HyperRapid NXT / HyperRapid NX
Industrial picosecond Laser System

Pre-Installation-Guide
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This Pre-Installation-Guide replaces all previous versions.
Pre-Installation Guide

Introduction

Thank you very much for your interest in our product. This document is intended for customers who decided (or are in the process) to purchase a HyperRapid NXT / HyperRapid NX picosecond industrial laser-system by Coherent Kaiserslautern GmbH.

Coherent reserves the right to change this information or perform technical modifications without notice. Furthermore we cannot guarantee the accuracy of information given in this document. Coherent Kaiserslautern GmbH will not take any responsibility for inappropriate preparation due to wrong or misunderstood information.

In order to prepare the customer site for installation, the Pre-Installation Guide includes information regarding positioning, connections and system start-up requirements. It is recommended to have the customer site prepared prior to receiving the laser shipment, so that the customer can have a "plug-and-play" installation of the laser system. The individual needs and expectations for each customer may require additional information or preparation. Contact Coherent if more information is needed.

The Pre-Installation guide (this document) can be found in https://www.coherent.com/support/main/manuals- and- guides . For further information refer to the Operator's Manual.

Datasheet and GUI of the HyperRapid NXT / NX can be found in https://www.coherent.com/lasers/laser/hyper-rapid-nx.
The SMC chiller manual (HRS024-A-20 / HRS024-W-20) can be found in https://www.smcusa.com/help-support/instruction-manuals/temperature-control/.

The Operator's Manual of the laser system can be found in the envelope included in delivery (blue Coherent USB-stick). Alternatively open the About tab in the GUI and click on Laser Operator's Manual.

If you do not use the GUI, open the terminal and enter:

```
?IP    returns the IP-address of the connected laser
?MANUAL returns: checksum and operator's manual-name
```

Open a Web-browser (e.g. Internet Explorer) or the Windows Explorer and enter: "http://"IP-address of the connected laser system (result of ?IP) the operator's manual-name (result of ?MANUAL without checksum.) Make sure to copy the exact syntax of the file-name. IP address and name separated by "/":

http://IP-address/HNXT_HRNX_eng_1307716_REV.pdf

**NOTICE!**
The Operator's Manual can be found on the USB-stick (included in delivery), in the GUI, via command (when connected to the laser system) or alternatively it can be provided by your Sales-representative.

The Certificate of Conformity (CoC) contains important system-individual technical information and final measurements. It is included in the system delivery box, located in the DIN A4 documentation envelope (printed on paper). Make sure to provide this document during installation as well as operation. The Operator's manual refers to certain parameters listed in the CoC. A number of parameters are system-individual and should be available for changing the pulse-mode, activating PulseEQ (if ordered), max. selectable pulse-repeption-rate, etc.
NOTICE!
The CoC is the final report indicating technical information and measurements. The content is important during installation as well as operation. Make sure to have this document available near the system-controlling computer.

**Hardware Simulator**

The HyperRapid NXT / HyperRapid NX simulator software is an external program (running in Microsoft Windows) which emulates some parts of the system-hardware. The behavior of the simulator is quite realistic with certain restrictions (such as safety features, etc.). The simulator can be connected via Ethernet to the Coherent GUI, terminal or customer software. A connection via RS–232 or USB cannot be simulated.

**Purpose of the Simulator**

The simulator is meant mainly for new customers / integrators, who are not yet familiar with the system-features or would like to develop a customer-individual system-controlling software. Another benefit of the simulation might be the possibility to enhance an existing customer-software without using a real laser-system. The development might be requested to start prior to laser-system arrival or without occupying a tool necessary for production.

**NOTICE!**

Contact Coherent Kaiserslautern GmbH Service to receive the hardware simulator program (D167940) and instruction (D168340).

**Software Commands List**

This chapter can be found in the external commands-list document.

**For further information please refer to the external commands-list document.**
**Ambient condition**

The ambient conditions must be observed during storage, transport, installation and operation of the laser system. Ensure reasonable transport conditions, free of major shocks, jolt or fall. Protect the whole system against frost, gases, moisture and dust. Use original packing material for relocation.

Before unpacking the laser wait for 6 hours to allow for thermalization of all components.

<table>
<thead>
<tr>
<th>Table Title</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature range during transportation</td>
<td>-10°C to +50°C (14°F up to 122°F)</td>
</tr>
<tr>
<td>Relative humidity during transportation</td>
<td>5% up to 90%, non-condensing</td>
</tr>
<tr>
<td>Temperature range for optimal operation</td>
<td>+15°C up to +30°C (59°F up to 86°F)</td>
</tr>
<tr>
<td>Relative humidity during operation</td>
<td>&lt;60%, non-condensing</td>
</tr>
<tr>
<td>Dew point</td>
<td>&lt;22°C</td>
</tr>
<tr>
<td>Maximum altitude for operation</td>
<td>2000 meters above sea level (850 – 1050 hPa)</td>
</tr>
</tbody>
</table>

Transportation at lower temperatures shall be avoided. The whole cooling system needs to be completely drained and blown dry (prior to transportation).

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**CAUTION!**

Environmental conditions that exceed these specifications could result in instrument failure. Keep the HyperRapid NXT / HyperRapid NX laser in a dry place. Moisture could cause malfunction. Mistreatment may damage the device, in particular the output window.

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**NOTICE!**

In case customer components are being added to the system, consider that the environmental conditions could deviate (permitted range of ambient temperature, humidity, etc.).
Safety

The product is a class IV / class 4 laser which is defined by regulations e.g. ANSI Z136 in the US and IEC 60825 internationally. All national and local safety regulations might be dependent on the location and need to be fulfilled. This is even more important for integrators who additionally need to fulfill the regulations of the final machine destination. All persons working in the area of the laser system or with the laser system need to be informed of possible hazards and safety regulations at all times.

Laser safety requires the entire beam path to be integrated, interlocked and sealed. Ensure the prevention of possible direct or indirect exposure, especially to the eyes and skin. Be aware of that IR is in the non-visible spectral range and can pose a hazard.

All personnel working in the area of the laser beam must wear laser safety glasses rated for the specific wavelengths being generated by the laser system in accordance with EN207. Never work in the area of an exposed beam without laser eye protection!

Make sure to announce a certified 'Laser safety officer' (LSO), refer to ANSI Z136 for more information.

The implementation of an interlock-chain is required. Emergency stop button, system-activation key, door-interlocks, warning lamps, etc. are examples of such safety features; refer to section "Safety Control (D-Sub 15)" on page 44.
Unpacking the system on delivery

Check ShockWatch and TILTWatch Indicators outside and inside the crate. Also check for any damages. Take photos if necessary. Let the driver of the delivery company sign and inform Coherent.

Inspect the package & product together with the transportation company. In case of any damages please report this in the shipping documents (airway bill) and inform your transportation insurance (if contracted) as well as Coherent.

The laser system should acclimate for 6 hours in ambient room temperature prior to opening the shipping containers.

For further information refer to the external document "Unpacking HNXT_HRXN_eng_1317906_REV".

