation – Male DB-9 pin connector providing pins for wavelength input/output, amplitude modulation input and trigger signals
- Ethernet – 10/100 MBps BASE-T Ethernet port for IP connectivity to the laser
- External Bus Female DB-15 pin connector – connects the laser to other systems or accessories. The connector provides RS-485 bus control interface, 12V DC power and an extension of the interlock safety circuit for connected accessories. If no accessories are connected the supplied bus defeater must always be placed on the connector to loop back the interlock safety circuit.
- AC inlet - standard IEC C-14 mains inlet connector

Table 2  ADJUSTIK rear panel layout

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AC mains inlet</td>
<td>4</td>
<td>10/100 BASE-T Ethernet port</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>LEMO door interlock connector</td>
<td>5</td>
<td>External bus</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Modulation (input and output)</td>
<td>6</td>
<td>Cooling fins</td>
<td></td>
</tr>
</tbody>
</table>

Note: The pin assignments of the connectors are described in Appendix C

Optical specifications

Main optical output
The laser’s main output is classified as a laser CLASS 3B. The main output can be identified by the laser aperture label next to it.

Monitor Output
The monitor output is classified as a laser CLASS 1 output and therefore does not require a laser aperture label.
Laser features

**Thermal tuning**  The wavelength of the laser can be controlled using a thermal tuning technique that changes the temperature of the laser’s fiber. The fiber laser is mounted under tension on a substrate. When the temperature of the substrate changes, the laser cavity length also changes due to thermal contraction or expansion. Further, the temperature of the laser cavity itself also changes such that the laser wavelength changes in response to both thermo-optic and physical changes in the optical path length. See “Tuning the wavelength” on page 82.

**Fast wavelength modulation**  The laser includes the capability to use an external signal to modulate the emission wavelength using a Piezo. The Piezo allows the modules output wavelength to be modulated using an external electrical signal.

**Input circuits**  Section “Fast wavelength modulation” on page 33 provides examples of fast wavelength modulation circuits and performance.

**Wavelength+/- Signal**  To modulate the wavelength, apply an external differential signal to Modulation connector on the rear panel. See “Modulation input/output” on page 97 for the connector’s pin assignment.

As this signal varies and increases its positive potential, the wavelength increases. Figure 3 shows the frequency response when the fast wavelength modulation feature is utilized. The graph shows the response for both standard and wide thermal tuning substrates.

*Figure 3*  Frequency response using wavelength modulation

The response shown in Figure 3 is for a laser with a wavelength at 1550 nm. The response is scaled linearly with the wavelength of the laser. Further, the Narrow Thermal Tuning module which has less vibration sensitivity, shows resonances that
Laser features

are higher in frequency. These modules are therefore more suitable for applications where modulations between 30 and 45 kHz are required.

**Note:** The frequency response is relatively flat up to 20 kHz, but resonances are seen at frequencies at and above the first resonance occurring at approximately 30 kHz. Wavelength modulation can be used for frequencies above 20 kHz, but it is recommended to avoid modulating the laser at the resonance frequencies.

**External cavity stabilization**

X15 modules support the use of the Pound-Hall-Drever technique to reduce low frequency phase noise to an ultra-low level. It requires that the X15 output is stabilized using an external cavity circuit. Refer to “External cavity stabilization (ADJUSTIK X15)” on page 41 for details of the implementation.

**Amplitude modulation**

If the laser includes the VOA option, and electrical input signal or the built-in function generator can be used to modulate the laser output power. Modulation of the output power ranges from 0 to 100% of the output power.

**Amplitude +/- Signal**

To modulate the power, apply an external differential signal to Modulation connector on the rear panel. A differential signal applied to these pins varies the VOA attenuation directly. See “Modulation input/output” on page 97 for the connector’s pin assignment.

**Setpoint**

When amplitude modulation is used, the maximum power output can be limited to a preset value. This value is known as the “setpoint” and it limits the maximum output to less than the 100% power level.

**Note:** For more information on using Amplitude modulation with either an external signal or the built-in function generator, See “Amplitude modulation” on page 40.

**Operating mode**

All modules can operate in Current mode, where the current in the pump feeding the fiber laser is kept stable. Some variants can operate in Power mode as well, where the power out of the fiber laser is kept fixed.

- **Current mode** – the current in the pump feeding the fiber laser is held stable.
- **Power mode** – the power out of the fiber laser is held at a fixed level.

The mode set depends on both the model and the application, refer to Table 3 for the recommended mode to use. See “Setting the operating mode” on page 82.

**Table 3** Recommended power modes

<table>
<thead>
<tr>
<th>ADJUSTIK model</th>
<th>Power mode</th>
<th>Current mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>C15 &amp; Y10</td>
<td>Better Power Stability</td>
<td>Better Frequency Stability</td>
</tr>
<tr>
<td>E15 &amp; X15</td>
<td>Better Performance</td>
<td>Not Recommended</td>
</tr>
</tbody>
</table>
Note: Modules that support both modes are configured from the factory to operate in Power mode.

**Trigger**
A trigger logic input or output pin (see Table 18) is available on the Modulation connector. The trigger pins can be used for two purposes:

- To apply (input) a logic signal that initiates laser emission (A logic high initiates emission.)
- To output a logic signal that indicates laser emission. (Active high is output.)

For more information on connecting the trigger see “Connecting the trigger input or output” on page 85.

**Auto-start**
The laser includes an Auto-start control bit, when the bit is set, laser emission is enabled immediately after power is connected. This mode can be useful for applications where no communication with the module is possible. See “Auto start” on page 82.

**Interlock**
To enable emission using auto-start, the interlock signal in the electrical interface must be high when the module is powered up.

Note: Auto-start will not turn ON the laser emission if after power-up, the interlock signal subsequently changes to high.

**Koheras ADJUSTIK & ACOUSTIK**
If the module is used within either the ADJUSTIK or ACOUSTIK chassis, auto-start is overruled and cannot start laser emissions even if the auto-start bit is set.

**KeyUpdater**
To enable/disable the Auto-Start feature, use the KeyUpdater tool with either key below.

- **Enable key – enables the Auto-start feature**
  Q1PTF-9PCA1-9TF9P-723J9-9E9QV-V8999-99999-9E999-99999-9999N-IPUB6
- **Disable key – disables the Auto-start feature**
  E0TDG-FT190-FDGFT-N6O3F-FAF0K-KZFFF-FFFFF-FFFFF-FFFFF-G6BF9

**High temperature shutdown**
To prevent thermal run-away when the laser module temperature exceeds 65 °C, the emission is automatically turned off. The high temperature shutdown feature uses the thermal control function inside the laser to turn off the emission.

Note: The laser remains ON and has communications enabled, only the emission is turned off by the feature.
Power verification

This feature internally monitors the output power level from the fiber stage. If power drops below a predefined level in relation to the measured pump current, laser emission is automatically shut off.

*Note:* The slope is different for each individual laser as their emission efficiency varies.

The feature prevents for example, the output power reaching its maximum value if feedback disappears (unexpectedly) to the internal output power control function.

---

Safety

*Warning:* The lasers are rated as class 3a lasers and are therefore hazardous. Before turning on the laser, ensure to read and understand all safety statements of the document:

*Koheras ADJUSTIK Safety, Handling and Regulatory Information*

A paper copy of this document is included with your laser. If you do not have access it, you can download a copy from:


---

Optical interface

The laser has two optical outputs (marked with an ‘A’ and a ‘B’ on the front of the module). Assignment of the output type depends on the laser configuration ordered from the factory. The optical outputs are assigned as either:

- **Main** – this is the laser’s primary optical output (typically Class 3B) near which, a laser aperture label is affixed.

- or -

- **Monitor** – this is a low power output intended for monitoring purpose only. The output is classified as a laser CLASS 1 and therefore it does not require a laser aperture label.

Contact NKTP support for information on how the laser’s optical ports are assigned. See “Support contact details” on page 96.

---

Optical fibers, connectors and adapters

If an optical output is assigned to port A or B, it can be configured as either:

- fiber patch cords with FC/APC connectors (FC/APC pig-tail)
— or —

- connector adapters (FC/APC adapter or SC/APC adapter)

**Polarization Maintaining Output (Panda PM 1550)**

If the module includes an optional Panda polarization maintaining fiber cord, the slow axis is by default aligned to the connector key. Because of this, the laser polarization (E-field) is parallel to the key.

**Table 4: Optical Interface Specifications**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>SMF28</th>
<th>PM 1550</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiber Mode Field Diameter$^1$</td>
<td>~10 microns</td>
<td>~10 microns</td>
</tr>
<tr>
<td>Numerical Aperture</td>
<td>0.14</td>
<td>0.125</td>
</tr>
</tbody>
</table>

1. Mode field diameter is approximate - contact NKT Photonics Support for more information (Support contact details on page 96).

---

**User interface**

The laser and any associated accessories are controlled using NKT Photonics CONTROL Graphical User Interface (GUI) installed on a PC or the front panel interface.

As an option, the laser can also be controlled using NKTP’s Software Development Kit (SDK) for custom applications. For further information regarding the SDK refer to the software and drivers link at NKTP’s support webpage:


The PC or custom microprocessor can connect using either the USB serial port on the front panel or the 10/100 BASE-T Ethernet port on the rear panel.

