Koheras BASIK MIKRO

Low noise single frequency laser module

Instruction Manual

NKT Photonics A/S
Blokken 84
DK-3460 Birkerød
Denmark.

Covered by NKTP intellectual
property rights.

Manufactured in Denmark.

Complies with 21CFR 1040.10
except for deviations pursuant
to Laser Notice No. 50, dated
June 24, 2007.

INVISIBLE LASER RADIATION
AVOID EXPOSURE TO BEAM
CLASS 3B LASER PRODUCT

Maximum output power: 500 mW
Wavelength: 900 - 2100 nm
EN 60825-1:2007

LASER
APERTURE

NKT Photonics
XXXXXXXX
XXXXXXXX

NKT Photonics
the power of light

This product is protected by intellectual property rights including one or more of the following granted or pending patents:

Patents
US7.809.029, US7.792.408, AU1007999, AU731781, B1.007.999, CA2.279.420, CH1.007.999, GE69.838.840.2, DK1.007.999, F10.07.999, UK1.007.999, IRE1.007.999, LUX1.007.999, Mon1.007.999, P1.007.999, S1.007.999, US6.151.429, AU736,870, AU772980, CA2.310.316, GE1040375, F1040375, UK1040375, US6.449.293

Patent applications
CA2.570.544, C2.0058.002.1131.7, EP05.754.189.8, N 20.070.420

Laser safety compliance:

IEC 60825-1:2014

FDA (Food & Drug Administration): 21CFR 1040.10 and 1040.11 (except for deviations pursuant to Laser Notice 50, dated June 24, 2007)

FDA accession number #12R0005-002

Table of Contents

1 General

Please take the necessary time to read this manual. It contains important information on safety issues concerning the usage of the Koheras BASIK MIKRO low noise single frequency laser module.

The safety might be seriously impaired if the instructions are not followed carefully.

This manual covers the Koheras BASIK MIKRO laser module, with the product numbers beginning with K0x2.

The Koheras BASIK MIKRO is a Class 3B laser and only persons who are familiar with laser safety regulations are allowed to operate these modules.

WARNING: invisible radiation emitted from this laser.

CAUTION: Use of controls or adjustments or performance of procedure other than those specified herein may result in hazardous radiation exposure.

If you have any questions concerning this product, please do not hesitate to contact us at support@nktphotonics.com.

Description Koheras BASIK MIKRO is a single frequency distributed feedback (DFB) fiber laser system in a new rugged package with passive vibration reduction, offered as stand-alone laser module.

The Koheras BASIK MIKRO features ultra-narrow linewidth in the Hertz range and exceptionally low frequency and intensity noise superior to other comparable sources.

The Koheras BASIK MIKRO is ideal for coherent sensor applications in oil/gas exploration, perimeter and submarine detection, wind LIDAR and coherent optical communications. Furthermore Koheras BASIK MIKRO is an ideal seed laser for other laser systems.

A PC application is available for monitoring and control of the Koheras BASIK MIKRO. Please refer to the software manual for more information about how to use the graphical user interface.

It is recommended to keep this manual in the area close to the Koheras BASIK MIKRO module, so operators can use it as reference book if required.

2 Laser Safety

Never switch on or attempt to operate the Koheras BASIK MIKRO before reading, understanding and fully familiarizing yourself with the contents of this chapter.

Introduction This chapter is divided into four sections:
- **General Safety Aspects**
  Explains aspects relating to the safe operation of the laser device. See section General Safety Aspects.
- **Special Safety Aspects**
  Outlines the risks specific to working procedures with and on this laser device. See section Specific Safety Aspects.
- **Safety compliance list**
  See section Safety Compliance List.
- **Overview of safety-relevant labels**
  Shows the design and describes the safety labels. See section Labels.
- **Laser goggles.**
  See section Laser protective goggles.

2.1 General Safety Aspects

2.1.1 Basic Operation and Use

Basic Safety The Koheras BASIK MIKRO has been designed in accordance with state-of-the-art standards and recognized safety rules. Nevertheless, its use can constitute a risk to the user or third parties or cause damage to material property.

The Koheras BASIK MIKRO system is not approved nor tested for use in treatment or diagnostics of human and animals and does not comply with European, US or Rest of World requirements for medical device lasers.

Warning: Potential eye and skin burns! Only use the laser according to the procedures described in this manual. Using the laser outside the scope of this manual is not covered by the warranty.

The Koheras BASIK MIKRO must be used only in perfect conditions and according to the procedures described in this manual.

Follow the instructions in this manual, and only let safety conscious persons, who are fully aware of the risks involved, operate the Koheras BASIK MIKRO.

Any functional disorders, especially those affecting the safety of the Koheras BASIK MIKRO, must be rectified immediately.

2.1.2 Organizational Measures

Laser Safety Officer In accordance with the valid national regulations for prevention of accidents, the user is required to appoint a responsible person as the Laser Safety Officer (LSO).

His responsibility is to effect the knowledgeable evaluation of laser hazards and to monitor and enforce their control.