What is necessary for installation

- Pallet truck for transporting the euro-pallet
- Phillips-screwdriver to open the crate-top-cover (PZ2) (do not open any Torx-screws)
- Allen-key: metric, size 5 (for M6 hex-screws used in order to attach the laser head onto the pedestals)
- Allen-key: imperial, additionally needed in case of imperial screws for attaching the pedestals onto the customer's table
- Allen-key: metric, size 2.5 for M3 hex-screws in order to remove the output-window transportation-cover and optionally in case of attaching light devices in front of the output window
- Tools for attaching the chiller filter-kit:
  1. Allan-key: metric, size 4 (for the M5 hex-screws)
  2. Metric Spanner (open-end wrench) 14 mm; (alternatively adjustable wrench)
- Wire cutter, cardboard cutter
- 4 people for lifting the laser head out of the box (approx. head weight); alternatively a (portable) lifting device. 4 attachable handles as well as lifting eye-bolts are included in delivery (tapped holes are: M8x20). Use the plastic washers (included in delivery)

- Trolley to transport the laser head and chiller
- Adequate table (granite, cast stone or alternatives with low thermal expansion) where the positions for the feet are prepared for attachment (tapped holes and holes for the dowel pins according to technical drawing)
- Beam dump for testing purposes (safety issue) and measurements
- Breadboard in order to safely attach measuring devices with a set of corresponding screws
- Computer (not included in delivery) in order to control the laser system including network- card (or alternatively RS-232 interface)
- Ethernet cable (recommended), alternatively RS-232 cable in case the laser system is supposed to not be controlled via Ethernet. Data-logging is exclusively possible via Ethernet
- Fulfill laser safety in a lockable room or with protecting portable walls (laser safety goggles, etc.)
Chiller requirements

The cooling is important for the stability and operation of the laser system. Do not use any other chiller than the proposed one from Coherent, refer to section "SMC chiller" below. If there is a reason against this chiller, do not hesitate to contact Coherent Kaiserslautern GmbH.

The laser system requires Coolflow IGE. Coherent cannot take responsibility for other coolants used. The chiller is dimensioned for exchanging the heat of the laser system. Do not include further devices into this chain.

SMC chiller

In order to operate the laser, a chiller is necessary. Coherent offers a chiller from SMC with the following power requirement:

- single phase 200 to 230 VAC, 50/60 Hz

Deviating voltages require a transformer.

The SMC chiller has a nominal cooling capacity of 2100 W @ 50 Hz or 2400 W @ 60 Hz.

CAUTION!
In case of deviating mains voltage a transformer is necessary and needs to be ordered separately.

Figure 1: SMC chiller
Two different versions concerning the cooling method are available:

**Water-to-Air Chiller**

This chiller needs an adequate power connection and a sufficient air flow must be guaranteed at the front and at the back of the chiller.

**Water-to-Water Chiller**

This chiller needs an adequate power connection and an additional primary water circuit, which needs to be connected to both Rc3/8 (female) ports at the rear side of the chiller (facility water inlet/outlet).

The chiller is not remotely switched on. It is necessary to switch on the chiller manually. The presence of a chiller is detected by an integrated flow sensor (into the laser head). Set the chiller temperature to 23°C.

Initially stabilizing the water temperature can take approximately 20 min.

Verify that the coolant in the chiller is at a proper level. Preventive maintenance for the chiller (changing water and filter at the same time) is mandatory (see section "Maintaining intervals" on page 1). Refer to section "Maintaining the chiller" on page 1 for maintenance instructions.

In order to ensure enough heat exchange (in case of a water to air system) make sure that there is sufficient amount of space behind the chiller (>0.5 m / >20 inches). Also the air circulation / ventilation and fresh air supply should not be constricted.

| HRS024-A-20, 50 Hz, water-air-chiller 200-230 VAC Single Phase | HRS024-A-20, 60 Hz, water-air-chiller 200-230 VAC Single Phase |
Required facility water flow rate (in case of water-water chiller)

**NOTICE!**
Before the chiller can be operated, install the filter kit at the rear side of the chiller. Refer to section "Install SMC filter device" below.

**NOTICE!**
Programming the cooling specifications is required prior to system operation; refer to section "Chiller programming" on page 17.

The long-term performance of the system is highly dependent on using the approved coolant. Using any other coolant will void the warranty. The Coherent order-number can be found in section "Maintenance intervals" on page 1.

Before the SMC chiller can be used it is necessary to install a filter system together with a bypass-channel to the rear side of the chiller. This procedure is valid for SMC-chillers only. Do not hesitate to contact Coherent Service for support if anything is unclear. The procedure might take approx. half an hour.

**WARNING!**
Switch off and unplug from mains before proceeding.
**NOTICE!**

Do not use force on pre-assembled parts during the plumbing work. Never unscrew or loosen assembled parts which are sealed with Teflon tape; this could create a leakage. If this happens, unscrew the connection and attach new Teflon-sealing. In case of any doubt, contact a plumbing expert.

Refer to the image below to find all necessary parts.

**Additional tools needed:**
- Allen key: metric, size 4 (for the M5 hex-screws)
- Metric Spanner (open-end wrench) 14 mm; (alternatively adjustable wrench)

![Figure 2: Filter- & Bypass- assembly parts](image)

<table>
<thead>
<tr>
<th>POS</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tool to open the filter housing (necessary for filter change during maintenance)</td>
</tr>
<tr>
<td>2</td>
<td>Metric M5-screws (necessary to attach the filter-unit to the chiller)</td>
</tr>
<tr>
<td>3</td>
<td>Filter assembly with attached mounting-bracket</td>
</tr>
<tr>
<td>4</td>
<td>chiller output part</td>
</tr>
<tr>
<td>5</td>
<td>chiller return part</td>
</tr>
<tr>
<td>6</td>
<td>short thick hose</td>
</tr>
<tr>
<td>7</td>
<td>long thin hose</td>
</tr>
<tr>
<td>Step</td>
<td>Image</td>
</tr>
<tr>
<td>------</td>
<td>-------</td>
</tr>
<tr>
<td>1</td>
<td><img src="image1.png" alt="Image" /></td>
</tr>
<tr>
<td>2</td>
<td><img src="image2.png" alt="Image" /></td>
</tr>
<tr>
<td>Step</td>
<td>Image</td>
</tr>
<tr>
<td>------</td>
<td>-------</td>
</tr>
<tr>
<td>3</td>
<td><img src="image1.png" alt="Image" /></td>
</tr>
</tbody>
</table>
| 4    | ![Image](image2.png) | Attach the open end of the short hose (6) into the left side of the filter assembly (3).  
Screw the mounting bracket (attached to the filter) with both M5-screws (2) to the rear side of the chiller (top edge, using the tapped holes in the chiller-housing) in order to hold the filter in place. |
<table>
<thead>
<tr>
<th>Step</th>
<th>Image</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td><img src="image1.png" alt="Image" /></td>
<td>Loosen the screw of the outlet bypass and put the screw onto the hose. Attach the long hose (7) to the outlet bypass. Tighten the screw again so that the hose gets fixed. Use the spanner for tightening the screw.</td>
</tr>
<tr>
<td>6</td>
<td><img src="image2.png" alt="Image" /></td>
<td>Loosen the screw of the inlet bypass and put the screw onto the hose. Attach the long hose (7) to the inlet bypass. Tighten the screw again so that the hose gets fixed. Use the spanner for tightening the screw.</td>
</tr>
</tbody>
</table>

**Chiller programming**

Before starting the chiller make sure to define and set the following parameters on the chiller display.

- Set the temperature of the circulating fluid to 23°C (73.4°F)
- Set the max. temperature to 30°C (86°F)
- Set the automatic chiller reaction to STOP (when exceeding the max. temperature)
- Set the key-lock to ON after all changes completed

---

Make sure to follow this procedure in order to prevent damages in the system. The parameters and reaction are valid independently of the chiller type and manufacturer.
In case of using a SMC water-air or water-water chiller refer the following procedure.

![SMC chiller display](image)

**Key-lock**

The key-lock function prevents unintended changes when pressing buttons. The default setting is *off*. If it is switched *on*, follow this procedure, so that changes are getting possible. Do not forget to repeat this setting after changes are completed in order to return to key-lock.