Section 2 includes chapters describing the front panel interface and NKTP’s CONTROL software and how to control the laser with them.
Status LEDs

The front panel houses four status LEDs as described in Table 5. The LEDs are located on the front panel as shown in Figure 1.

Table 5 Status LEDs

<table>
<thead>
<tr>
<th>LED Name</th>
<th>Condition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>ON Green</td>
<td>AC mains connected and power switch is in the ON position.</td>
</tr>
<tr>
<td></td>
<td>ON Red</td>
<td>Fault with the DC power supply</td>
</tr>
<tr>
<td></td>
<td>OFF</td>
<td>System switched off or no AC mains power</td>
</tr>
<tr>
<td>Status</td>
<td>OFF</td>
<td>One of the following:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>* Interlock is reset but there is no emission from the system</td>
</tr>
<tr>
<td></td>
<td></td>
<td>* Alternatively firmware is being uploaded to the system main control board. During firmware upgrade the interlock cannot be reset and no emission from the system is possible.</td>
</tr>
<tr>
<td></td>
<td>ON Orange</td>
<td>Interlock fault or the interlock needs to be reset.</td>
</tr>
<tr>
<td></td>
<td>Flashing Orange</td>
<td>The system main control board is scanning for modules attached to the system and accessories connected to the external bus.</td>
</tr>
<tr>
<td></td>
<td>ON Green</td>
<td>Laser emission enabled and the system is stabilized.</td>
</tr>
<tr>
<td></td>
<td>Flashing Green</td>
<td>Laser emission enabled but the system has not stabilized.</td>
</tr>
<tr>
<td></td>
<td>ON Red</td>
<td>Either one or multiple modules in the system or connected to the External Bus have shut down.</td>
</tr>
<tr>
<td></td>
<td>Flashing Red</td>
<td>Firmware is being uploaded to modules in the Koheras ADJUSTIK system or accessories connected to the External Bus.</td>
</tr>
<tr>
<td>Emission</td>
<td>ON Red</td>
<td>Laser emission is ON.</td>
</tr>
<tr>
<td></td>
<td>OFF</td>
<td>Laser emission is OFF.</td>
</tr>
</tbody>
</table>

Note: DO NOT OPERATE the laser until you are familiar with the controls and have taken all precautions necessary as described in the document: Koheras ADJUSTIK Safety, Handling and Regulatory Information.
A Koheras ADJUSTIK chassis has a number of labels on it that indicate hazards, regulatory, or manufacturing information. The labels are located on the panels described in Table 6 with the panels shown in Figure 4 and Figure 5.
### Table 6 Module labels

<table>
<thead>
<tr>
<th>Label</th>
<th>Panel</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classification - Emission</td>
<td>Top</td>
<td>Safety information stating the laser emission hazards and the laser’s class</td>
</tr>
<tr>
<td>Hazards</td>
<td></td>
<td>rating.</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>Rear</td>
<td>Manufacturing information including address, part and serial number, date</td>
</tr>
<tr>
<td></td>
<td></td>
<td>manufactured and regulatory compliance.</td>
</tr>
<tr>
<td>Product Information</td>
<td>Top</td>
<td>Safety label showing the emission specifications of the laser.</td>
</tr>
<tr>
<td>Laser Radiation Warning</td>
<td>Top</td>
<td>Safety information alert indicating this area of the laser is near a source</td>
</tr>
<tr>
<td></td>
<td></td>
<td>of dangerous laser emissions.</td>
</tr>
<tr>
<td>Laser Aperture Fiber</td>
<td>Fiber</td>
<td>Safety information alert indicating the location of the aperture where laser</td>
</tr>
<tr>
<td>connector</td>
<td></td>
<td>radiation is emitted from the laser. If the module includes a monitor output,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>this is a class 1 laser output and does not require a a label.</td>
</tr>
</tbody>
</table>
2 Modulation

This section presents further information on how to implement:

- Wavelength modulation (fast) – “Fast wavelength modulation” on page 33
- Amplitude modulation (VOA) – “Amplitude modulation” on page 40
- External cavity stabilization – “External cavity stabilization (ADJUSTIK X15)” on page 41

**Note:** Wavelength modulation must be specified when ordering the laser.

**Note:** An E15 ADJUSTIK is capable to decrease output power down to 30% of the nominal level. However, the laser’s performance will vary depending on the level of the output power set. Therefore the E15’s performance is only guaranteed at the nominal (maximum) output power setting.

---

### Fast wavelength modulation

If the fast wavelength modulation option is included with the laser, the output wavelength can be modulated using an external varying electrical signal, the internal function generator, or both.

The wavelength of a Koheras ADJUSTIK can be modulated with either:

- an external electrical signal applied to the modulation input,
- the internal function generator
- or both

The firmware in the laser is designed so at least one of the two is enabled. Table 7 provides a description with cross-references of the settings involved when using fast wavelength modulation.
The Wavelength+/- pins (see Table 18) are a differential input/output used for wavelength modulation of the laser. You can configure the wavelength modulation option so that the interface is used either as input or output. It is preferential to use a differential signal for the modulating signal applied. When using a differential signal, the combined voltage of the Wavelength+ and Wavelength- pins modifies the wavelength with the following results:

- a negative voltage results in a lower output wavelength.
- whereas a positive voltage results in a higher output wavelength.

### Table 7: Wavelength modulation settings

<table>
<thead>
<tr>
<th>Setting</th>
<th>Function</th>
<th>For CONTROL see</th>
<th>For SDK see</th>
</tr>
</thead>
<tbody>
<tr>
<td>External wavelength modulation</td>
<td>Sets wavelength modulation to external signal mode.</td>
<td>page 68</td>
<td>page 84</td>
</tr>
<tr>
<td>Internal function generator</td>
<td>Sets wavelength modulation to internal function generator mode.</td>
<td>page 69</td>
<td>page 84</td>
</tr>
<tr>
<td>Modulation frequency</td>
<td>Sets the frequency of the internal function generator. The settable range is from 0.008 Hz to 100 kHz.</td>
<td>page 70</td>
<td>page 85</td>
</tr>
<tr>
<td>Modulation amplitude</td>
<td>Sets the modulation maximum amplitude to between 0 &amp; 1000% when using the internal function generator mode.</td>
<td>page 71</td>
<td>page 86</td>
</tr>
<tr>
<td>Waveform</td>
<td>When set to internal function generator mode, waveform sets the signal type to either sinusoidal or sawtooth.</td>
<td>page 69</td>
<td>page 86</td>
</tr>
<tr>
<td>Signal output</td>
<td>Sets the wavelength+/-pins to output the internal function generator signal.</td>
<td>page 70</td>
<td>page 87</td>
</tr>
<tr>
<td>Wavelength modulation</td>
<td>Toggles all wavelength modulation functionality and settings on or off.</td>
<td>page 71</td>
<td>page 88</td>
</tr>
</tbody>
</table>
Differential input  When configured as an input, the Wavelength+/- interface can be connected to a differential signal with an amplitude up to 2x 5 Vpp as shown in Figure 6.

**Figure 6** Differential input signal for wavelength modulation

[Graph showing differential input signal]

Note: To prevent noise being induced that could create undesired phase noise, it is recommended to disable the wavelength modulation setting when it is not in use.

Single-ended to differential  The circuit shown in Figure 7 is an example of how to generate a differential signal from a single-ended input. In this example, a 5 Vpp single-ended input signal with a 0 V common-mode voltage generates a 2x 5 Vpp differential signal with a 2.5 V common mode voltage.

**Figure 7** Single-ended to differential

Singled-ended input  If a differential signal is not available, a single-ended signal as shown in Figure 8 can be applied to the Wavelength+ input. In this case, connect Wavelength- to
Fast wavelength modulation

2.5 V or GND. A single-ended 5 Vpp signal generates half the modulation compared to a differential 2x5 Vpp input.

**Figure 8** Single-ended input signal with 2.5 V

![Figure 8](image)

**Figure 9** shows the Wavelength- pin connected to the same potential as the common mode voltage of the Wavelength+ signal, the optical output will be modulated around its center wavelength.

**Figure 9** Single-ended input with 2.5 V on an unused branch

![Figure 9](image)
In Figure 11, the Wavelength- signal is connected to GND and the Wavelength+ signal is modulated between 0 and 5 V as shown in Figure 10, the optical output is modulated above its thermally controlled wavelength.

**Figure 10** Single-ended input signal with GND on an unused branch

**Figure 11** Single-ended input connections with 0 V on an unused branch
Fast wavelength modulation

**Differential output**
If the **Wavelength+/-** pins are configured as an output, a differential signal will be present at the pins as shown in **Figure 12**. The differential signal amplitude can be up to 2x 5 Vpp with a common mode voltage of 2.5 V.

**Figure 12** Differential output signal

The differential output signal can be used for example, as the input signal for other Koheras ADJUSTIK lasers.

**Wavelength modulation coupling**
You can select either internal AC or DC coupling of the modulation signal. If AC coupling is chosen, the laser’s high pass filter function has a cut-off frequency of 1.6 Hz. Setting the Koheras ADJUSTIK X15 to DC coupling allows the laser to lock to an external reference signal that for example, uses the Pound Drever Hall technique. In this mode, the laser adjusts its wavelength so the differential error signal level on the **Wavelength+/-** input leans towards 0 V.