The instruction manual must always be at hand where the Koheras BASIK MIKRO is used. In addition to the operating instructions, observe and instruct the user in all other generally applicable legal and other mandatory regulations relevant to accident prevention.

Protective Equipment	These compulsory regulations also deal with the issuing and/or wearing of personal protective equipment. The necessity of reading the instruction manual applies especially to persons working only occasionally on the Koheras BASIK MIKRO.

Use protective equipment, wherever required by the circumstances or by law.

Warning: Risk of serious injury through incorrect operation! Personnel entrusted to operate the Koheras BASIK MIKRO must have read the instruction manual and in particular the safety instructions. |
| Safety Labels | Ensure that all safety-relevant labels are attached to the laser device in accordance with the label location diagrams in Section Labeling and local regulations. Make sure that these labels are always complete and perfectly legible.

If any labels are missing, immediately inform NKT Photonics A/S. In the event of safety relevant modifications or changes in the behavior of the Koheras BASIK MIKRO during operation, stop the laser device immediately and report the malfunction to NKT Photonics A/S.

Never make any modifications, additions or conversions which might affect safety. This also applies to the installation and adjustment of safety devices. |

2.1.3 Selection and Qualification of Personnel – Basic Responsibilities

Qualified Personnel	Make sure that only authorized personnel work on or with the Koheras BASIK MIKRO. Statutory minimum age limits must be observed. Employ only trained or instructed staff and set out clearly the individual responsibilities of the personnel for operation and set up.

2.1.4 Safety Instructions Governing Specific Operational Phases

Precautions	Take the necessary precautions to ensure that the Koheras BASIK MIKRO is used only when in a safe and reliable state.

In the event of malfunctions, stop the laser device immediately and lock it. Have any defects rectified immediately.

Before starting the Koheras BASIK MIKRO ensure that nobody is at risk. Brief operating personnel before beginning special operations, and appoint a person to supervise the activities. Ensure that the operations area is adequately secured. |

2.2 Specific Safety Aspects

Specific safety aspects are:
- Physical hazards related to the system. See Section Physical Hazards.
- Protection of the users of the system against these hazards. See Section Personnel Safety.
- Constructive protective measures against these hazards. See Section Constructive Safety Features.

Lasers and laser systems are classified according to their relative hazards. These devices have been classified under the international Standard IEC 60825-1:2007 and meet 21CFR 1040.10 and 1040.11 (except for deviations pursuant to Laser Notice 50, dated June 24, 2007).

Within this classification, the Koheras BASIK MIKRO is a Class 3B laser

2.2.1 Physical Hazards

Warning   The laser beam is very dangerous to the eyes and skin!

The following are hazardous,
- Direct radiation-light as it leaves the laser.
- Reflected radiation-light which has hit a surface and bounced off.
- Diffuse radiation-light, which has hit a surface, bounced off, and scattered.

Emitted Light   In case of malfunction the Koheras BASIK MIKRO may provide laser radiation with power levels up to 500 mW. The operating wavelength is between 900 nm to 2100 nm. Despite the non-ionizing nature of the operating wavelengths, damage can still occur to living tissue as a result of heat produced during radiation absorption. All radiation of the Koheras BASIK MIKRO lies outside the visible range. Suitable beam dumps must be used at all times when the laser product is operating.

In general, the maximum permissible radiation exposure for the skin is several times greater than for the eye. Safety measures with regard to the radiation hazard are therefore mainly based on dangers for the eye. Not only are the direct laser beam hazardous, but unchecked reflections of laser light also constitute a potential hazard.

2.2.2 Personnel Safety

Personnel Protection   **The Koheras BASIK MIKRO is a Class 3B laser.**

Warning:
Risk of serious injury! Always wear protective eyewear when there is a chance of exposure to radiation from the laser. Before putting on the protective eyewear, check them for any obvious defects. As the filter in the protective eyewear provides protection for only a narrow band of wavelengths, make sure you are wearing the appropriate protective eyewear for the laser device in question. Check with your Laser Safety Officer or other safety personnel for guidance in selecting the appropriate eyewear.

Radiation Safety
The Koheras BASIK MIKRO emits near-infrared radiation (900-2100 nm), which constitutes a hazard to personnel during periods of operation.

Protective Eyewear   The ANSI (American National Standards Institute) standard for safe use of lasers requires that a set of protective goggles blocking the appropriate laser wavelength should be worn while operating or servicing Class 3B lasers.

Clearly label the goggles with an optical density and the specified wavelength. To avoid confusion, keep these goggles separate from other safety glasses and personal protective equipment.

Using the wrong type of goggles is dangerous. It can be worse to have improper eyewear and a false sense of security than to have no eyewear and take precautions based on the absence of protection. Even if you are wearing protective goggles, never look directly into the beam; intense laser radiation is capable of destroying the protective filter.

Eye Protection   **Warning:**
Potential eye burns! Only use the laser according to the procedures described in this manual. Safety interlocks are only to be overruled by authorized personnel.

The following guidelines describe some of the actions necessary to avoid injury caused by the laser beam. Always follow these guidelines and take additional

precautions if necessary.