- Press and hold the *MENU* key twice for approx. 2 seconds to enter the setting menu

- *SE.01* (key-lock) appears on the display. Make sure that it is set to *off*. If not, change it with the arrow keys (▼ ▲) and confirm with *SEL*

- Press the *MENU* key once in order to return to the main screen (displaying the circulation fluid temperature)

- After all changes are completed, consider to activate the key-lock by pressing *MENU* for approx. 2 seconds twice, *SE.01*, arrow key until *on*, confirm with *SEL* and return to normal operation with *MENU*

**Change unit of temperature**

The default setting of the temperature is Centigrade (°C). In order to change the unit, follow this procedure:

- Press and hold the *MENU* key twice for approx. 2 seconds (refer to section Key-lock if not possible)

- Repeat pressing the *SEL* key until *SE.12* is displayed

- Select temperature unit with (▼ ▲) key (C/F) and confirm by pressing *SEL*

- Press the *MENU* key once in order to return to the main screen (displaying the circulation fluid temperature)
Change unit of pressure

The default setting of the pressure is Mega-Pascal (MPa). In order to change the unit, select SE.13 similar to the procedure described above; select between (MPa/PSI).

Set requested temperature

Press the arrow keys (▼▲) in order to change the (red) Set Value to 23°C (73.4°F). During operation of the chiller the Process Value will reach and control the requested temperature.

Set max. temperature

By default the max. temperature is set to 45°C (113°F). Reduce the value to 30°C (86°F):
- Press and hold the MENU key 3 times for approx. 2 seconds (refer to section Key-lock if not possible) until the display shows AS.01 (Alarm settings).
- Repeat pressing the SEL key until AS.04 (Detection temperature for circulating fluid discharge temperature rise) is displayed.
- Reduce the value to 30°C (86°F) by using the arrow key (▼); each push changes the value by 0.1°C step; push and hold changes by 1°C step.
- Press SEL in order to confirm the setting.
- Press MENU to leave the programming and return to the main display.

Change chiller reaction

In case of rising temperature above the limit the corresponding action of the chiller should stop the fluid circulation. Follow this procedure for programming:
- Press and hold MENU 3 times for 2 seconds (refer to section Key-lock if not possible).
- Press SEL 2 times until AS.03 appears (Changing of circulating fluid discharge temperature rise).
- The Set value (red) displays A.run. Change this parameter to A.StP by using the arrow keys (▼▲). A.StP means that the chiller will STOP in case of the corresponding Alarm (temperature rise above limit temperature in this case).
- Press SEL in order to confirm the setting.
- Press MENU to leave the programming and return to the main display.
It is recommended to enable key-lock after all changes completed (refer to beginning of this section). For further details refer to the SMC chiller - manual.

Power supply options

The HyperRapid NXT / HyperRapid NX laser head requires +48 V (DC) +/- 5% with >1800 W. Coherent provides two optional devices:

- 3 U power supply, 19" rack mount required in Europe (CE conform)
- 1 U TDK-Lambda power device, 19" rack mount including three single power supplies combined (integrator responsible for conformity topics)

The Coherent provided power supply is not allowed to be used for any other devices or applications than connecting to the HyperRapid NXT / HyperRapid NX.

It is recommended to add a strain-relief to the power cords (mains and umbilical). Additionally make sure to protect cables against mechanical forces (such as tension, traction, torsion, clamping, crushing, squeezing, cutting forces, etc.).

Refer to the following sections to find description of both devices. Delivery depends on the customer's order.

Please note that all electrical work (e.g. designing, configuring and connecting, etc.) should only be performed by a certified electrician.

The power supply does not include a mains switch nor Emergency Stop button.

Coherent recommends to fuse all components adequately. A multiple socket outlet is not recommended due to the fact that in total the wire cross section might be underdimensioned.
WARNING!
Unplug and disconnect from mains before starting any work on the power supply.

Power supply 3U

The 3 U 19" power supply provides +48 V(DC). The height of the supply is 3 U (rack unit). The primary side of the Coherent power supply can be connected to a mains voltage of 100–230 VAC (50/60 Hz).

Make sure that the secondary poles remain potential-free. Do not ground the minus-pole.

Front view PSU 3U

Two LED's are located on the right side of the power supply. They are illuminated green when the power supply gets connected to mains. The cooling fans of the power supply should not be obstructed in order to maintain an air flow from the front to rear. The device can be fixed into the 19" rack unit with 4 screws (M6).

Figure 4: Front view of the power supply

Attach the 4 feet if the power supply is not integrated into a 19" rack. Insert each foot into the corresponding hole located on the bottom of the device. Lock the foot by carefully stamping the pin into the foot itself. In order to detach the feet again, remove the device ground plate (4 screws bottom view) and push the pin back out of the foot.
Figure 5: Bottom view, feet inserts for stand-alone use

**Rear view PSU 3U**

The following components are located on the rear side of the power supply:

![Figure 6: Rear view of the power supply](image)

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mains connector single phase (L – phase, N – neutral and PE – ground), 100–230VAC (50/60 Hz)</td>
</tr>
<tr>
<td>2</td>
<td>Mains fuse</td>
</tr>
<tr>
<td>3</td>
<td>Output fuse</td>
</tr>
<tr>
<td>4</td>
<td>Output, 48V DC connector for the laser head</td>
</tr>
</tbody>
</table>

Please note that all electrical work (e.g. designing, configuring and connecting, etc.) should only be performed by a certified electrician.
Make sure to protect the cables against disconnection, mechanical forces and against contact by hand (if necessary).

Top view PSU 3U

Refer to the drawing below. Units are displayed in Millimeter. Allow at least 100 mm behind the power supply for cables and the D-Sub connector. The power supply front and rear should not be covered or obstructed to guarantee an efficient heat exchange.

Figure 7: Top view of the power supply, dimensions in mm

Power supply 1U

The TDK-Lambda power device is a 19"-frame including three single power supplies combined. The height of the supply is 1 U (rack unit). The primary side of the Coherent power supply can be connected to a mains voltage of 100-230 VAC (50/60 Hz) via three C13 (IEC 60320) cables. Make sure to adequately fuse them.

Make sure to always turn on all 3 power supplies at the same time. Use one single circuit breaker to protect all 3 power supplies simultaneously.
Make sure that the secondary poles remain potential-free. Do not ground the minus-pole.

Front view PSU 1U

The PSU consists of three power supplies which are identical to each other and can be extracted and exchanged (make sure to disconnect from mains prior to exchanging). The cooling fans of the power supplies should not be blocked as this provides cooling air flow from the front to rear. Each power supply has 3 LEDs that indicate the voltage status: DC OK, DC FAIL, AC OK.

Rear view PSU 1U

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sensor D-Sub connector</td>
</tr>
<tr>
<td>2</td>
<td>+ 48 VDC, up to 3000 W</td>
</tr>
<tr>
<td>3</td>
<td>0 VDC (do not ground)</td>
</tr>
<tr>
<td>4</td>
<td>GND, ground</td>
</tr>
<tr>
<td>5</td>
<td>DIP-switches, all in OFF-position</td>
</tr>
<tr>
<td>6</td>
<td>C14 (male) mains connectors, make sure to connect all 3 plugs</td>
</tr>
</tbody>
</table>

WARNING!
Unplug and disconnect from mains before starting the following procedure.
Connect the power supply according to this procedure:

- Connect the sensor-connector (1) to the D-Sub plug
- Connect the blue PLUS-cable from the sensor-connector and both PLUS-cables from laser head to (2)
- Connect the black MINUS-cable from the sensor-connector and both MINUS-cables from laser head to (3)
- Connect the Ground-cables to the housing-screw (4)
- Make sure that all DIP-switches (5) are set to OFF-position
- Connect all three plugs (6) to mains-cables (cable providing C13 (female) connectors)
- Connect all 3 power-cables with mains. Make sure that they are adequately fused
- Make sure to protect each cable against disconnection

Refer to the drawing below. Units are displayed in Millimeter. Allow at least 120 mm behind the power supply for cables. The power supply front and rear should not be covered or obstructed to guarantee an efficient heat exchange.

**Figure 10: Top view of the power supply, dimensions in mm**
**Electrical power connections**

The delivery of power cables is dependent on the order. A system without power supply does neither include the mains cable nor the 48 V-cable for the laser head. The mains cable will be delivered with the European "Schuko"connector. Please make sure to provide the appropriate connector (to replace the "Schuko") suitable for your region (and region of end-customer in case of machine-integration).