**Narrow vs. Wide modulation range**
You can set the wavelength modulation operation to either narrow or wide range. As detailed in **Table 8**, the operation characteristic of each range depends on the laser type (X15 or E15/C15/Y15).

**Table 8** Narrow vs wide band wavelength modulation

<table>
<thead>
<tr>
<th></th>
<th>Koheras ADJUSTIK X15</th>
<th>Koheras ADJUSTIK E15/C15/Y10</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Narrow</strong></td>
<td>Very limited modulation can be obtained, i.e. maximum ~30 MHz. The extremely low phase noise is maintained in this mode.</td>
<td>Maximum 0.8 GHz modulation for E15/C15 and 1 GHz for Y10.</td>
</tr>
<tr>
<td><strong>Wide</strong></td>
<td>Maximum ~600 MHz modulation, but the extremely low phase noise is NOT maintained in this mode.</td>
<td>Maximum 8 GHz modulation for E15/C15 and 10 GHz for Y10. Small negative impact on low frequency phase noise.</td>
</tr>
</tbody>
</table>

**Frequency response**
For X15 lasers, the frequency response of the wavelength modulation feature differs from that of the E15/C15/Y10 lasers. The graphs in **Figure 13** (X15) and...
**Figure 14** (E15/C15/Y10) shows the response when the modulation signal varies from 1 to 100 kHz.

**X15 frequency response**

**Figure 13** shows the measured frequency response of the ADJUSTIK X15 for both wide and narrow ranges:

- **Wide** – 600 MHz tuning at low frequencies with a smooth roll-off to a 3 dB cut-off at 300 Hz.
- **Narrow** – 30 MHz tuning with a slight peak at ~3 kHz.

**Figure 13** ADJUSTIK X15 wavelength modulation response

---

**E15/C15/Y10 frequency response**

**Figure 14** shows the measured frequency response of the ADJUSTIK E15/C15/ Y10 for both wide and narrow ranges:

- **Wide** – E15/C15 – 8 GHz with a 3 dB cut-off at 200 Hz
  Y10 – 10 GHz with a 3 dB cut-off at 200 Hz
Amplitude modulation

If the laser includes the VOA option, the output emission power level can be modulated. The power amplitude can be modulated with either an electrical input signal or the built-in function generator. When the output power is modulated, the maximum level cannot exceed the configured output power setpoint.

Amplitude+/- Signal

The Amplitude+/- pins of the electrical interface are a differential input used for amplitude modulation or power control of the laser.

Unlike the Wavelength+/- pins, the Amplitude+/- pins are input only.

Input signals

- Figure 15 shows a differential signal consisting of two 5 Vpp input signals connected to the Amplitude+/- pins. When the summation of the two signals is 0 V or below, the result is no output power. Output power will increase...
when the summation exceeds 0V and reaches its maximum (the power setpoint) +5 V separation.

**Figure 15** Differential input for amplitude modulation

- Alternatively, **Figure 16** shows the amplitude+/- negative pin connected to ground with the positive branch connected to a signal that varies between 0 V and +5 V.

**Figure 16** Single-ended input for amplitude modulation

---

**External cavity stabilization (ADJUSTIK X15)**

A Koheras ADJUSTIK X15 can be locked to an external cavity to obtain lower low-frequency phase noise by using the Pound-Drever-Hall technique. **Figure 17**
External cavity stabilization (ADJUSTIK X15)

depicts a general layout of the devices in a Pound-Drever-Hall configuration used with an X15 ADJUSTIK.

**Figure 17** ADJUSTIK X15 in Pound-Drever-Hall configuration

Setting up external cavity stabilization

Follow the steps below to configure and enable external cavity locking:

1. Enable external modulation (see “Modulation Source” on page 68).
2. Configure the wavelength modulation input as DC coupled (see “Modulation Coupling” on page 69).
3. Configure the laser to operate in narrow modulation range (see “Modulation Range” on page 70).
4. Turn wavelength modulation on (see “Turning on wavelength modulation” on page 71).
5. Set the update interval (see “Integrating update interval” on page 70).

Once enabled, the laser constantly adjusts its wavelength so that the Pound-Drever-Hall loop results in a 0 V differential applied at the Wavelength+/- input pins.

When using external cavity stabilization, differential input is preferred to achieve the lowest noise performance.
This section describes how to manage and operate the laser and includes the chapters:

- “Communicating with the Laser” on page 53
- “Turning ON the Laser” on page 57
- “Using CONTROL” on page 63
2 Front Panel Menu

Overview

The front panel features an LCD system menu and controls that can be used to configure and operate the laser. The menu items available are listed in Table 9.

Table 9 Front panel menu items

<table>
<thead>
<tr>
<th>Menu Item</th>
<th>Function</th>
<th>See</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top menu</td>
<td>Displays the wavelength, output power and system messages.</td>
<td>Top menu on page 46</td>
</tr>
<tr>
<td>Wavelength</td>
<td>Sets the wavelength as either an absolute or relative value.</td>
<td>Wavelength on page 46</td>
</tr>
<tr>
<td>Wavelength display</td>
<td>Sets the method the wavelength is displayed and configured as either absolute or relative values.</td>
<td>Wavelength display on page 47</td>
</tr>
<tr>
<td>W1 Modulation</td>
<td>Enables external or internal wavelength modulation.</td>
<td>W1 modulation on page 47</td>
</tr>
<tr>
<td>W1 mod. Gain</td>
<td>Gain adjustment for the wavelength modulation signal.</td>
<td>W1 mod. Gain on page 47</td>
</tr>
<tr>
<td>W1. mod. Source</td>
<td>Selects to use either an external or internal signal for wavelength modulation.</td>
<td>W1 mod. source on page 48</td>
</tr>
<tr>
<td>W1. mod. Coupling</td>
<td>Selects either AC or DC coupling to be used with wavelength modulation.</td>
<td>W1 mod. Coupling on page 48</td>
</tr>
<tr>
<td>W1. mod. Range</td>
<td>Selects to use either narrow or wide range for wavelength modulation.</td>
<td>W1 mod. Range on page 48</td>
</tr>
<tr>
<td>Power/current mode</td>
<td>Configures the laser to operate in either power or current mode.</td>
<td>Power /current mode on page 49</td>
</tr>
<tr>
<td>Power</td>
<td>Adjusts the emission output power level.</td>
<td>Power on page 49</td>
</tr>
<tr>
<td>Power unit</td>
<td>Sets the power units displayed and configured in either mW or dBm.</td>
<td>Power unit on page 49</td>
</tr>
<tr>
<td>Watchdog timer</td>
<td>Sets a watchdog timer in seconds to disable emissions if CONTROL communications is lost.</td>
<td>Watchdog timer on page 50</td>
</tr>
<tr>
<td>Display backlight</td>
<td>Adjusts the intensity of the LCD panel light.</td>
<td>Display backlight on page 50</td>
</tr>
<tr>
<td>IP Address</td>
<td>Configures the IP address of the laser.</td>
<td>IP Address on page 50</td>
</tr>
</tbody>
</table>

General operation

Enter button
Press the enter button to perform the following:

- Enter a sub-menu from the top level.
- Confirm selection of a parameter item in a menu when modifying settings.
- Sets the parameter item when modifying settings.

Return button
Press the return button to go back to the parent item or level.

Selection dial
Turn the selection dial left or right to:
• Navigate to sub-menu’s from the top level.

• Adjust parameter values once selected with the enter button.

Emission button - see “Emission button” on page 50
Press this button to:

• Enable laser emission.

• Disable laser emission.

General navigation
When idle, the display panel always returns to the top menu level. To access sub-menu items press the enter button and turn the selection dial until the desired sub-menu appears. Press the return button to exit a sub-menu and return to the top or parent menu.

Modifying parameter values
Press the enter button multiple times to select a digit of a parameter. When the digit is flashing, use the selection dial to modify the value. Press the enter button again to move to another digit of a parameter.

Top menu
The top level menu (Figure 18) displays the emission wavelength (absolute or relative), emission power (dBm or mW) and any operational messages such as for example, an interlock warning. When the front panel controls are idle, the laser reverts to displaying the top menu from the child menus.

Figure 18  Top level menu

Wavelength
Enter the Wavelength menu (Figure 19) to change the center wavelength of the laser emission. You can specify it as an absolute wavelength or specify a relative offset from the nominal wavelength.
Wavelength display  The *Wavelength display* menu (Figure 20) sets the center wavelength to be displayed as either absolute (the actual wavelength) or relative (the offset from the standard wavelength). Changing between absolute and relative with this menu affects both the *Top* menu and *Wavelength* menu.

- **Absolute** – displays the actual wavelength in both the *Top* and *Wavelength* menus.
- **Relative** – displays the relative offset wavelength from the nominal wavelength.

**Figure 20** Wavelength display menu - set as Absolute

W1 modulation  Enter the *W1 modulation* menu to turn ON or OFF the wavelength modulation feature to modulate the wavelength of the laser. (see “Fast wavelength modulation” on page 33)

**Figure 21** Wavelength modulation - ON

W1 mod. Gain  Use the *W1 mod. Gain menu* to adjust the gain of the signal used to modulate the wavelength. Enter the menu and adjust the gain from 0 to 242.5%.
**Figure 22** Wavelength modulation gain setting menu

*W1 mod. source*  The *W1 mod. Source* menu sets the modulation source used for wavelength modulation. The source can be set to either Internal (internal generator) or External (signal applied to the wavelength modulation pins).