- When eyewear is necessary, make sure it provides full protection, that is, it must have sufficient optical density (OD) to reduce exposure from an enabled laser beam (either direct beam or specular reflection) to a level below the maximum permissible exposure (MPE. The MPE and OD requirement must be evaluated for each enabled laser beam).
- Laser eyewear protection must be labeled with wavelength-dependent OD information.
- Make sure that all personnel in the vicinity of the laser wear protective eyewear.
- Permit only qualified personnel to operate the laser.
- Never intentionally look directly into any laser beam.
- Avoid indirect viewing of direct or reflected laser radiation. Specular reflections (from reflective surfaces) can be as dangerous as the direct laser beam. Do not view the beam through optical instruments unless the optics is designed to filter the laser wavelength.
- Take precautions to ensure that there are no reflecting objects in the path of the laser beam.
- Do not deviate from standard operating procedures when working with laser equipment.
- Use lasers only in approved applications and locations. Take adequate precautions to prevent unauthorized personnel from entering the area where a Class 3B laser is operating. Do not use lasers around untrained personnel. Ensure that all personnel in the area observe proper safety precautions.
- Report all incidents of exposure to your supervisor.
- Clearly display warning signs indicating the laser enclosed area with an additional warning light outside the door.
- Adhere to local and national regulations governing the safe use of lasers.

Depending on system variant the Koheras BASIK MIKRO system provides infrared laser emission between 900 and 2100 nm. Protective eyewear must provide sufficient protection for these wavelengths. The laser protective goggles must provide minimum OD 3+ protection.

A suggestion for protective eyewear could be goggles with FG1 filter from LaserShield. More information can be found at:
http://www.noirlaser.com/filters/fg1.html

Skin Protection **Warning:**
Potential skin burns! Direct and reflected laser radiation can burn exposed skin. Only use the laser according to the procedures described in this manual. Safety interlocks are only to be overruled by authorized personnel.

- Although the skin can withstand considerably higher radiation intensity than the eyes, tissue may be burned to a greater or lesser degree, depending on the radiation time and the irradiation intensity.
- Avoid contact between the skin and the beam, or specular reflections of the beam. Reflections of the beam may be as dangerous as the beam itself. Wear appropriate protective clothing to protect the skin whenever necessary.

2.2.3 Constructive Safety Features

Safety Features   The laser device is equipped with the following constructional safety features:

- Appropriate Class 3B label affixed to laser device enclosure (see section Labeling).
- All parts of the laser where laser radiation may possibly escape are marked with the appropriate adhesive danger signs (according to IEC 60825).
- The electrical interface of the Koheras BASIK MIKRO includes pins for the laser interlock circuit (see section Electrical Interface). The interlock switch shuts down the laser remotely, for instance, if a door connected with the switch is opened.

2.2.4 General Safety Features

General Safety   The Koheras BASIK MIKRO is an OEM laser designed to be built into a laser system. The Koheras BASIK MIKRO therefore does not have key-switch controlled laser operation.

2.3 Safety Compliance List

CE Approval   The Koheras BASIK MIKRO is CE-marked and has complies with FCC and VCCI as well.

FDA Approval   The Koheras BASIK MIKRO and complies with 21CFR 1040.10 except for deviations pursuant to Laser Notice 50, dated June 24, 2007.

UL and CSA   The equipment is not UL- or CSA-approved. The system does not have a main inlet
Approval   and no voltages inside the system are higher than 60 VDC (nominal).

2.4 Labeling

This section contains a description of the safety labels on the Koheras BASIK MIKRO and shows their location on the equipment. Ensure that all warning labels are affixed to the system as outlined in this chapter prior to operating the system.

2.4.1 Labels used on Koheras BASIK MIKRO

The Koheras BASIK MIKRO contains the following labels:
- Invisible Classification label, see figure 2-1.
- Laser label, see figure 2-2.
- Specification label, see figure 2-3.
- Laser Aperture label, see figure 2-4.
- Item label, see figure 2-5.

Invisible   The invisible classification label informs about invisible laser radiation from the Koheras BASIK MIKRO. The Koheras BASIK MIKRO is a Class 3B laser product. Exposure to eye and skin must be avoided from both direct and scattered radiation.

INVISIBLE LASER RADIATION
AVOID EXPOSURE TO BEAM
CLASS 3B LASER PRODUCT

Figure 2-1: Classification label

Laser Source   The Laser label indicates that laser light is emitted from the Koheras BASIK MIKRO.

Figure 2-2: Laser label

Specification   The Specification label provides information about what kind of laser emission is radiated from the Laser Aperture and that the Koheras BASIK MIKRO product complies with the IEC 60825-1 standard.

Figure 2-3: Specification label

Aperture Label   The Laser Aperture label is placed next to the main fiber output on top of the module and indicates the location of the optical main output and hereby the Laser Aperture. The Laser Aperture label warns users that laser light is emitted from this Laser Aperture.