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**Coherent recommends to fuse all components adequately. A multiple socket outlet is not recommended due to the fact that in total the wire cross section might be underdimensioned.**

---

<table>
<thead>
<tr>
<th><strong>Cable for PSU 3U (dependent on order)</strong></th>
<th><strong>Device end</strong></th>
<th><strong>Cable length</strong></th>
<th><strong>Customer end</strong></th>
<th><strong>Image</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>System Power supply (connecting the power supply to mains)</td>
<td>open cable ends</td>
<td>2 m</td>
<td>CEE 7/4 (Schuko-plug)</td>
<td><img src="image_url" alt="Image" /></td>
</tr>
<tr>
<td>Laser head (48 V power cable between PSU 3U and laser head)</td>
<td>D-Sub 5W5 male (for connection to PSU)</td>
<td>5 m</td>
<td>D-Sub 5W5 female (for connection to laser head)</td>
<td><img src="image_url" alt="Image" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Cable for PSU 1U (dependent on order)</strong></th>
<th><strong>Device end</strong></th>
<th><strong>Cable length</strong></th>
<th><strong>Customer end</strong></th>
<th><strong>Image</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>System Power supply (connecting the power supply to mains), 3 cables</td>
<td>C13 (IEC 60320)</td>
<td>2 m</td>
<td>CEE 7/4 (Schuko-plug)</td>
<td><img src="image_url" alt="Image" /></td>
</tr>
<tr>
<td>Laser head (48 V power cable between PSU 1U and laser head)</td>
<td>cable-lugs to be connected to power supply</td>
<td>5 m</td>
<td>D-Sub 5W5 female (for connection to laser head)</td>
<td><img src="image_url" alt="Image" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Cable for SMC chiller (dependent on order)</strong></th>
<th><strong>Device end</strong></th>
<th><strong>Cable length</strong></th>
<th><strong>Customer end</strong></th>
<th><strong>Image</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>SMC chiller HRS (mains power supply)</td>
<td>C13 (IEC 60320)</td>
<td>2 m</td>
<td>CEE 7/4 (Schuko-plug)</td>
<td><img src="image_url" alt="Image" /></td>
</tr>
</tbody>
</table>
What needs to be prepared

- The laser head shall be positioned horizontally, on a flat surface made of low expansion material (ideally granite) in order to eliminate temperature and vibration issues. (A modern alternative might be cast stone). This surface needs threaded holes in order to position and fix the laser head, refer to section "Laser head mounting" on page 39

- The location of the laser should be relatively clean and free of condensation. For the environmental conditions please refer to section "Ambient condition" on page 7

- Provide adequate electrical power plugs / connections (if deviating from the described ones above), which are sufficiently fused

- Provide a mains switch for the power supply

- Provide an Emergency Switch for the complete system

- Make sure to not ground the minus-pole of the secondary-side of the power supply (they have to remain potential-free)

- The chiller cooling liquid will be included in delivery (if the chiller is ordered). To maintain the chiller (liquid-exchange) it is recommended to attach a valve to the drain-outlet. A conversion fitting (material: POM, R3/8 male thread) is provided

- The HRS024-W-20 (SMC water-water) chiller is equipped with two female Rc3/8 pipe threads. Provide the corresponding fittings and facility water line equipment (refer to the separate chiller manual)

- A filter-system has to be attached (by the customer) to the rear side of the chiller; refer to the HyperRapid NXT / HyperRapid NX Operator's manual for more details

- An external PC with Microsoft Windows 7 installed; monitor, keyboard and mouse connected; necessary to control the laser system

- BNC-signal lines: Gate, Trigger, Sync, Ext Mod, Pulse Monitor. The number of required connections depends on the application but in order to drive a scanner or positioning-table at least the Gate-Input needs to be connected. BNC-cables are not included in the delivery. The laser head provides HD-BNC-plugs (bulkheads). Adapter-cables to BNC are included in the delivery (length 30 cm, 12 inch). Alternatively use HD-BNC cables with 75 Ω

<table>
<thead>
<tr>
<th>Adapter cable connectors</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>BNC bulkhead for customer cable</td>
<td>HD-BNC plug to the laser head 75 Ω</td>
</tr>
</tbody>
</table>

- Local area network connection: Ethernet cable (not included in delivery) with category CAT.5 (100 Mbit/s) minimum (optionally: cross-link cable might be required for computer-to-computer-connection)

- Optional: D-Sub 9 cable with female connector if the Safety Box is replaced by machine integrated safety functions (emergency stop, laser emission indicator, power on LED, key-switch); refer to section "Safety box" on page 47

- D-Sub 15 cable with male connector to use the Safety Control features; refer to section "Safety Control (D-Sub 15)" on page 44. Provide an adequate interlock-chain which can be connected to the interface. Bridging these safety circuits is not allowed and would decrease the Functional Safety Performance Level. The responsibility to fulfill relevant safety-regulations remains with the customer. Choose the appropriate Mode (0 software control, 1 hardware control) with integrating the corresponding interfaces (relays, safety interlocks, push button, active safety device, etc.; not included in delivery)

- Optional: D-Sub 25 cable with a male connector to use Status outputs

- RS-232 cable in case the system shall be controlled via RS-232
• Laser safety requirements must always be satisfied. Certified laser eye protection has to be worn by all personnel working in the area of the laser. All persons working with and around the laser must be aware of and informed about hazards associated with laser radiation.

• Check if a laser safety officer (LSO) might be required. He needs to be authorized by the management to conduct such duties.

• In case the system is being implemented into an enclosed laser-processing-area, adequate door-locking devices as well as shutter control via safety devices (e.g. PILZ automation) might be required and implemented into the inter-lock chain.

• Consider a protection of the power supply cables against mechanical forces.

• The laser beam path might need to be covered by an adequate housing, tubes, cabinet, etc.

• A scanner-card (or a function-generator) might be needed to create TTL-signals (GATE). This is dependent on your application.

• Power meter in order to measure the optical output; refer to http://www.coherent.com/products/index.cfm?1713/PowerMax-USB-RS-Sensors (e.g. the PowerMax USB meter)

• Establish an Ethernet connection: When using a firewall on the external PC (or network), ensure that the specified communication port is available. It is recommended to use DHCP in order to find the corresponding IP-address. The IP-address of the system can be changed and individually defined by sending the command: IP nnn.nnn.n.n and rebooting the system.

• In case of external software control, e.g. for a machine integration, it is either possible to use the Coherent GUI or customer-individual software-control.
To safely position test equipment (beam profiling and power sensors) in front of the laser head, the customer must provide an optical breadboard. We recommend to use a thin aluminum bench plate with thread holes for screws. The customer can choose either metric or imperial units for the breadboard. Provide at least 10 corresponding screws that fit the thread size of the breadboard.

Aluminum plates are available from e.g. Thorlabs:
- [300 x 450 x 12.7] mm with M6 taps, approx. weight 6 kg
- [12 x 18 x 1/2] inch with 1/4 in taps, approx. weight 13 lbs

Please help us to ensure the highest possible safety! Do not hesitate to contact Coherent Kaiserslautern GmbH (refer to first page) in case of any doubt about the (laser) safety of the measurement procedures, so that a solution can be found in advance.

Coherent Service technicians are engaged to check the laser-safety situation provided by the customer and might request further provisions which could delay the installation procedure.

Please also provide a stable table (150 x 70 cm or larger) for positioning the laser head and the optical breadboard in front. In order to secure the beam output area, provide a protective housing such as laser safety curtains or black-anodized aluminum plates with a height of 25 cm (10 inches) which can be positioned vertically as a frame.