*Figure 23* Wavelength modulation source signal set to internal

**W1 mod. Coupling**  Use this menu to set the how to couple the wavelength modulation signal. Enter the *W1 mod. Coupling* menu and set the signal coupling to either AC or DC coupling.

*Figure 24* Wavelength modulation signal coupling set to AC

**W1 mod. Range**  In the *W1 mod. Range* menu (*Figure 25*), you can set the depth of the modulation range to either Narrow or Wide. Refer to “Narrow vs. Wide modulation range” on page 38 for more information on how to set the range.

*Figure 25* Wavelength modulation range set to Narrow
Power /current mode

The Power/current mode menu (Figure 26) sets the operation mode of the laser to either (constant) Power mode or (constant) Current mode. Refer to “Operating mode” on page 25 for further information on setting the mode.

Figure 26  Operation mode set to constant power mode

![Figure 26 Operation mode set to constant power mode](image)

Power

Use the Power menu to tune the level of the laser’s output emission power. The maximum output power level for the Koheras lasers is listed in Table 1.

Figure 27  Power tuning menu

![Figure 27 Power tuning menu](image)

Note: For C15 and Y10 variants the power is fixed and cannot be adjusted.

Power unit

Power can be set and displayed in either milliwatts (mW) or decibel-milliwatts (dBm). Select this menu item and turn the selection dial left or right to set the power units to either mW or dBm.

Figure 28  Power unit menu - set to mW

![Figure 28 Power unit menu - set to mW](image)
**Watchdog timer** Set the watchdog timer to disable the laser automatically if it loses communications with CONTROL executing on a PC. The timeout for the timer can be set between 1 and 255 seconds. Set it to OFF (with the selection dial) to turn off the function.

*Figure 29* Watchdog timer setting

---

**Display backlight** Use the *Display backlight* menu to adjust the back light intensity of the LCD display panel. Enter the menu and turn the selection dial left or right to vary the intensity.

*Figure 30* Setting the intensity level of the LCD panel back light

---

**IP Address** The rear panel of the laser supports a standard 10/100 baseT Ethernet port. Use this menu to set the IP address of the laser.

*Figure 31* IP address setting

---

**Emission button** Press the Emission button to turn laser emission ON and OFF. The Emission LED on the front panel will be ON RED when the laser emission is enabled.

*Warning:* You must follow all safety regulations required for the location where the laser will be operated.

*Warning:* Turning on the laser will emit hazardous laser Class 4 radiation. Ensure to observe and implement all safety regulations, warnings and cautions in this guide and the *Koheras ADJUSTIK Safety, Handling and Regulatory Information* document before continuing.
Caution: Do not turn on the laser if it has been exposed to temperature and humidity beyond the operating specifications. The Koheras ADJUSTIK is designed to operate in a non-condensing environment from +18 to +30°C (or 35°C). Before turning on the laser, allow it at least 30 minutes to reach room temperature. Turning on a laser that is too cold or hot may lead to the system being damaged.

Further ensure the laser is securely installed and connected according to the procedures in “Mechanical Installation” on page 79 and “Connecting the Laser” on page 83. This means the laser should be installed in the recommended environment with power applied and at the very minimum, the door switch interlock connected.
The laser is managed using NKT Photonic’s CONTROL software (GUI) installed on a PC

- Or through the NKT Photonics Software Development Kit (SDK) to integrate with a custom control system.

This chapter focuses on how to obtain and install CONTROL and then setup communications between a PC and the laser using either an USB or Ethernet connection.

**CONTROL software**

The laser is shipped with the NKT Photonics CONTROL software installer on a USB key. You can also download the most recent CONTROL software from the following link:

https://www.nktphotonics.com/lasers-fibers/support/software-drivers/

The CONTROL software is capable of controlling, configuring and monitoring the laser.

**Installing the software**

After downloading the CONTROL installer software onto a PC, double click the installer and follow the built-in wizard. Further details on installing the software is available in Appendix E.

**Connecting the laser to a PC with CONTROL**

Connect the laser to a PC with CONTROL installed on it using either a USB or Ethernet cable. Follow the steps in:

- **Procedure 1** to connect to the laser using a USB cable.
- **Procedure 2** to connect to the laser using an Ethernet cable.

**Procedure 1 Connecting a PC to the laser using a USB cable**

<table>
<thead>
<tr>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
</tbody>
</table>
Connecting the laser to a PC with CONTROL

4 Launch the CONTROL software by either:
   
   - [clicking on Windows – Start – Programs – NKT Photonics – CONTROL](#)
   
   - or –
   
   - double clicking the CONTROL shortcut on the desktop

5 The CONTROL window opens.
   
   Click on the “Connect” button in the upper left region of the window.

6 CONTROL automatically scans for any connect lasers and accessories available on both COM and configured Ethernet ports.

7 The CONTROL and STATUS panels for the laser will open.
   
   If multiple lasers are connected to the PC, click on the ADJUSTIK laser icon from the device selector list to open the CONTROL panels for the desired laser.

**Ethernet connection**

To connect the laser to the PC using Ethernet, the PC and the laser must have their Ethernet ports connected to the same or separate IPv4 subnets. If separate subnets are used they must be accessible to each other. However, to configure the laser’s IPv4 address and port, you must first connect to it using a USB cable directly from a PC using CONTROL.
Procedure 2 Connecting a PC to the laser using Ethernet

**Action**

1. Open CONTROL and from the Connect menu list select Config to open the Port Configuration window.

2. In the Port Configuration window, click on the “Create new port” button.

3. The “Create new network port” window appears. Configure the port parameters as described below:
   - **Name** – Enter a name for the Ethernet connection (e.g. Lab-Laser-2).
   - **Host IP Addr.** – Select a Host IP Address from the drop down list of the computer’s available network adapters.
   - **System IP Addr.** – Enter an IPv4 address for the laser’s network adapter - see IP Address on page 50.
   - **Protocol** – Select either UDP or TCP. UDP is the default and recommended.
   - **Host Port** – Enter a TCP or UDP port the PC will use for communications with the laser. The default value is 10001.
   - **System Port** – Enter a TCP or UDP port the laser will use for communication with the CONTROL PC. The default value is 10001. **Note:** If you connect multiple lasers over IP to the same NKTP CONTROL PC, each laser must be configured with a unique local system port.
   - **Timeout (ms)** – Enter a timeout value in milliseconds. When CONTROL sends a request to the laser, it will wait for a reply from the laser until this timeout value expires. Default value is 100 milliseconds.

4. Click the Save button to save the configuration of the new Ethernet connection.
5 To delete or modify a configured port:
   1. Highlight the port and click the delete button
      - or -
   2. Click the edit button
   3. Click Save when finished.

6 Using a CAT5 or better Ethernet cable, connect the laser’s Ethernet port either directly to a CONTROL PC Ethernet port or to a subnet accessible by the PC.

7 From the Connect drop down menu, click on the Ethernet connection you configured in step 3 to connect CONTROL to the laser.

   Note: If CONTROL cannot access the port configured for the laser, verify that the CONTROL PC has connectivity with the laser by executing a PING test.
4 Turning ON the Laser

Safety

Before you turn ON the laser, ensure that you are completely familiar and follow all safety information and recommendations stated within this document and the document:

Koheras ADJUSTIK Safety, Handling and Regulatory Information

You must follow all safety regulations required at the location where the laser will be operated.

Preparation

The laser is ready to be turned on when the following steps are completed.

1. The laser is securely installed and connected according to the procedures in “Mechanical Installation” on page 79 and “Connecting the Laser” on page 83. This means the laser should be installed in the recommended environment with power applied and at the very minimum the door switch interlock.

2. The laser is connected to a PC through either a USB or Ethernet connection and the PC has CONTROL installed on it and executing according to the procedures in “Communicating with the Laser” on page 53.

3. The FC/APC connector is placed so that any emissions are contained within the working application such as a beam dump that can safely absorb the emitted beam power.

Warning: Turning on the laser will emit hazardous laser Class 3B radiation. Ensure to observe and implement all safety regulations, warnings and cautions in this guide and the Koheras ADJUSTIK Safety, Handling and Regulatory Information document before continuing.

Warning: Ensure the fiber connector face (tip) is clean. Optical power transmitted through the connector may burn particles on the connector face damaging it.

Note: When connecting the output fiber patch cord, ensure to match it with an appropriate fiber type.

Caution: Do not turn on the laser if it has been exposed to temperature and humidity beyond the operating specifications. The laser is designed to operate in a non-condensing environment from +15°C to +60°C. Before turning on the laser, allow it at least 30 minutes to stabilized at the operating room temperature. Turning on a laser that is too cold or hot may lead to the system being damaged.
Enabling and disabling emission

Enable emission (CONTROL)

To turn on the laser using CONTROL follow the steps in Procedure 3.

Note: The laser is equipped with internal temperature sensors that monitor the temperature of sensitive components. If these components are outside their specified temperature range, the laser source will halt emissions.