Figure 2-4: Laser Aperture label

Item   *The Item label provides information about:*
- *the manufacturer of the system (NKT Photonics)*
- *the product number (P/N) for the actual system, e.g. K012-100-605*
- *the serial number (S/N) for the actual system 8 digits, e.g. 13510178*
- *when the actual system was manufactured, e.g. 02-2014 for February 2014*

Figure 2-5: Item label

In addition to safety and item labels following is printed on the module:

- *the name of the product, i.e. Koheras BASIK MIKRO*
- *the manufacturer of the system (NKT Photonics A/S, Blokken 84, DK-3460 Birkerød, Denmark)*
- *compliance with the EU consumer safety and environmental requirements (CE-mark)*
- *where the product is manufactured, e.g. in Denmark*
- *that the product is covered by NKT Photonics property rights*
- *Laser Notice No. 50, which indicates that the product complies with FDA requirements*

2.4.2 Label Positions

The positions of safety labels and silk screen on the top cover and front are shown on figure 2-6.

Figure 2-6: Safety labels on Koheras BASIK MIKRO

3   Requirements

Room Requirements   The Koheras BASIK MIKRO is a Class 3B laser product and the operation room and operation conditions need to comply with the following requirements:

- CFR21 1040.10 & Laser Notice LN50
- IEC / EN 60825-1

Alternatively the Koheras BASIK MIKRO should be operated in accordance with local regulations for a Class 3B laser source.

Warning   **Make sure that at all times during system operation the beam path is known and controlled. Wear suitable protection and make sure everybody in the laser area is aware of the fact that the system is being operated.**

4 Interface

4.1 Front Panel

The front panel of the Koheras BASIK MIKRO contains the following.

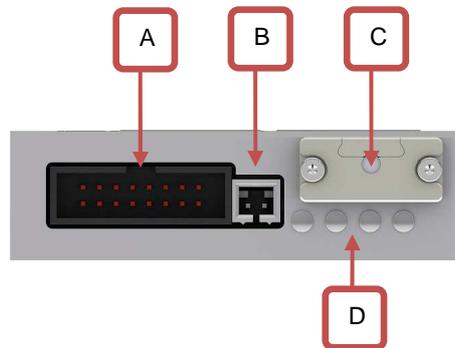*Figure 4-1: Front panel of Koheras BASIK MIKRO*

Front Panel
Functions

A. Electrical Interface
B. Wavelength Modulation Input
C. Optical Output
D. LEDs

4.1.1 Electrical Interface

The electrical interface on the Koheras BASIK MIKRO module features power supply for the module, digital communication, interlock signals, etc.

Connector Type

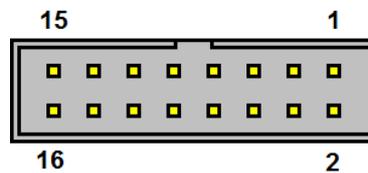The connector used in the Koheras BASIK MIKRO for the electrical interface is a 16 pins IDC type.

Figure 4-2: Electrical interface pin-out

Pin Connections   The table below provides the pin-out of the electrical interface.

Pin no.	Name	Description
1	Module OK	Low: module enable low OR module not stable (frequency tuning) High: module stable (frequency)
2	Emission	Collector output with internal 240 Ω resistor in series. High when the Koheras BASIK MIKRO has laser emission ON. Anode from a LED can be connected directly to this pin and the Cathode to GND to indicate laser emission externally.
3	RS485-	The negative/inverted part of the RS485 communication signal.
4	RS485+	The positive/non-inverted part of the RS485 communication signal.
5	Interlock loop+	Positive connection of interlock loop. Should be connected to Interlock loop- (pin no. 7) to enable laser emission from the system.
6	Enable	Logic input. Must be High (5V) in order to achieve laser emission. If emission has been obtained and Enable goes low, emission is shut off.
7	Interlock loop-	Negative connection of interlock loop. Should be connected to Interlock loop+ (pin no. 5) to enable laser emission from the system.
8	Interlock	Logic input. Must be High (5V) in order to achieve laser emission. If emission is obtained and Interlock goes low, emission is shut off. This control input is for personal safety, and handled with redundancy inside the module.
9-12	GND	0 volt / ground.
13-16	12V	+ 12 volt supply voltage for Koheras BASIK MIKRO module.

Table 4-1: Electrical interface pin-out

A 16 pin female IDC type connector should be used to interface with the Koheras BASIK MIKRO.

4.1.2 Wavelength Modulation Input

The Koheras BASIK MIKRO module features an electrical connector for fast wavelength modulation. The wavelength modulation input has only a function on laser modules that features wavelength modulation.

Part numbers   Part numbers K0x2-xxy-xxx, where 'x' can be any number but 'y' is either '2' or '3' features fast wavelength modulation.

Connector Type   The connector is a 2-pin SL type connector and the matching connector to be used should be 50-57-9402 from Molex or similar.
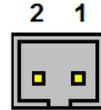

Figure 4-3: Wavelength modulation pin-out

Pin Connectors   The table below provides the pin-out of the wavelength modulation input.