Figure 11: Alignment table, top view
**Mechanical dimensions of the laser head**

Refer to the technical drawing (section "Technical drawing" on page 38) in order to find dimensions of the laser head.

Sufficient access to the laser head in an integrated machine must be provided for service & maintenance (defined in the technical drawing). Also, make sure a power meter can be placed into the optical beam path for diagnostic purposes.

Coherent recommends to leave at least 160 mm (6.3 inches) at the back side of the laser head for the electrical wires and water hoses. Also include adequate cover tubing, guiding systems or protections against mechanical forces (if necessary).

Do not hesitate to contact your Coherent representative in case you need further support.

If requested Coherent can provide a 3D CAD-STEP file of the laser head.

**Laser head**

The laser head consists of a

- Seeder comprising of a mode-locked oscillator and a pulse-picker
- Amplifier
- Attenuator
- Modulator
- Optional: a second (SHG, 532 nm) or third harmonic (THG, 355 nm) generator
- Safety shutter

The direction of polarization (vertical or horizontal) is dependent on the output wavelength and defined in the specification data sheet.
Figure 12: Perspective front view of laser head

Always ensure that the following conditions are met to prevent damage to the system:

- no moisture can condense on the unit
- no aggressive gases penetrate the case
- the laser system is protected against frost

Such conditions may destroy the laser system.
Front view

Figure 13: Front view of the laser head

1  Output aperture (cover removed)
2  Laser emission indicator
3  Front cover, DO NOT OPEN, Coherent Service only
4  Adapter threads for housing / protecting elements, refer to section "Output window" below

Output window

Located on the laser head front side there are 4 thread holes (M4, 8 mm depth) and 2 dowel pin-holes (ø 4.02 mm); refer to the image below. Attaching a beam-tube or a telescope in front of the output window is possible using these holes. Additionally it is necessary to support the element with an adequate stand (to prevent influences on the output-laser-beam due to mechanical forces). Make sure, that the screws are not longer than the threads itself (prevent mechanical forces inside the threads).

In case your system emits UV-light, it is necessary to protect the output-window (against dust and particles) by a sealed beam-path-tubing (carried by adequate stands).
We recommend to protect the output window with a sealed tube. In case of UV lasers, this is mandatory.

Make sure to turn off the laser system and protect against unintended activation when working on the beam output.

Rear view

Figure 15: Rear view of the laser head

1 Electrical interface, refer to section "Connectors" on page 1
2 Coolant return, warm water to chiller
3 Coherent Service only, do not open
4 Coolant supply, cold water from chiller
The function and characteristics of each interface is described in the list below. All round connectors are HD-BNC (bulkhead) except Pulse Monitor, which is BNC. The connectors can be found on the rear side of the laser head.

**NOTICE!**
Make sure to use 75 Ω HD-BNC connectors for position 1-5. Adapter cables HD-BNC to Standard-BNC connectors are included in delivery. 50 Ω HD-BNC connectors are not allowed due to deviating pin-size.

**NOTICE!**
Input connectors (Pos. 1, 2, 3) are covered by a terminating resistor cap. Use these terminating caps as long as the signal is generated internally. Limit the signal to 0-5V (max. 5V) in case of external supply (provided by a function generator or scanner-device, etc.).

Emission of radiation is possible when Ext Mod is selected but no termination or driver is connected. Residual radiation is possible at any time.

<table>
<thead>
<tr>
<th>POS</th>
<th>Name</th>
<th>Signal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ext Mod</td>
<td>0–5 V</td>
<td>INPUT: analog signal to modulate the output power; relation is not linear. Select the corresponding feature in the software (refer to section &quot;Graphical user interface&quot; on page 1). Use HD-BNC connector with 75 Ω or the adapter-cable included in delivery. Connect the device prior to activation. Use the terminating resistor (included in delivery) if the input is not used</td>
</tr>
<tr>
<td>POS</td>
<td>Name</td>
<td>Signal</td>
<td>Description</td>
</tr>
<tr>
<td>-----</td>
<td>---------------</td>
<td>-----------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>2</td>
<td>Gate</td>
<td>TTL</td>
<td>INPUT: provide application-signal to toggle the laser output. Use HD-BNC connector with 75 Ω or the adapter-cable included in delivery. Use the terminating resistor (included in delivery) if the input is not used. Choose <strong>Internal &amp; Gated</strong> or <strong>External &amp; Gated</strong> to activate the input (refer to section &quot;Application signals&quot; on page 54)</td>
</tr>
<tr>
<td>3</td>
<td>Trigger</td>
<td>TTL</td>
<td>INPUT: provide signal of the requested repetition-rate. Use HD-BNC connector with 75 Ω or the adapter-cable included in delivery. Use the terminating resistor (included in delivery) if the input is not used. Choose <strong>External</strong> or <strong>External &amp; Gated</strong> to activate the input (refer to section &quot;Application signals&quot; on page 54)</td>
</tr>
<tr>
<td>4</td>
<td>Sync 1</td>
<td>TTL</td>
<td>OUTPUT signal of internal amplifier frequency, signal does not include the Gate-information); reserved for Coherent-Service. Use HD-BNC connector with 75 Ω or the adapter-cable included in delivery</td>
</tr>
<tr>
<td>5</td>
<td>Sync 2</td>
<td>Impedance: 75 Ω (pulse width: 700 ± 200 ns)</td>
<td>OUTPUT signal synchronous to emitted pulses (or burst groups), signal including GATE-status (independent of the shutter state). Use this signal to synchronize external devices. Use HD-BNC connector with 75 Ω or the adapter-cable included in delivery</td>
</tr>
<tr>
<td>6</td>
<td>USB</td>
<td>—</td>
<td>USB-B interface connector, refer to section &quot;USB Connection&quot; on page 1</td>
</tr>
<tr>
<td>7</td>
<td>Ethernet</td>
<td>—</td>
<td>Network connector for communication, refer to section &quot;Ethernet Connection&quot; on page 1</td>
</tr>
<tr>
<td>8</td>
<td>RS-232</td>
<td>—</td>
<td>D-Sub 9 (female) RS-232 interface (in case Ethernet is not used), refer to section &quot;RS-232 connector&quot; on page 1</td>
</tr>
<tr>
<td>9</td>
<td>Safety box</td>
<td>—</td>
<td>D-Sub 9 (male) connector for the Safety Box, refer to section &quot;Safety box&quot; on page 47</td>
</tr>
<tr>
<td>10</td>
<td>Safety Control</td>
<td>—</td>
<td>D-Sub 15 (female) connector for the Safety control, refer to section &quot;Safety Control (D-Sub 15)&quot; on page 44</td>
</tr>
<tr>
<td>11</td>
<td>Status</td>
<td>—</td>
<td>Output: D-Sub 25 connector, refer to section &quot;Status connector&quot; on page 49</td>
</tr>
<tr>
<td>12</td>
<td>Power supply</td>
<td>48 V, &lt;60 A</td>
<td>D-Sub 5W5 male, connected to the power supply A1, A2: +48 VDC, ±5% A3, A4: GND; A5: Earth</td>
</tr>
<tr>
<td>13</td>
<td>Pulse Monitor</td>
<td>Impedance: 0–2 V, 50 Ω</td>
<td>OUTPUT: electrical signal synchronized to the optical pulses (photodiode signal for diagnostics), variable amplitude. Reserved for Coherent Service, use BNC connector</td>
</tr>
</tbody>
</table>
NOTICE!
Note that the impedance of the input-interfaces are dependent on the signal frequency. The value decreases above a signal-frequency of 1 kHz.
Technical drawing

Find the functional measurements of the laser head in the following drawing, including Service space and positions of the feet receptacles.