Procedure 3 Turning on the laser using CONTROL

<table>
<thead>
<tr>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Connect to the laser using the procedures in Communicating with the Laser on page 53.</td>
</tr>
<tr>
<td>2 If Interlock in the status panel is RED and Status is AMBER, check the following:</td>
</tr>
<tr>
<td>1. The door interlock circuit is open – Connecting the safety interlock on page 83</td>
</tr>
<tr>
<td>2. The external bus is not looped back with a bus defeater – Connecting the safety interlock on page 83</td>
</tr>
<tr>
<td>3. The key switch is set to OFF – proceed to step 2.</td>
</tr>
<tr>
<td>3 Turn the key switch on the front panel to the ON position.</td>
</tr>
<tr>
<td>4 To enable emission, click the Emission button once.</td>
</tr>
</tbody>
</table>

The emission indicator (next to the Emission button) turns RED

The Status indicator turns:
- GREEN – the laser is operating normally
- Flashing GREEN – the laser has not reached operating temperature (warming up)
- RED – a system ERROR or interlock opened with emission enabled. (Emission will be disabled.)
Enable emission (front panel)

To turn on the laser using the front panel controls follow the steps in Procedure 3.

Note: The laser is equipped with internal temperature sensors that monitor the temperature of sensitive components. If these components are outside their specified temperature range, the laser source will halt emissions.
**Procedure 4**  Turning on the laser using CONTRO4

**Action**

1. Connect to the laser using the procedures in Communicating with the Laser on page 53.

2. a. If the External bus is in an open circuit state or not terminated with the included bus defeater – the **External interlock** message is displayed.

   To clear it, close all bus connections and place a bus defeater on the last device’s External bus connection in the bus chain.

   **Note** if the laser is operating in standalone mode, place the bus defeater on the External bus connector.

   ![External interlock](image)

   **External bus chain or door interlock circuit open**

   ![Door interlock](image)

   **Door interlock** message – the message is displayed if the door interlock circuit is open. Close the circuit to clear the message.

3. If the **Key switch off** message is displayed – go to step 4.

4. Turn the key switch on the front panel to the **ON** position.

   ![Front panel key switch](image)

   **Front panel key switch is in the OFF position**

5. The **Laser off** message indicates laser emission can be enabled.

   To enable emission, press the emission button on the front panel – see **Figure 2**.

   ![Laser is ready to enable emission](image)
Action

6 Emission ENABLED message – the emission wavelength and power level is displayed.

Emission is ENABLED
Enabling and disabling emission

**Action**

7 *Interlock opened* message – this message will be displayed if there is a break anywhere in the interlock circuit.

Emission will be disabled and the status LED on the front panel will be ON RED.

---

8 **a. Adjust wavelength** – Press the enter button and using the selection dial select the Wavelength setting menu. Once selected use the selection dial and enter button to adjust the wavelength ($\lambda$).

**b. Adjust power** – to modify the output power, use the selection dial and enter button to select the Power menu item. In the menu, use the selection dial and enter button to adjust the power level.

---

9 To disable emission – click the Emission ON/OFF button once and *Laser off* message is displayed on the front panel.
Using CONTROL

CONTROL overview

The CONTROL interface includes multiple panels and a selection of menu drop down items in the upper left corner. Using the Window drop down menu, you can add or remove the displayed panels and panels can be dragged within the main window or into separate windows. The panels and menu shown in Figure 32 are briefly described Table 10 with links to more details descriptions.

Table 10  CONTROL panels and menu items

<table>
<thead>
<tr>
<th>Panel</th>
<th>Function</th>
<th>See</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status Panel</td>
<td>This panel displays the selected device status, emission control and a CONTROL settings menu.</td>
<td>Status panel on page 65</td>
</tr>
<tr>
<td>Menu Items</td>
<td>Four drop down menus with multiple functions.</td>
<td>CONTROL menu items on page 74</td>
</tr>
<tr>
<td>Quick Connect</td>
<td>Provides a button when clicked, scans all available PC ports for connected NKTP products.</td>
<td>Connecting to the laser on page 65</td>
</tr>
<tr>
<td>Control Panel</td>
<td>The control panel provides controls for the laser. For example, It provides configuration controls such as the wavelength and power.</td>
<td>CONTROL – Control panel on page 76</td>
</tr>
<tr>
<td>Application Log</td>
<td>This panel displays a debugging log that can be saved to a file.</td>
<td>Application log on page 75</td>
</tr>
<tr>
<td>Serial Monitor</td>
<td>To also help debugging issues, this panel displays multiple port and device parameters.</td>
<td>Serial monitor on page 74</td>
</tr>
</tbody>
</table>

Figure 32  GUI panel navigation
Relocating panels

The panels displayed by GUI can be dragged to other positions within the main interface or into a separate floating panel. **Procedure 5** describes how to move a panel:

**Procedure 5** Relocating panels

<table>
<thead>
<tr>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Left click hold the top title bar of a panel.</td>
</tr>
<tr>
<td>2. While holding the left mouse button down, drag the panel to another position in the main window.</td>
</tr>
<tr>
<td>3. When the background turns blue in a new GUI position, release the mouse button to place the panel. (see Figure 33)</td>
</tr>
<tr>
<td>4. Alternatively, drag the panel outside the main window and release the mouse button. A separate window for the panel will be created. (see Figure 34)</td>
</tr>
</tbody>
</table>

**Figure 33** Panel dragged to a new location in the main window -

**Figure 34** Panels dragged outside the main window
**Toggling panels**

Use the Menu > Window drop down menu to check and uncheck panels to be displayed. A blue check mark indicates the panel is displayed.

*Figure 35* Panels dragged outside the main window

![Figure 35 Panels dragged outside the main window](image)

**Note:** Clicking the X in the upper right corner of any panel will also close it.

**Connecting to the laser**

When CONTROL is launched, the Welcome panel is displayed as in *Figure 36*. In the menu bar, click the ‘Connect’ drop down menu and then click on the COM port your laser is using to connect the PC to the laser. The Control and Status panels will be displayed when the laser connects to the GUI.

See “Connecting the laser to a PC with CONTROL” on page 53

*Figure 36* Welcome screen and connecting

![Figure 36 Welcome screen and connecting](image)

---

**Status panel**

The Status Panel provides status indicators, error messages, emission control function and a settings drop down menu.
Status indicators  The panel displays the following indicators:

Interlock  Indicates if power is connected to the laser.

- ON Green – Interlock circuit closed
- ON Red – Interlock circuit open

Status  Indicates the laser thermalization and operation capability:

- ON Green – The laser has reached the set point temperature and has stabilized.
- ON Amber – The laser is in the process of warming up or an error is detected.
**System info**  The System Info section shows the following:

- Laser serial number
- Laser firmware version

**Measurements**  Displays the system temperature.

**WL mod button and indicator**

**Button**  The WL mod button turns the wavelength modulation ON or OFF.

**Indicator**

GREEN – wavelength modulation is ON.
GREY – wavelength modulation is OFF.

**Note:** The WL mod button and indicator is only displayed by CONTROL if the wavelength modulation feature is included with the laser.

**Emission button**  The Emission button turns the laser emission ON. See “Enabling and disabling emission” on page 58.

The button indicator will turn ON RED when any laser emissions are generated. Otherwise, it will be OFF GREY.

**Warning:** Class 3B laser emissions will be emitted when the Emission button LED is ON RED.

**CONTROL settings**

The GUI settings are accessible by clicking the gear icon 🛠️ in the upper right corner of the Status panel. Clicking the gear icon displays a menu of setting items as shown in Figure 38:
The wavelength of the laser can be modulated using either the laser's internal function generator or an external signal. From the Settings (gear) drop-down menu select **Wavelength modulation**. Depending on the modulation source selected, Figure 39 to Figure 40 show the **Wavelength modulation** menus. Within these menus you can configure multiple parameters that affect the modulation functionality.

**Note:** The **Settings - Wavelength modulation** menu item is only available if the laser includes the wavelength modulation feature.

**Modulation Source**

The source signal used to modulate the wavelength is selectable. Click on the **Source** drop-down menu to select one of three source modes:

- **Internal** (Figure 39) – wavelength is modulated using the laser’s internal function generator
- **External** (Figure 40) – wavelength is modulated by connecting an external signal to the Wavelength+- pins.

You can connect an external signal to either the ADJUSTIK interface board connectors as described in “Connecting modulation signals” on page 85 or directly to the main electrical interface pins. The pin assignments are described in Table 18 on page 97. For information regarding example signal generation circuits, refer to section “Fast wavelength modulation” on page 33.
Modulation Type (internal mode)
If the Modulation source is set to Internal, you can set the signal waveform type that is generated internally. Click the Type drop-down menu arrow and select either Sinusoidal, Triangle, Sawtooth or an Inverse sawtooth waveform.

Modulation Coupling
You can select to couple the modulation signal using either AC or DC coupling. Click on the Coupling drop-down menu arrow and select either AC or DC coupling. Refer to “Wavelength modulation coupling” on page 38 for further information.

Note: When using wavelength modulation with an X15 laser, and the Modulation range parameter is set to Narrow, the modulation signal will be AC-coupled and the DC-component enters a software integrating function that tunes the wave-
length up or down when the DC-voltage varies either positive or negative respectively. The speed of wavelength tuning is set with the Integrating update interval.