Pin no.	Name	Description
1	Wavelength+	Positive control signal for fast wavelength modulation. The higher positive signal on Wavelength+ relative to Wavelength- leads to a larger optical wavelength. The voltage level on this pin must be between -10 and +100 volt relative to Wavelength-.
2	Wavelength-	Negative control signal for fast wavelength modulation. The voltage level on this pin must be between -10 and +10 volt relative to GND.

Table 4-2: Wavelength modulation pin-out

Capacitance   The wavelength modulation function is made with a piezo element inserted in the laser substrate where the fiber laser is mounted. The piezo element is from an electrical point of view seen as a capacitor with a capacitance at 450-700 nF.

Slew Rate   The slew rate of the electrical signal must not be larger than 50 V/ms. For a sinusoidal signal applied to the Wavelength+/- input this corresponds to maximum 159 Hz at 100 Vpp.

4.1.3 Optical Output

Optical Output   The Koheras BASIK MIKRO module has a fiber patch cord, which features the optical output. Default connector type is FC/APC. Patch cord jacket is 3 mm and default length is approx. 50 cm.

PM   If the module has polarization maintaining output, slow axis is default aligned to key, i.e. laser polarization (E-field) is parallel to key.

4.1.4 LEDs

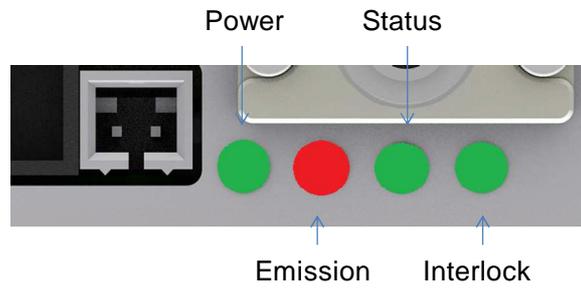The front panel holds four LEDs which indicate different states.

Figure 4-4: LEDs

Power	Off: module is not powered up Red: supply voltage low Green: supply voltage OK Flashes yellow: module is transmitting data
Emission	Off: no emission from the module Red: laser emission from the module
Status	Yellow: module enable low OR module not stable (frequency tuning) Green: module stable (frequency)
Interlock	Green: Interlock status is okay Red: Interlock status is not okay

4.2 Module Case

4.2.1 Heat Transfer Surface

Heat Transfer
Surface

Heat generated in the Koheras BASIK MIKRO module should be transferred to the environment. All power consuming parts inside the Koheras BASIK MIKRO module is thermally connected to the bottom of the module case, hence the module should have a proper thermal path from the bottom of the module case to the environment.

Thermal Resistance

Thermal resistance ($R_{\theta)}$ to the environment depends on the maximum environmental temperature, the maximum module temperature and maximum power consumption for the module.

$$R_{\theta} = (t_{module} - t_{environment}) / P_{max}$$

Where t_{module} is 60 °C and P_{max} is 10 Watt.

4.2.2 Mounting Holes

Mounting Holes

The module features six mounting holes that can be used for mounting and fixation of the Koheras BASIK MIKRO module. Please refer to the mechanical drawing at the end of this document for specifications on the actual positions of the mounting holes.
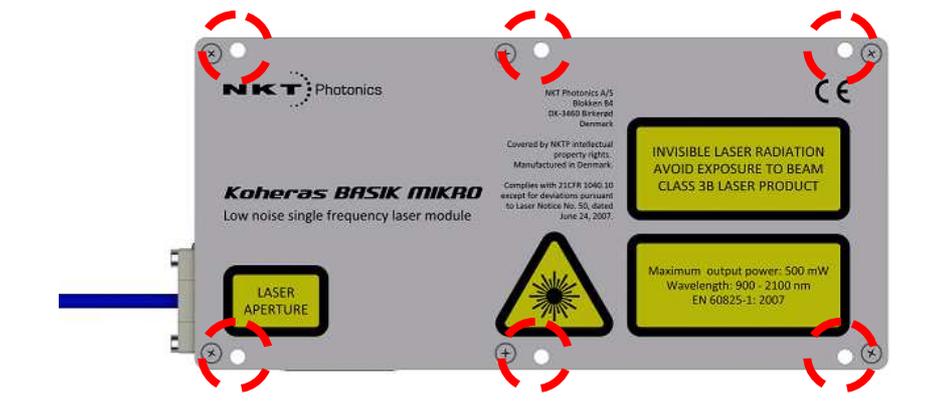

Figure 4-5: Mounting holes

5 Features and Functions

The K0x2 Koheras BASIK MIKRO module exists in different variants with different possibilities and options. The graphical user interface, NKT Photonics CONTROL, is very user-friendly, where only available options are shown for the specific module. The manual for NKT Photonics CONTROL provides additional information if needed.

For those who want to develop their own software and interface with the K0x2 Koheras BASIK MIKRO module, please refer to the Software Development Kit, which provides information about how to communicate with the module.

Because of the different variants, possibilities and options the following sub-sections contains some information about registers and bits as help together with the Software Development Kit for those who wants to develop their own software. This information is *written in italics.*

5.1 Thermal Tuning

Thermal Tuning
: The wavelength can be controlled by changing the temperature of the fiber laser. The fiber laser is mounted under tension on a substrate, and thus when changing the temperature of the substrate, the laser cavity length changes also. Since the temperature of the laser cavity itself will also change, the laser wavelength changes in response to a combination of thermo-optic and physical change of the optical path length.