Figure 17: Technical drawing of laser head, dimensions in mm
**Laser head mounting**

The head is placed on a three-point kinematic mount:

- 3 feet, screwed into the laser head bottom (POS 4), do not remove these (ball-shaped head) screws from laser head
- Retaining in 3 different feet pedestals (POS 1, plane, cone and V-groove), plate thickness: 13.5 mm, counter sunk drilling depth for cylinder-head-screw is 6.4 mm
- Each foot is secured by a clamp (POS 3), which is mechanically decoupled by a spring washer-package (located above the ball-shaped head, POS 4). The clamp is fixed by two metric M6 cylinder-head-screws (POS 2) for each pedestal. These screws are included in delivery. Do not use any other (special screw, surface treated).

![Figure 18: Laser head foot, front view](image)

- Locate the 3 feet plates (POS 1) on your table, refer to the following image (Pedestal plates, top view). Use 6 screws (M6x20 or 1/4", length 3/4")
- Optionally use 6 alignment pins (DIN7, ø6x20 mm) in order to position the feet-plates on your table precisely
- Fix the pedestals with 2 screws (for each pedestal) onto your surface. Do not use any (spring-) washers. In the following image the metric system is indicated blue, the imperial system is indicated green. We recommend to tighten these screws with 4 Nm, make sure that threads in the table are dimensioned sufficiently (depths and thread material)
- Place the laser head onto the 3 feet plates, so that the ball-shaped-heads reside in the cone, V-groove and plane
- Position each clamp onto the spring washer-package
• Use 6 M6x18 cylinder-head-screws to initiate the force between spring washers and laser head (POS 2); tighten with 4 Nm

• Left and right of each clamp (POS 3) are 2 bars (POS 5) attached to the laser head housing. Fix these bars (POS 5) using two M6 screws onto the pedestal (POS 1). Repeat this for all 3 feet. The housing is mechanically decoupled from the laser head underneath and therefore needs its own fixation

![Figure 19: Housing fixation (POS 5)](image)

**NOTICE!**
Do not use any spring-washers. Tighten the M6 screws with 4 Nm. In case the laser beam is directed onto an adjustment mirror, the alignment pins might not be necessary. Refer to the following image and also to section "Technical drawing" on page 38 in order to find dimensions.
<table>
<thead>
<tr>
<th>Color in image</th>
<th>Qty</th>
<th>Holes</th>
<th>Items</th>
<th>To be provided</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>red</td>
<td>6</td>
<td>Pinhole ø 6.02 mm</td>
<td>Alignment pin (DIN 7) ø6x20 mm</td>
<td>by customer</td>
<td>exact positioning using alignment pins</td>
</tr>
<tr>
<td>green</td>
<td>6</td>
<td>Hole for imperial screw (2&quot; raster); thread depth ≥ 0.6 inch in the customer table</td>
<td>1/4&quot; imperial screw, length ≥ 3/4 inch</td>
<td>by customer</td>
<td>attachment of plates onto a customer-surface with imperial dimensions; torque is material-dependent (4 Nm recommended)</td>
</tr>
<tr>
<td>blue</td>
<td>6</td>
<td>Hole for metric screw (50 mm raster); thread depth ≥ 15 mm in the customer table</td>
<td>M6 screw, length ≥ 20 mm</td>
<td>by customer</td>
<td>attachment of plates onto a customer-surface with metric dimensions; torque is material-dependent (4 Nm recommended)</td>
</tr>
<tr>
<td>pink</td>
<td>6</td>
<td>Thread hole</td>
<td>M6x18, special material, do not use any other screw</td>
<td>included in delivery</td>
<td>attach clamp to compress the spring packages; recommended torque 4 Nm</td>
</tr>
<tr>
<td>orange</td>
<td>6</td>
<td>Thread hole</td>
<td>M6x18, special material, do not use any other screw</td>
<td>included in delivery</td>
<td>fixes laser head housing to the pedestals; torque 4 Nm</td>
</tr>
<tr>
<td>cyan</td>
<td>3</td>
<td>functional surface (cone, groove and flat)</td>
<td>—</td>
<td>—</td>
<td>defines position of the laser head</td>
</tr>
</tbody>
</table>
The dimensions of the pedestals and distances are displayed in mm. All dimensions are tolerated with ±0.1 mm.

Figure 20: Pedestal plates, top view
The HyperRapid NXT / HyperRapid NX incorporates a functional safety board (FS). In case the customer considers to create a risk assessment evaluation, the functional safety board might help to increase the safety performance level (dependent on further customer-specific situations / circumstances). This electronic-board monitors the status of the **Safety Box** (D-Sub 9 connector) and the **Safety Control** Interface (D-Sub 15 connector). It gives feedback on fault conditions and is equipped with a self-detection (upon signal redundancy). A feedback of the actual system status is delivered with the **Status connector** (D-Sub 25 connector).

The safety board controls the following functions:

- **Safety Box** includes a key-switch, emergency stop button, a green Power On LED and a white Laser Emission LED. Alternatively replace the device by your own machine integrated safety elements, refer to section "Safety box" on page 47

- The **Safety Control** provides two possible modes (refer to section "Safety Control (D-Sub 15)" on the facing page) in order to control the shutter via software or externally by customer hardware

- The **Status connector** provides output signals indicating the actual status of the system (independent of the software), refer to section "Status connector" on page 49
Safety Control (D-Sub 15)

The interface Safety Control (D-Sub 15) offers two different options for controlling the shutter. The modes can be switched via software command. Send \texttt{SMOD=0} or \texttt{SMOD=1}. Send \texttt{?SMOD} to query the current mode with the response of 0 or 1. The status of the mode is saved and reloaded on start-up:

- **Mode 0: Software Control**
  The shutter can be operated by software (GUI or serial commands) if appropriate hardware contacts are closed and no faults existing

- **Mode 1: External User Control**
  The system is activated by a push-button (provided by customer, e.g. for machine integration). This is the initial system-release-signal after the system has been powered on (and key-switch turned) or to confirm an error-correction. If the functional-safety-board (FS) is error free, the laser diodes will be enabled but not lasing

In order to turn on the laser diodes, send the corresponding software-signal (in the GUI or via command), refer to section "Operating sequence" on page 51. In order to confirm an error-correction, send the command \texttt{FACK=1} and press the Start Release Push button. The shutter is operated by two independent hardware interfaces.

Both modes are described in the next chapter.
The mode 0 offers the control of the shutter via software (GUI or command). The shutter can be opened as long as the indicated conditions are fulfilled. All contacts are potential free. Use these contacts to implement a customer-individual safety circuit (e.g. cabinet-door indicator or open-request device, etc.) via relay or mechanical switches.

Both user-connectors (UC1&UC2) must be closed before the start-release can be activated. This is also the condition for an operable shutter. Opening one (or both) switches would establish an interlock (in this case the connector would have to be closed again and fault acknowledged by command \texttt{FACK=1}).

**User connector** | **Description** |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>UC1 (normally open)</td>
<td>PIN 3 connect to PIN 4 in order to enable the shutter (refer to UC2 for additional requirement)</td>
</tr>
<tr>
<td>UC2 (normally open)</td>
<td>PIN 7 connect to PIN 8 in order to enable the shutter (refer to UC1 for additional requirement)</td>
</tr>
</tbody>
</table>

**NOTICE!**

In order to operate the shutter (via software), UC1 AND UC2 have to be closed. Any other condition closes the shutter or prevents opening.

Make sure to fulfill laser safety before opening the shutter via GUI or command.
Make sure to implement an adequate interlock chain (such as e.g. door-interlock or active safety device). Bridging the connectors is not allowed and would decrease the functional safety performance level.

**Safety Control**

**Mode 1**

The Mode 1 offers a hardware control of the shutter. All contacts are potential free. The *Start release push button* needs to be integrated by customer and pressed once on start-up or after eliminating an error (see section "Operating sequence" on page 51); the activation is edge triggered. Closing this connection permanently is also possible, but after eliminating an error, as well as after system start-up (power-on), the connection would have to be reset (open and close) in order to confirm the error correction.