**Modulation Range**
For X15 lasers, you can use the Modulation Range drop-down menu to set the modulation range to either narrow or wide.

When set to “Narrow”, modulation depth is limited but the X15’s low phase noise is maintained. To increase the modulation depth, change the range setting to “Wide”. When the modulation range is set to “Wide”, phase noise will increase.

*Note:* Refer to “Narrow vs. Wide modulation range” on page 38 for further information on configuring the modulation range.

**Signal output**
You can output the internal generator signal (internal modulation) from the wavelength modulation pins of the laser. To output the signal from the pins, set the Modulation type to “Internal” and the Signal output selector to Enabled. To disable the signal output, set the Signal output drop-down menu to “Disabled”.

When multiple lasers are used, one laser can be used as a master signal generator with the other lasers configured as slaves.

1. For all the lasers, connect the Wavelength+ pins together and the Wavelength- pins together.
2. Designate one laser as the master by setting it to operate in “Internal” modulation mode with the Signal output setting Enabled.
3. All other laser’s will operate in slave mode by setting them to operate in “External” modulation mode.

**Integrating update interval**
You can set the update interval of the software integration function with this setting. The setting is intended for use with X15 lasers when they are set to DC coupling and Narrow modulation range.

**Internal generator Frequency**
When the modulation source is set to Internal, the frequency of the internal generator signal can be adjusted to between 8 MHz (0.008 Hz) and 100 kHz (100,000 Hz). To adjust the frequency, use either the slider or the direct input field in the upper right corner of the slider.

**Narrow and Wide modulation gain**
You can use this slider to increase the gain of an external modulation signal input applied to the Wavelength+/- pins. Increasing the gain will directly increase the wavelength modulation achievable with the signal.
Internal generator power Level
You can set the output power level of the internal function generator to between 0 and 100%. Use the slider or the field in the upper right corner of the Level slider to adjust the modulation level.

Internal generator Offset
The offset of the internal modulation signal can be adjusted between -100 and +100% dependent on the modulation level. For example, if the modulation level is set to 40%, the offset can be adjusted between -60 and +60%. The sum of modulation level and the absolute offset can be a maximum of 100%.

Integrating Update Interval
The integrating update interval sets the update interval for a software integrating function. The function is only available on X15 systems with Coupling configured as DC and Range set to Narrow.

Turning on wavelength modulation
To enable wavelength modulation, in the status panel lower right click the WL mod button. The indicator next to the button turns ON green. Clicking the button again once turns off the feature.

Power/Current mode
The laser output controls can be set to either Power or Current mode as described in “Operating mode” on page 25. Click the menu item shown in Figure 43 to toggle the mode. The Control panel will automatically switch to the controls for the new mode.
Ethernet  System IP Address
The System IP address is used for manual setup of the IP address for the Koheras ADJUSTIK system. Please notice that the IP address for the Koheras ADJUSTIK should be on the same sub-net as the computer that should control the Koheras ADJUSTIK.

System Port
The System port defines what port number the Koheras ADJUSTIK system should use for reception of telegrams. This port number should match the Remote Port setting in Ethernet Connections. Default setting is 10001.

Host IP Address
The Koheras ADJUSTIK can be configured so it only accept telegrams from a defined IP address. Use the Host IP address field to define what IP address the Koheras ADJUSTIK should be responsive to. If the Host IP address is set to 000.000.000.000 (default setting) the Koheras ADJUSTIK will be responsive for all IP addresses on the Ethernet network.

Host Port
The Host port defines what port the Koheras ADJUSTIK frame should use for transmission of telegrams to the computer. If the Computer port is set to 0, this means that the Koheras ADJUSTIK will use the same port for transmission as for reception (i.e. as configured under ADJUSTIK port). Default setting is 0. If Local port in Ethernet Connections is configured different than the Remote port, the Computer port should match the Remote port.

MAC Address
The MAC address for the Koheras ADJUSTIK frame is shown in the bottom of the Ethernet settings. The MAC address is not configurable but unique for every product.

Figure 44  Ethernet setting

Watchdog
The Koheras ADJUSTIK features a watchdog for monitoring of USB or Ethernet communication. If CONTROL is disconnected from the chassis, the watchdog disables emission after its timeout expires.
Enable Watchdog
To turn the watchdog on, select ON from the drop-down menu next to Enable watchdog. To turn the watchdog off, select OFF.

Watchdog timeout
When CONTROL communications is disconnected, the Watchdog timer starts. When it reaches the Watchdog timeout setting, emission is disabled. The Watchdog feature must be set to ON.

*Figure 45* Watchdog setting

Clock  Within the Clock setting menu the system date and time can be read or set automatically by updating the settings from a connected PC.

Date
Displays the system date in the format DD/MM/YYYY.

Time
Displays the system time in 24 hour format: HH:MM:SS.

Set to computer clock
Click the Set button to updated the system time and date from a connected PC’s current time and date setting.

*Figure 46* Clock setting
View  Check the System info box to display the laser serial number, firmware release number or system temperature within the status panel.

*Figure 47* View setting

<table>
<thead>
<tr>
<th>Settings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>View</strong></td>
</tr>
<tr>
<td>└── System info</td>
</tr>
<tr>
<td>└── Measurements</td>
</tr>
</tbody>
</table>

**User text:**

**ADJUSTIK**

---

**CONTROL menu items**

There are four drop down menus in the main control window as highlighted in *Figure 48*. Click on the items in the menu to reveal the drop down menus.

*Figure 48* Menu items

<table>
<thead>
<tr>
<th>Menu Item</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>File</strong></td>
<td>Exits the GUI program</td>
</tr>
<tr>
<td><strong>Connect / Disconnect</strong></td>
<td>Disconnects the currently connected device from GUI.</td>
</tr>
<tr>
<td><strong>Window</strong></td>
<td>Selects whether or not to display the Application Log and the serial monitor.</td>
</tr>
<tr>
<td><strong>Help</strong></td>
<td>Displays the current version of GUI and provides access to the included GUI user help.</td>
</tr>
</tbody>
</table>

**Serial monitor**  You can view the real time RS-232 serial communication messaging to and from the laser using this panel. The panel can be used for:

- Debugging communication with the laser.
- Issuing CLI commands to the laser using the command input field.
CONTROL menu items

The panel is enabled by placing a check mark on the Window pull down menu next to the Serial Monitor item.

To close the panel click on the upper right corner “X”.

Application log

In addition to the Serial Monitor, the Application Log panel is used for debugging serial communications. The panel displays time stamps for both COM port open and close times and also general status information. You can clear, save and print the log data using the buttons in the upper left corner.

The panel is enabled by placing a check mark on the Window pull down menu next to the Application Log item.

To close the panel click on the upper right corner “X”.

Figure 49 Serial monitor

Figure 50 Serial Monitor
CONTROL – Control panel

For the Koheras ADJUSTIK the control panel can be configured to present different operating mode controls for either Power or Current mode. The modes are selected by clicking on the Settings drop down menu (gear icon) in the status panel. See “CONTROL settings” on page 67.

**Power mode**  In the Power operating mode the optical output power level is used to control the laser’s output. The panel provides both a wavelength offset control in picometers and output power control that can be scaled in either mW or dBm.

**Current mode**  In the Current operating mode the current in the fiber pump is kept at a constant level. Only the wavelength offset control is available in the control panel menu.

*Note:* For C15 and Y10 variants the power is fixed and cannot be adjusted. For these module variants, a power slider control is unavailable.
SECTION 3

INSTALLING THE LASER

This section describes how to install the laser and includes the chapters:

- “Mechanical Installation” on page 79
- “Connecting the Laser” on page 83
6 Mechanical Installation

The laser chassis is designed to be installed on a flat surface or rack-mounted in a standard 19 inch rack. This section describes how to mount the laser module to ensure optimal function and ensure that heat generated by the laser is adequately dissipated.

General

All chassis types must be installed on a level surface or rack that is free from vibrations. The ambient temperature surrounding the laser should be stable and free from any sources that could cause temperature fluctuations. Temperature changes and vibrations may affect the laser’s operation and result in abnormal operation.

**Caution:** For reliable operation, the laser should not be exposed to corrosive agents or excessive moisture, heat sources or dust.

Heat dissipation

The heat generating components within the laser are thermally connected to a large heat sink mounted on the rear panel. Ensure that the installation space supports adequate airflow in the vicinity of the rear panel heat sink.

*Figure 52* Rear panel heat sink

Rack mounting the laser

The laser can be mounted in a standard 19 inch rack using rack mounting screws and cage nuts. *Figure 53* shows the laser’s flange on the right side being affixed to a standard rack. You can use the finger grips on the flange to help balance the laser when you are mounting it in a rack. Once mounted in a rack, it is important
Placing the laser on a table or shelf

that there is adequate airflow at the rear of the laser so that the cooling fins can effectively dissipate the heat generated by the laser.

To avoid injury and damage, NKTP recommends that when rack mounting the Koheras ADJUSTIK two persons are present. One person can position the laser while the other fastens it to the rack.