Laser Substrates
: There are two different types of fiber laser substrates available for the Koheras BASIK MIKRO module. The standard substrate provides limited thermal tuning. If more thermal tuning is required the large thermal tuning substrate should be chosen. However this provides reduced immunity to vibrations and acoustic pick-up.

Part Numbers
: For part numbers K0x2-xxy-xxx, where 'x' can be any number, the number 'y' tells which kind of substrate is used for the fiber laser. If 'y' is '0' or '2' the laser has the large thermal tuning substrate. If 'y' is '1' or '3' the laser has the limited thermal tuning substrate.

Registers
: *The relation between temperature and fiber laser wavelength is stored in the laser module. So in order to tune the laser thermally, write the desired wavelength relative to the nominal wavelength to register 0x2A.*

5.2 Wavelength Modulation

Wavelength modulation is an option for Koheras BASIK MIKRO. Laser modules that include this option can be modulated with an electrical input signal.

Part Numbers

Koheras BASIK MIKRO modules with part numbers K0x2-xxy-xxx, where 'x' can be any number and 'y' is either '2' or '3', have the wavelength modulation option. As described in the previous section option '2' provides larger thermal tuning than '3', but '3' is more immune with respect to vibrations than '2'.

Wavelength+/-
Signal

The Wavelength+/- in the Wavelength modulation input connector is an input used for wavelength modulation of the laser. A positive voltage (on Wavelength+ relative to Wavelength-) leads to a larger wavelength.

Please notice that wavelength modulation is not centered around the nominal wavelength, caused by thermal tuning of the laser, as the signal applied to Wavelength+/- must be biased positive.

It is recommended to connect Wavelength+/- to each other with e.g. a jumper when modulation is not used, to prevent noise pick up which could create undesired phase noise.

Frequency
Response

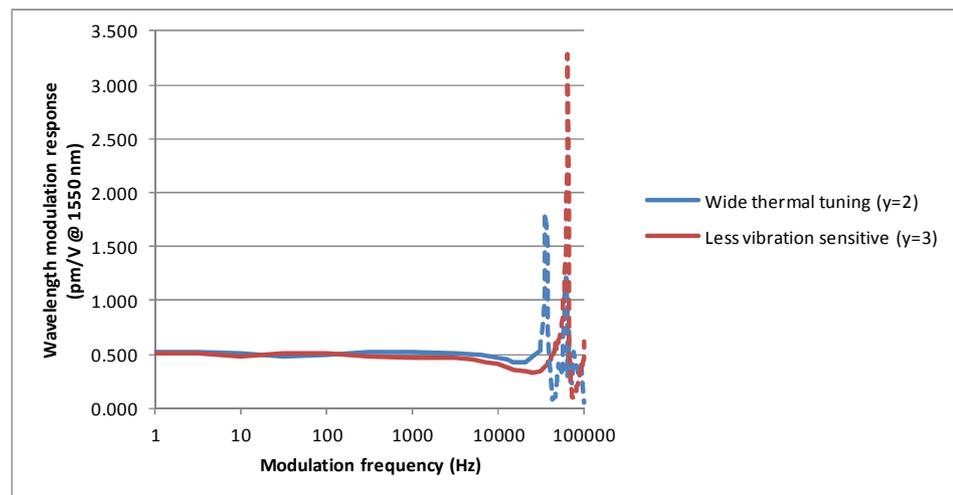The frequency response for wavelength modulation is shown in the figure below.

Figure 5-1: BASIK MIKRO wavelength modulation response

The response shown in the figure above is for a laser with a wavelength at 1550 nm. The response is scaled lineary with the wavelength of the laser, hence a Koheras BASIK MIKRO Y10 module with a wavelength at 1064 nm has a response at ~0.36 pm/V at low frequencies.

The frequency response is fairly flat up to 20 kHz, but resonances are seen at frequencies at ~30 kHz and above. Wavelength modulation can be used for frequencies above 20 kHz, but it is recommended not to modulate the laser at the resonance frequencies.

As it can be seen in the figure above, the substrate providing less vibration sensitivity has its resonances higher in frequency, so modules with this substrate is more suitable for aplications with modulation in between 30 and 45 kHz is required.

5.3 Operating Mode

All modules can operate in the so-called 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.

Power mode provides the best performance for Koheras BASIK MIKRO E15 and X15 modules and is the recommended choice. Power mode for Koheras BASIK MIKRO C15 and Y10 provides best power stability, whereas Current mode provides better frequency stability. The recommended choice for Koheras BASIK MIKRO C15 and Y10 thus depends on the requirements of the application.

Modules, that feature both Current mode and Power mode, will be configured from factory to operate in Power mode.

Register
On modules where it is possible to shift between the two operating modes, use register 0x31 bit 8, where '0' means Power mode and '1' means 'Current mode'.