Both user-connectors (UC1&UC2) must be open before the start-release can be activated. After system start-up use both connectors to operate the shutter. In case of an interlock or fault condition, make sure that both UC's are opened (so that the shutter can resume operation).

<table>
<thead>
<tr>
<th>User connector</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start release</td>
<td>Push-button (between PIN 1&amp;2) in order to enable the system on start-up or after eliminating an error</td>
</tr>
<tr>
<td>UC1 (normally open)</td>
<td>PIN 3 connect to PIN 4 in order to enable the shutter (in order to open the shutter UC2 must be closed also)</td>
</tr>
<tr>
<td>UC2 (normally open)</td>
<td>PIN 7 connect to PIN 8 in order to enable the shutter (in order to open the shutter UC1 must be closed also)</td>
</tr>
</tbody>
</table>
NOTICE!
Shutter opens when UC1 AND UC2 are closed. Any other condition closes the shutter or prevents opening.

Make sure to fulfill laser safety before closing both user-connectors (in order to open the shutter).

Make sure to implement an adequate interlock chain (such as e.g. door-interlock or active safety device). Bridging the connectors is not allowed and would decrease the functional safety performance level.

Safety box

The safety box (connected to the D-Sub 9 plug) offers the functions described below. In order to integrate the laser into a machine it is necessary to replace the Safety Box with corresponding functions of the machine. In this case, provide the same circuit as shown in the schematics. The Laser Emission LED is monitored by the functional safety board (FS). Connect a LED or use a resistor (180-200 Ω) between Pin 1 and Pin 2 (of the D-Sub 9 plug). This is necessary for the laser to operate.

<table>
<thead>
<tr>
<th>POS</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Emergency Stop</td>
<td>hit in order to activate (rotate and pull in order to release, interlock has to be confirmed)</td>
</tr>
</tbody>
</table>

Figure 23: Safety Box
### Feature | Description
--- | ---
Laser Emission LED | Connect a white LED (specified for 3-3.6V, without internal resistor) between PIN 1 & 2. Alternatively bridge 1&2 with a resistor of 180-200 Ω. The FS will create an error without the LED or alternatively the resistor.
Power ON LED | Connect a green LED between PIN 3 & 9 (optionally); not necessary to bridge without LED.
Key-switch & Emergency Stop button | Connect system key-switch and emergency stop button (both provided by customer) according to schematics.
GND | PIN 8 & 9: ground

The system cannot start if the corresponding connections are not established (key-switch, emergency stop AND Laser Emission LED).
**NOTICE!**
In case of system integration, replace the Safety box by a system circuit and add the features described in section "Safety Control (D-Sub 15)" on page 44.

**Status connector**

The status outputs are potential free, max. voltage and current are 60 V, 1 A. Refer to table below for the PIN-assignment of the D-Sub 25 female connector:

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laser ready</td>
<td>PIN 3 connected to PIN 2 when Laser ready</td>
</tr>
<tr>
<td></td>
<td>PIN 3 connected to PIN 4 when Laser not ready</td>
</tr>
<tr>
<td>Laser emission</td>
<td>PIN 6 connected to PIN 5 when internal emission existing</td>
</tr>
<tr>
<td></td>
<td>PIN 6 connected to PIN 7 when internal emission not activated</td>
</tr>
<tr>
<td>Shutter</td>
<td>PIN 9 connected to PIN 8 when shutter open</td>
</tr>
<tr>
<td></td>
<td>PIN 9 connected to PIN 10 when shutter closed</td>
</tr>
<tr>
<td>Emergency Stop</td>
<td>PIN 12 connected to PIN 11 when Emergency Stop not activated</td>
</tr>
<tr>
<td></td>
<td>PIN 12 connected to PIN 13 when Emergency Stop activated (which results in shut-down of internal laser-sources)</td>
</tr>
<tr>
<td>Faults</td>
<td>PIN 14 connected to PIN 15 when faults present (send command \texttt{?F} to verify and \texttt{FACK=1} after eliminating a fault)</td>
</tr>
<tr>
<td></td>
<td>PIN 14 connected to PIN 1 when faults not present</td>
</tr>
</tbody>
</table>

![Status Signals](image)

**Figure 25: Status Signals**
GUI installation

Install the GUI on the external client PC (provided by the customer) running Microsoft Windows 7 operating system. Unzip the file *Coherent GUI.zip* and start the setup program. Follow the displayed procedure.

**NOTICE!**
The software can be downloaded from the following link: [https://www.coherent.com/lasers/laser/industrial-short-pulse-lasers/picosecond-lasers/hyper-rapid-nxt](https://www.coherent.com/lasers/laser/industrial-short-pulse-lasers/picosecond-lasers/hyper-rapid-nxt)

Switching the Safety Control Mode

The decision is necessary if the system is supposed to be operated with a software-controlled or hardware-controlled shutter. In order to change the safety control mode, a few conditions must be fulfilled. In case the shutter is supposed to be operated via software (GUI or command), no action required because SMOD=0 is the default value. The command SMOD is memorized by the system and needs to be defined just once, see also section "Safety Control (D-Sub 15)" on page 44.

<table>
<thead>
<tr>
<th>SMOD=1 → SMOD=0</th>
<th>SMOD=0 → SMOD=1</th>
</tr>
</thead>
<tbody>
<tr>
<td>shutter supposed to be software controlled</td>
<td>shutter supposed to be hardware controlled</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Key switch &quot;0&quot; (off)</th>
<th>Key switch &quot;0&quot; (off)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>UC1&amp;UC2 are open</th>
<th>UC1&amp;UC2 are open</th>
</tr>
</thead>
</table>

Send FACK=1 (or press *Clear* in the GUI) to acknowledge and clear faults

Send ?F to query the faults. Eliminate all faults if existing (except "Emergency Stop")

<table>
<thead>
<tr>
<th>Send SMOD=0</th>
<th>Send SMOD=1</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Key switch &quot;1&quot; (on)</th>
<th>Key switch &quot;1&quot; (on)</th>
</tr>
</thead>
</table>

— Press push button —

Send FACK=1 (or press *Clear* in the GUI) again

Follow the starting procedure, refer to section "Operating sequence" on the next page
**Operating sequence**

This section shows an example of sequence to start the system and define parameters (without the GUI). Integrating further commands is dependent on individual purposes.

- Connect the laser head to the power supply and the power supply to mains
- Turn on the chiller
- Check that the Emergency Stop button is released
- Make sure that the Safety Control Mode is correctly defined, refer to section "Safety Control (D-Sub 15)" on page 44
- Set key-switch (of the Safety box) to "I" position, see section "Safety box" on page 47
- Make sure that the Ethernet or COM-Port connection is established, see section "Prepare communication" on page 1
- Depending on the Safety Control Mode following deviating procedures are necessary:

<table>
<thead>
<tr>
<th>In case SMOD=0 requested, shutter <strong>software</strong> controlled</th>
<th>In case SMOD=1 requested, shutter <strong>hardware</strong> controlled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make sure that both user-connectors UC1&amp;UC2 are <strong>closed</strong> (Interlock-chain)</td>
<td>Make sure that both user-connectors UC1&amp;UC2 are <strong>open</strong></td>
</tr>
<tr>
<td>Send <strong>FACK=1</strong> (or press <strong>Clear</strong> in the GUI) to acknowledge and clear faults</td>
<td></td>
</tr>
<tr>
<td>Send <strong>?F</strong> to display active faults. Correction of faults necessary</td>
<td></td>
</tr>
<tr>
<td>Send <strong>?W</strong> to display active warnings. Follow the corresponding advise if necessary</td>
<td></td>
</tr>
<tr>
<td>Send <strong>FACK=1</strong> (or press <strong>Clear</strong> in the GUI) to acknowledge faults</td>
<td></td>
</tr>
<tr>
<td>Press the Start-button in the GUI or send the command <strong>START</strong></td>
<td>Press the hardware push-button, refer to section &quot;Safety Control (D-Sub 15)&quot; on page 44</td>
</tr>
<tr>
<td>—</td>
<td>Send <strong>FACK=1</strong> (or press <strong>Clear</strong> in the GUI) again; <strong>?F</strong> returns “System OK”</td>
</tr>
<tr>
<td>Send <strong>?STATE</strong> to query the system status, loop this query and wait until the return value is &quot;1&quot; (on)</td>
<td></td>
</tr>
</tbody>
</table>
Further commands are customer-individual and application dependent. The listed procedures are meant as simple examples of command sequences. Parameters are not stored and need to be defined on each start-up.