Figure 53 Image of the laser rack mounted

Rack mounting flange with finger grips

x4

Placing the laser on a table or shelf

For installations where the laser is placed on a level surface, the laser is equipped with four (4) rubber feet on its bottom panel (Figure 54). Be sure to include adequate space at the rear of the laser so that the cooling fins can effectively dissipate the heat generated by the laser. Additionally the surface should be free from vibrations and any source that could cause temperature variations. Figure 55 shows the laser placed on a solid table-top with no nearby heat sources and with adequate free-space for the cooling fins.
Figure 54 Rubber mounting feet

Figure 55 Table or shelf mounting

Operating and storage environment

Appendix A details the required ambient operating and storage environment specifications.

**Warning:** The Koheras ADJUSTIK is a Class 3B laser product and its operation facility and conditions must comply with the standards listed below or similar:

- CFR21 1040.10 & Laser Notice LN50
- IEC / EN 60825-1
Placing the laser on a table or shelf
Connecting the Laser

Before operating the laser, follow the procedures in this chapter to ensure its correct and safe operation.

For information on how to connect:

- **The Safety Interlock** – see “Connecting the safety interlock” on page 83
- **Power** – see “Connecting power” on page 85
- **Modulation signal inputs and outputs** – see “Connecting modulation signals” on page 85
- **The Optical Output** – see “Connecting modulation signals” on page 85
- **Trigger** – see “Connecting modulation signals” on page 85

Connecting the safety interlock

To comply with safety regulations and help provide a safe operating environment, the safety interlock of the laser must be connected to a switch activated by an access door to the laser’s enclosure. When the connected switch is opened by the door, it opens the interlock circuit which turns off laser emissions.

**Interlock operation**

Laser emission can be enabled when the connected interlock circuits are closed. There are two circuits: one circuit is connected through a door switch.

Figure 56 Interlock connected to a door switch - Laser ON

When either the door switch or the external bus circuit opens (see Figure 57) the circuit, the laser’s electronic logic detects this and shuts down the laser.
Connecting the safety interlock

**Figure 57** Interlock connected to a door switch - Laser SHUTDOWN

![Diagram of interlock system](image)

**Caution:** Do not short-circuit the Interlock input. Short-circuiting the interlock circumvents safety regulations and NKT Photonics does not take liability for any injuries or damage caused by doing so.

**Caution:** The switch connected to the interlock must be of an approved type. Further, the switch must be installed in a manner so that its operation cannot be fixed in the open state using a tool.

**Warning:** If the interlock is bypassed using an interlock defeater, personnel may be exposed to hazardous laser radiation. To reduce the risk to personnel, the person or group responsible for operation of the equipment must undertake a risk assessment and provide personnel with appropriate personal protective equipment and safety training.

**Connecting an interlock switch**

Follow the steps in Procedure 6 to connect a safety door switch to the interlock circuit of the laser.

**Procedure 6** Connecting the door interlock circuit

<table>
<thead>
<tr>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
</tbody>
</table>
| 3 | Perform a continuity test using a multimeter:  
  • First connect the multimeter leads to the interlock plug terminals.  
  • Confirm when the enclosure door is closed, the meter shows the circuit as closed.  
  • Confirm when the enclosure door opens, the meter shows the circuit as open. |
| 4 | Insert the LEMO connector into the LEMO interlock connector on the rear panel of the laser. |

**Bus defeater**

A bus defeater must be placed on the last device in the External bus chain topology. In Figure 56 the bus defeater is placed on the bus output connector of a connected accessory.
Connecting power

The External bus includes an extension of the interlock circuit. The defeater plug loops the circuit at the last External bus connector in the system with no other devices attached to the bus chain. If no defeater is used, the interlock circuit will be open and disable the laser in the chassis in the same manner as the door switch opening. The defeater is included with the ADJUSTIK, it is a standard male DB-15 connector with the necessary pins looped back – see Table 12 on page 79.

Connecting power

Power is supplied to the laser through the rear AC input connector. The connector is a standard C-14 type designed for use with an AC power cord that is fitted with a C-13 connector. Electrical and cable specifications are listed in Table 11.

Table 11 Power specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC Mains Input</td>
<td>100-240 VAC @ 50-60 Hz</td>
</tr>
<tr>
<td>Power cord</td>
<td>The power cord must be capable to safely transmit the laser’s specified AC ratings while maintaining a safe connection with the local AC mains outlets. The power cord used must follow local or national regulations.</td>
</tr>
<tr>
<td>AC connector (inlet)</td>
<td>IEC 60320 – C14</td>
</tr>
<tr>
<td>Power cord connector</td>
<td>The power cord must have an IEC 60320 C-13 connector.</td>
</tr>
</tbody>
</table>

Connecting modulation signals

Input and output wavelength modulation signals are described in chapter 2: “Modulation”. The signals are connected to the DB-9 pin connector on th rear panel, see “Modulation input/output” on page 97.

Connecting the trigger input or output

The laser includes a trigger logic input/output signal as part of the Modulation connector (see Table 18). The trigger signal can be used to either initiate or indicate laser emission.

Input trigger When set as an input a positive active high signal must be applied to the trigger pin to initiate emission. The diagram Figure 58 shows the trigger input.
Output trigger  When the trigger feature is set as an output, the trigger pin should be connected to an external pull-up resistor. The diagram Figure 58 shows the trigger output circuit.

Figure 58  Trigger input circuit

![Trigger Input Circuit Diagram]

The high and low voltage levels are defined by the following equations:

\[
\begin{align*}
V_{\text{high}} &= V_{\text{external}} \\
V_{\text{low}} &= V_{\text{external}} \times \frac{22k}{22k + R}
\end{align*}
\]

Connecting the optical output

Before connecting the optical output connector, ensure to check the connector tip using a fiber microscope. Using the microscope, check for any deformities, damage, residue or other contaminants at the optical tip of the connector. Either
clean the connector or contact NKT Photonics support if replacement is necessary.
Connecting the optical output
The appendices include:

- Appendix A on page 91: Specifications
- Appendix B on page 95: Service and Support
- Appendix C on page 97: Interface Pin Assignments
- Appendix D on page 99: CONTROL Installation
## Specifications

### Table 12 Optical

<table>
<thead>
<tr>
<th></th>
<th>X15</th>
<th>E15</th>
<th>C15</th>
<th>Y10</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Laser Emission</strong></td>
<td>CW - inherently single frequency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Beam Quality (M2)</strong></td>
<td>&lt; 1.05</td>
<td>&lt; 1.05</td>
<td>&lt; 1.05</td>
<td>&lt; 1.05</td>
</tr>
<tr>
<td><strong>Linewidth (kHz)</strong></td>
<td>&lt; 0.1</td>
<td>&lt; 0.1</td>
<td>&lt; 15</td>
<td>&lt; 20</td>
</tr>
<tr>
<td><strong>Max. Phase Noise [dB(μrad/√Hz)/m]</strong></td>
<td>-110 @ 1 Hz</td>
<td>-90 @ 10 Hz</td>
<td>-69 @ 10 Hz</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-125 @ 10 Hz</td>
<td>-110 @ 100 Hz</td>
<td>-89 @ 100 Hz</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-128 @ 1 kHz</td>
<td>-130 @ 20 kHz</td>
<td>-109 @ 20 kHz</td>
<td>-</td>
</tr>
<tr>
<td><strong>Max phase-noise [μrad/√Hz]/m</strong></td>
<td>3.1 @ 1 Hz</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>0.6 @ 10 Hz</td>
<td>32 @ 10 Hz</td>
<td>355 @ 10 Hz</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>0.3 @ 100 Hz</td>
<td>3.2 @ 100 Hz</td>
<td>36 @ 100 Hz</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>0.4 @ 1 kHz</td>
<td>0.3 @ 20 kHz</td>
<td>3.5 @ 20 kHz</td>
<td>-</td>
</tr>
<tr>
<td><strong>Peak RIN (MHz)</strong></td>
<td>~ 0.7</td>
<td>~ 0.7</td>
<td>~ 1.0</td>
<td>~ 1.5</td>
</tr>
<tr>
<td><strong>RIN level @ Peak / 10 MHz (dBc/Hz)</strong></td>
<td>&lt; -100 / &lt; -135</td>
<td>&lt; 100 / &lt; -135</td>
<td>&lt; -120 / &lt; -140</td>
<td>&lt; -105 / &lt; -140</td>
</tr>
<tr>
<td><strong>Optical S/N (50 pm res.) (dB)</strong></td>
<td>&gt; 50 (typ. &gt; 55)</td>
<td>&gt; 50 (typ. &gt; 55)</td>
<td>&gt; 65 (typ. &gt; 70)</td>
<td>&gt; 65 (typ. &gt; 70)</td>
</tr>
<tr>
<td><strong>Min. Thermal Tuning Wavelength Tuning Range (pm)</strong></td>
<td>+/- 125</td>
<td>+/- 350</td>
<td>+/- 350</td>
<td>+/- 240</td>
</tr>
<tr>
<td><strong>Total thermal tuning range [pm]</strong></td>
<td>350</td>
<td>1000</td>
<td>1000</td>
<td>680</td>
</tr>
<tr>
<td><strong>Fast Wavelength Modulation range (GHz)</strong></td>
<td>0.6</td>
<td>8</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td><strong>Fast Wavelength Modulation (KHz)</strong></td>
<td>up to 20</td>
<td>up to 20</td>
<td>up to 20</td>
<td>up to 20</td>
</tr>
<tr>
<td><strong>PM Output</strong> - PER (dB)</td>
<td>&gt; 23</td>
<td>&gt; 23</td>
<td>&gt; 23</td>
<td>&gt; 23</td>
</tr>
</tbody>
</table>

1. Lorenzian
2. Relative to the center wavelength at room temperature. If the laser case temperature is outside the range of approximately 10-50 °C, the range of detuning from the center wavelength may be reduced.
3. For the E15 variant, PM is optional.