5.4 Auto-Start

Auto-Start
The Koheras BASIK MIKRO module has an Auto-start control bit, which will initiate laser emission from the module when the module is powered up if this bit is set. This mode can be useful for applications where no communication with the module is possible.

Interlock
The Interlock signal in the electrical interface must be high when the module is powered up for the Auto-start of laser emission to happen. Even if Interlock goes High following, this will not initiate laser emission.

The Auto-start function can be enabled/disabled with NKT Photonics CONTROL in the Settings, Auto-start menu.

Register
Use register 0x31 bit 10 to enable/disable the Auto-start function, where '0' means 'disabled' and '1' means 'enabled'.

5.5 Emission Delay and Shutdown Delay

Emission Delay
The Koheras BASIK MIKRO module has a so-called Emission Delay register, which is set to 1.5 seconds. When emission is initiated the emission LED on the front of the module and the Emission output in the electrical interface will indicate emission right away, but laser light is not emitted until 1.5 seconds later.

Shutdown Delay
When emission is turned off either via micro-controller or if the Interlock or the Enable pins in the electrical interface is pulled down, laser emission is not aborted until 100 milli-seconds later. This delay is to ensure seed signal does not disappear before an interfacing amplifier is shut down when the module is used in an amplified system.

5.6 High Temperature Shutdown

High Temperature Shutdown
If the module temperature exceeds 65 °C, the module is shut down internally to prevent thermal run-away. During high temperature shutdown communication is still possible, but thermal control inside the module and laser emission is shut off.

Auto-Start
When the module temperature drops below 60 °C, laser emission is automatically re-initiated if laser emission was on before high temperature shutdown or if Auto-start is enabled.

5.7 Power Verification

If the internally monitored output power level from the fiber laser stage drops below a pre-defined level relative to pump current, laser emission is automatically shut off. The slope is different from module to module, as the emission efficiency varies between modules. This auto-shutdown will prevent e.g. the output power going to its maximum value in the case where feedback to the internal output power reading disappears.

6 Recommended Mounting

The Koheras BASIK MIKRO is designed to be used as a stand-alone module. The figure below shows the recommended way of mounting.
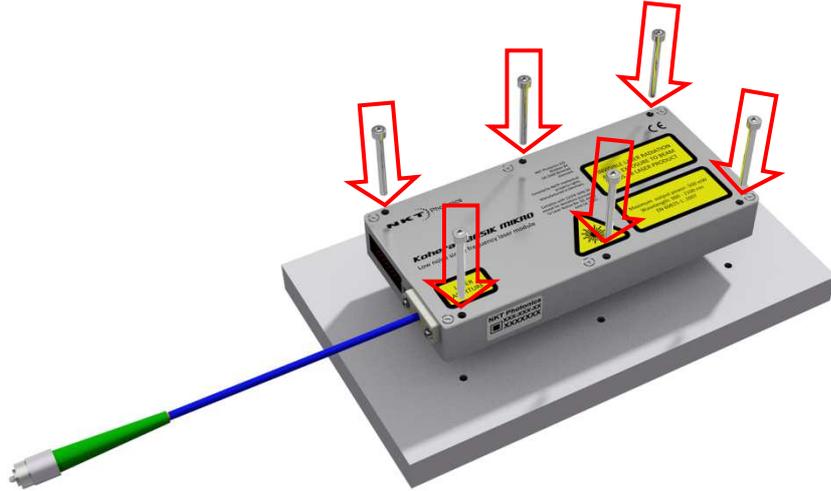

Figure 6-1: Mounting of Koheras BASIK MIKRO

Mount the Heat Transfer Surface on the rear of the module to some kind of heat sink. Use the Mounting Holes for fixation and to ensure good thermal contact the heat transfer surface.

For details about dimensions, please refer to Module Dimensions.

7 Operation

7.1 Precautions

Warning

Make sure at all times during system operation that the laser aperture is at a known and controlled location. Wear suitable protection and ensure everyone in the laser area is aware that the system is being operated.

Clean Patch Cable

Due to optical power transmitted through the single mode fiber surface of the optical connector(s) it is important to keep the connector face clean.

Please note which fiber type has been applied on the laser and match the patch cord accordingly.

7.2 Turning ON the Koheras BASIK MIKRO

Turning On

Use the following procedure to turn the system on.

Step	Procedure
1.	Mount the Koheras BASIK MIKRO module where it should be used with mechanical/thermal contact to an external heat sink.
2.	Connect the optical output from the Koheras BASIK MIKRO to its point of use.
3.	Ensure that both Interlock and Enable are pulled High according to description in Electrical Interface section.
4.	Provide 12 VDC to the Electrical Interface.
5.	Verify that the Power LED on the front panel emits green light.
6.	Turn on laser emission manually with graphical user interface, or let Auto-start turn on emission automatically.
7.	Wait for Status LED to emit constant green light and/or Module OK signal in the electrical interface to become High. Both signals indicate stable laser operation.

The Koheras BASIK MIKRO is now ready for use.

8 Computer Controlled Operation

Graphical User Interface

The Koheras BASIK MIKRO can be controlled from a computer via the NKT Photonics CONTROL software.