- **HB=n** to start the heartbeat function with n seconds timeout, recommended command for safety reasons. Make sure to regularly send or query a command within the timeout period n (otherwise the system would shut down the laser diodes); see section "Heartbeat Function" on page 1
- **PM=n** to set the pulse mode, see section "Application signals" on page 1
- **EM=0** to set the modulation to internal (software-control)
- **BURST=n** to set the amount of bursts
- **RRAMPSET=n** to define the requested pulse repetition rate in kHz

In case of a requested closed loop (with power regulation active), see section "Graphical User Interface" on page 1 send:

- Query **?PRIDLETIMEOK** after system-start up (in a loop) until it returns 1
- **PREENABLE=1** to set the control mode of the variable attenuator to closed loop (regulated)
- **PATTSET=nn** defines the requested power in Watt (which will be actively regulated by the attenuator). The maximum of this value can be checked by sending **?MAXIRPOWER**
- **?PATTSET** to query the requested power (valid for closed loop only)
- **RL=nnn** defines the analog level of output of the Modulator in percent (if EM=0)
- **S=1** to open the shutter (make sure to fulfill laser safety and block the beam into an adequate beam dump for testing purposes)
- **?POUT** to query the optical output power in Watt
- **S=0** to close the shutter
- **HB=0** to turn off the heartbeat function prior to turn-off
- **STOP** to stop the laser system
In case of a requested open loop (without active power regulation, see section "Graphical User Interface" on page 1) send:

- PENABLE=0 to activate open loop
- TATT=n to set the optical output power to n%
- ?POUT to query the optical output power in Watt

It is recommended to loop and frequently query certain values. Refer to the section "Monitoring Menu Tab" on page 1 and the corresponding commands in the external commands-list document (sorted by function, table Monitoring).

Frequently send ?W to query the warning status of the system. Various actions might be required due to individual warnings; system remains operational.

If the command returns warning code 537, 538, 539 or 540: consider at your own convenience sending S=0 to close the shutter, send STOP to turn off the laser diodes (system remains powered in status READY) and send MAINT to start the software maintenance. Loop ?MAINT until it returns 0. Then query ?PPLLINFO to get an information on the result of the maintenance sequence.

Resuming operation requires to begin the loop as described at the beginning of this section.

In order to repeat procedures (such as e.g. MAINT) after certain operating hours, ?HH (head hours) can be used for time-calculation.

Frequently send ?F to query the fault status of the system. Various actions might be required due to individual situations; system will stop the operation in case of a fault condition.
The following application-input-signals are described in this section: \textit{Trigger}, \textit{Gate} and External Modulation (\textit{Ext Mod}); as well as the output-signals \textit{Sync 2} and \textit{Pulse Monitor}. The corresponding connectors can be found at the rear side of the laser head, refer to section "Electrical connectors" on page 35. By making use of the internal acousto-optic modulator (AOM), the laser output can be adjusted in different ways (pulse picking, gating, modulating the pulse-energy). These modes can be defined in the GUI main window section \textit{Timing and Frequency} / \textit{Pulse mode} (refer to section "Graphical user interface" on page 1) or via command (refer to the external commands-list document).

\textbf{NOTICE!}
The temporal relation between signals is dependent on individual situations and might need to be measured by customer if relevant.

The HyperRapid NXT / HyperRapid NX laser can be operated at a steady pulse repetition rate (PRF defined internally) up to \textit{Output Pulse Repetition Rate} (value can be found in the CoC). The internal repetition rate can be selected through the Coherent GUI Main menu or via command \texttt{PM=0} and \texttt{RRAMPSET=n} (\texttt{n} indicates the pulse-repetition rate in kHz). The signal-inputs \textit{Trigger} and \textit{Gate} (interfaces at the laser head rear side) are ignored. \textit{Sync 2} is the output-signal synchronized to the internal pulse repetition rate, laser output and output-signal \textit{Pulse Monitor}. The time $t_1$ is approx. 1 $\mu$s.

![Figure 26: Internal trigger](image-url)
**External**

*External* defines the pulse repetition rate by applying a TTL-signal externally through the *Trigger* port on the rear side of the laser head. Choose this feature out of the Trigger mode menu or by sending the command PM=1. The trigger frequency is limited for HRR-systems to the value *Single pulse picking* (value can be found in the CoC); refer to section "High rep.-rate" on page 57 for more information. The laser pulse energy is depending on the pulse repetition rate. *Gate* input is ignored. The time $t_1$ is approx. 1 µs, $t_2$ is approx. 2 µs.

![Diagram: External trigger]

**Internal & gated**

This feature offers a static PRF (created internally) and driving the process-shutter with the external Gate-signal. Connect a TTL-Gate-signal to the *Gate* port on the rear side of the laser head. TTL high enables output pulses and TTL low inhibits output. The pulse repetition rate is defined internally and limited for HRR to the value *Single pulse picking* (value can be found in the CoC). Choose this feature out of the Trigger mode menu or by sending the command PM=2. The time $t_1$ is approx. 1 µs.

![Diagram: Internal trigger & Gate]
In case the application (e.g. scanner-head) offers two signals (PRF and Gate) separately, apply a **Trigger AND Gate** signal to the corresponding connectors located on the rear side of the laser head. Choose this feature out of the Trigger mode menu or by sending the command \( PM=3 \). The trigger frequency is limited for HRR to the value **Single pulse picking** (value can be found in the CoC). The time \( t_3 \) is approx. 1 µs, \( t_2 \) is approx. 2 µs.

**External & gated**

![Diagram](image1)

**Ext Mod**

The process shutter offers the possibility to modulate the pulse energy (limited to the frequency indicated in **Single pulse picking**, refer to CoC) in combination with all functions mentioned above. Use the analog input connector **Ext Mod** in order to influence the output-pulse-energy. The time \( t_3 \) is approx. 1 µs, \( t_4 \) is approx. 1 µs.

**Ext Mod**

![Diagram](image2)
Signals Trigger and Gate combined

In case your application-interface (e.g. scanner-card, translation stage, etc.) offers just one signal including the PRF and Gate signal together, refer to function External (described above). If the PRF is not included into this signal, refer to Internal & Gated.

Dynamic / static PRF

Changing the pulse repetition rate of the output (PRF) dynamically might be requested in case your application includes acceleration phases (such as start, stop and curves), refer to function External or External & Gated. On the other hand some application-interfaces provide "On-the-Fly"-signals excluding these acceleration segments on purpose and request a static PRF-signal, which can be created internally or provided by customer externally.

NOTICE!
Above Single pulse picking frequency, the following limitations apply:
1) Gating function is not synchronized to laser pulses anymore
2) Divider function does not work

High rep.-rate

Single pulse picking is possible by providing the rising edge of the Trigger-signal prior to each pulse. The maximum selectable frequency of the Trigger-signal is limited in case of High-Repetition-Rate-systems (HRR) to the value Output Pulse Repetition Rate, which can be found in the Certificate of Conformity (CoC).

Your laser system might be equipped with a pulse repetition rate above 1000 kHz (depends on your model). One intention of higher pulse output repetition rate is e.g. a faster processing. Note that the optimal pulse repetition rate is highly dependent on further specifications of application (e.g. absorption-efficiency of processing-material, range of scanner-/translation-table-speed, etc.).