### Table 13 Mechanical dimensions

<table>
<thead>
<tr>
<th>All chassis models</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Size (H x W x D)</strong></td>
<td>48.5 x 483 x 386 mm (1.91 x 19.02 x 15.20 in)</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>&lt; 7 kg (&lt; 15.4 lb)</td>
</tr>
</tbody>
</table>

### Table 14 Operating and storage environment

<table>
<thead>
<tr>
<th>All Chassis Models</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Operating Temperature</strong></td>
<td>15°C to 55°C (59°F to 131°F)</td>
</tr>
<tr>
<td><strong>Storage Temperature</strong></td>
<td>-20°C to 60°C (-4°F to 140°F)</td>
</tr>
<tr>
<td><strong>Operating Humidity (non-condensing)</strong></td>
<td>0 to 70%</td>
</tr>
</tbody>
</table>
### Table 15  Electrical

<table>
<thead>
<tr>
<th>All Chassis Models</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supply Voltage</strong></td>
<td>100 – 240 VAC@ 50-60 Hz</td>
</tr>
</tbody>
</table>

### Table 16  Safety and regulatory compliances

<table>
<thead>
<tr>
<th>Safety</th>
<th>Regulatory</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN 60825-1:2014: Safety of laser products</td>
<td>EN 61326-1:2013: Electrical equipment for measurement, control and laboratory use</td>
</tr>
<tr>
<td>Part 1: Equipment classification and requirements</td>
<td></td>
</tr>
<tr>
<td>[Laser Class 4]</td>
<td>EMC requirements – Part 1: General requirements</td>
</tr>
<tr>
<td>EN 61010-1:2010:Safety requirements for electrical equipment for measurement, control, and laboratory use</td>
<td>2004/108/EC Electromagnetic Compatibility</td>
</tr>
<tr>
<td>Part 1: General requirements</td>
<td>2011/65/EC Restriction of the use of certain Hazardous Substances in electrical and electronic equipment (RoHS)</td>
</tr>
</tbody>
</table>
Table 17 Mechanical dimensions
Servicing the laser

The laser have no user serviceable components. In case of malfunction, contact NKT Photonics using the support channels in section “Support contact details”.

**Caution:** Do not open the laser’s modules. The laser modules are equipped with warranty labels (see Figure 60) on the covers of the laser chassis. The warranty is void if the system is opened.

*Figure 60  Warranty seal*

**Caution:** The laser contains electro-static discharge (ESD) sensitive components. To avoid permanent ESD damage, use ESD protection precautions when handling the laser. Always connect the laser’s earth point to a ground earth within your facility.

**Opening the laser chassis**

There are no user serviceable components inside the laser chassis. Should your laser malfunction, and it cannot be serviced on site, it must be shipped to the NKT Photonics office in Birkeroed, Denmark.

**WARRANTY VOID IF REMOVED Label**

The unit is sealed with a label “WARRANTY VOID IF REMOVED”. It is strictly prohibited to remove the chassis cover.
Support contact details

For technical or general support, NKT Photonics can be contacted for help regarding issues and questions with your laser or its accessories.

Support Email  support@nktphotonics.com

Online support  http://www.nktphotonics.com (click on support)

Shipping address  NKT Photonics A/S
                     Blokken 84
                     DK-3460 Birkerød
                     Denmark
Interface Pin Assignments

Modulation input/output

The Modulation input/output interface on the laser is a 9 pin male DB-9 connector. The pin assignments are described in Table 18.

Table 18  Modulation connector pin assignment

<table>
<thead>
<tr>
<th>Pin #</th>
<th>Signal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Trigger</td>
<td>Logic input/output for either control or indication of laser emission. Active high. See Trigger for more information.</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>0 volt ground</td>
</tr>
<tr>
<td>3</td>
<td>Amplitude-</td>
<td>Negative branch of differential input/output for amplitude modulation.</td>
</tr>
<tr>
<td>4</td>
<td>AGND</td>
<td>0 volt analog ground for modulation signals</td>
</tr>
<tr>
<td>5</td>
<td>Wavelength-</td>
<td>Negative branch of differential input/output for wavelength modulation.</td>
</tr>
<tr>
<td>6</td>
<td>GND</td>
<td>0 volt ground</td>
</tr>
<tr>
<td>7</td>
<td>Amplitude+</td>
<td>Positive branch of differential input/output for amplitude modulation.</td>
</tr>
<tr>
<td>8</td>
<td>AGND</td>
<td>0 volt analog ground for modulation signals</td>
</tr>
<tr>
<td>9</td>
<td>Wavelength+</td>
<td>Positive branch of differential input/output for wavelength modulation.</td>
</tr>
<tr>
<td>10</td>
<td>RS485-</td>
<td>The negative/inverted link of the RS485 communication signal.</td>
</tr>
<tr>
<td>11</td>
<td>Not in use</td>
<td>For future use, do not connect anything to this pin.</td>
</tr>
</tbody>
</table>

External bus

The External bus connector on the rear panel of the laser is a female DB-15 connector. The pin assignments are described in Table 19.

Table 19  External bus pin assignment

<table>
<thead>
<tr>
<th>Pin #</th>
<th>Signal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NC</td>
<td>Not connected</td>
</tr>
<tr>
<td>2</td>
<td>RS485-</td>
<td>The negative/inverted link of the RS485 communication signal.</td>
</tr>
<tr>
<td>3</td>
<td>Interlock loop+</td>
<td>Positive connection of the interlock loop. Must be connected to Interlock loop- (pin no. 4) to enable laser emission from the system.</td>
</tr>
<tr>
<td>4</td>
<td>Interlock loop-</td>
<td>Negative connection of the interlock loop. Must be connected to Interlock loop+ (pin no. 3) to enable laser emission from the system.</td>
</tr>
<tr>
<td>5</td>
<td>Emission</td>
<td>Collector output with an internal 270 Ω resistor in series. Outputs a logic high when the Koheras ADJUSTIK system has laser emission ON. To indicate emission with an LED, its anode can be connected directly to this pin and its cathode connected to the GND (pins 5,6, 13 or 14).</td>
</tr>
<tr>
<td>10</td>
<td>RS485+</td>
<td>The positive/non-inverted link of the RS485 communication signal.</td>
</tr>
<tr>
<td>11</td>
<td>Not in use</td>
<td>For future use, do not connect anything to this pin.</td>
</tr>
</tbody>
</table>
### External bus

<table>
<thead>
<tr>
<th>Pin #</th>
<th>Signal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Interlock Logic Output</td>
<td>Outputs a logic high (5V) when the interlock circuit is closed and has been reset. This signal can be used to control safety related precautions on the External Bus.</td>
</tr>
<tr>
<td>5,6,13,14</td>
<td>GND</td>
<td>0 volt ground.</td>
</tr>
<tr>
<td>7,8,15</td>
<td>+12 V</td>
<td>12 volt supply voltage for external accessories. Maximum 4 A in total.</td>
</tr>
</tbody>
</table>
Installing CONTROL

Download the software from:

https://www.nktphotonics.com/lasers-fibers/support/software-drivers/

Follow the steps in Procedure 7.

**Procedure 7 Installing CONTROL**

<table>
<thead>
<tr>
<th>Action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>On the PC, launch the installer package and then click the Run button.</td>
</tr>
<tr>
<td>2</td>
<td>The installation wizard appears. Click Next to continue.</td>
</tr>
</tbody>
</table>
3. Accept to use the default installation directory or select another directory by clicking the Browse button.

   Click Next to continue.

4. Uncheck the components you do not require. By default, all components will be installed.

   Click Next to continue.

5. Read the End-User License Agreement, and select: “I accept the license.”.

   Selecting: “I do not accept the license” will end the installation wizard.

   Click Next to continue.
6 The wizard will create a start menu folder with program short-cuts. Use the default name or enter a new name for the folder. Click Next to continue.

7 Check the box to create a desktop shortcut to access Control. Click Next to continue.

8 Check the Silicon Labs driver installation (recommended) and click Next.
9. Click Install to install NKTP Control software on your PC. Click Cancel if you want to abort the installation.

10. The wizard displays a progress meter for the installation. **Note:** a normal install should only take a few seconds.

11. Click Next to install the UART drivers for the PC USB port.

12. Read the End-User License Agreement, and select “I accept this agreement”. Selecting “I don’t accept this agreement” will abort the driver installation. Otherwise, check the agreement accept button and click Next to install the driver.
Installing CONTROL

13 The drivers will be installed.

14 The Silicon Labs drivers is installed successfully.

   Click Finish to end the installation wizard.

15 CONTROL is now installed.

   Check the Run box to launch CONTROL when the Finish button is clicked.

   Click Finish.