Please refer to the manual for NKT Photonics CONTROL for details on installing and operating this software.

NKT Photonics CONTROL can be downloaded from our website on:
http://www.nktphotonics.com/support/software-drivers/

Software Development Kit

The Koheras BASIK MIKRO utilizes a binary protocol. For detailed information about how to communicate with the module via this binary protocol, please refer to the NKT Photonics Software Development Kit for details.

The Software Development Kit can be downloaded from our website on:
http://www.nktphotonics.com/support/software-drivers/
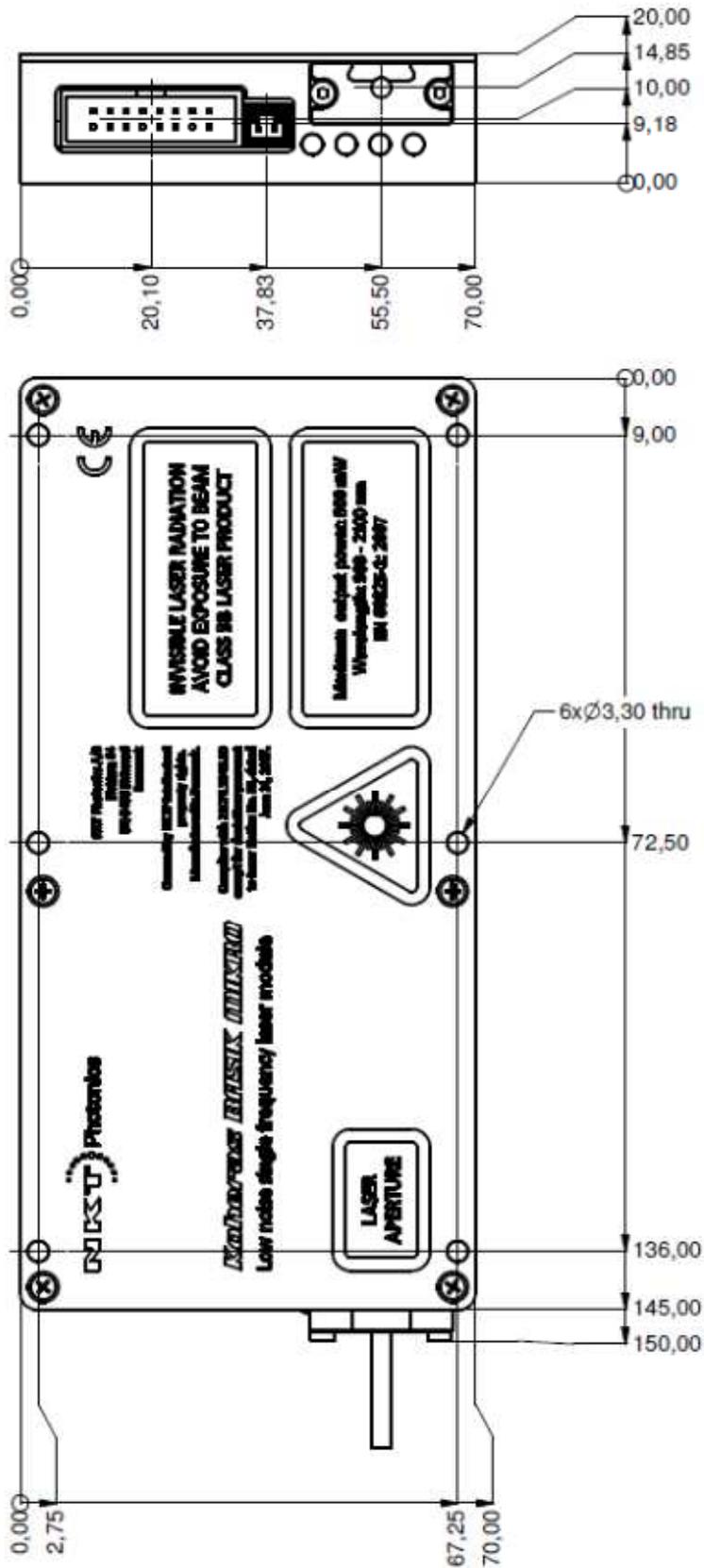
9 Service

The Koheras BASIK MIKRO does not contain any user serviceable parts. If the system starts to malfunction, consult NKT Photonics A/S. The unit is sealed with a label "WARRANTY VOID IF REMOVED" and the module should under no circumstances be opened.

10 Electrical and Mechanical Specifications

Specifications below are only for the Koheras BASIK MIKRO module itself.

Parameter	Conditions	Value	Unit
Operating temperature range	Module temperature	15 to 60	°C
Storage temperature		-20 to 60	°C
Humidity	Non condensing	0 to 70	%RH
Supply voltage		11 to 13	VDC
Power consumption		Max. 10	W
Wavelength+/- input voltage range		-10 to 100	V
Wavelength- voltage level	Relative to GND	-10 to 10	V
Height	See drawing below, (excl. pig-tail)	20	mm
Width		70	
Depth		145/150	
Weight		Approx. 0.35	kg

10.1 Module Dimensions