DFB13TK
Low-Noise DFB Laser System

User Guide

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Chapter 1 Introduction

1.1 Intended Use

The DFB13TK is intended to be used in a laboratory environment. For optimal performance the DFB13TK should be bolted down to an optical table or breadboard when in use. The DFB13TK should only be powered with the supplied Thorlabs DS12 power supply.

The product may only be used in accordance with the instructions described in this manual. Any other use will invalidate the warranty.

1.2 Explanation of Safety Warnings

⚠CAUTION Caution indicates a hazard with a low level of risk that, if not avoided, could result in minor or moderate injury.

NOTICE Indicates information considered important, but not hazard-related, such as possible damage to the product.

 Laser Radiation Warning

 Danger, Warning, or Caution

The CE/UKCA markings on the product are the manufacturer's declaration that the product complies with the essential requirements of the relevant European health, safety, and environmental protection legislation.

The symbol on the product, the accessories or packaging indicates that this device must not be treated as unsorted municipal waste but must be collected separately.

1.3 Description

The DFB13TK turnkey laser system seamlessly incorporates a high-power, narrow-linewidth O-band distributed feedback laser into a user-friendly benchtop housing. The integrated laser driver electronics are engineered to minimize electrical noise, ensuring the laser output achieves exceptionally low relative intensity noise (RIN) as well as its specified narrow linewidth. To mitigate the impact of back-reflected light, a fiber isolator is integrated at the laser output. Power is supplied by Thorlabs's DS12 power supply (12 V, 4 A).

Out of the box, the DFB13TK is configured with pre-set operating conditions, guaranteeing a minimum output optical power of ≥100mW. The inclusion of an enable push-button switch facilitates easy activation at a pre-set current level. For applications requiring customized laser operating conditions, the laser set-points can be adjusted using a command-line interface via USB connection to the instrument's back panel. This remote operation capability also enables users to toggle the laser on and off and monitor device status indicators.

For applications requiring current or temperature modulation, the laser system features three analog modulation inputs with SMA connectors on the front panel. These include an AC-coupled and a DC-coupled laser current modulation port. Additionally, a laser chip temperature modulation port is included, though it is turned off by default and can be activated via a command sent through the USB interface. Refer to Section 4.3 of this manual for further details on these features. The modulation ports can be utilized for either modulating the laser power/wavelength or for locking the laser wavelength to an optical frequency reference.

1.4 Technical Data

1.4.1 Specifications

Laser Specifications (Taken at Factory Preset Operating Conditions)				
	Symbol	**Min**	**Typical**	**Max**
Center Wavelength	λ_C	1305 nm	-	1315 nm
Output Power[a]	P_{OP}	100 mW	-	-
Laser Linewidth[b]	Δv	-	100 kHz	200 kHz
Mode-Hop-Free Operating Current[c]	$I_{Mode\text{-}Hop\text{-}Free}$	50 mA	-	500 mA
Mode-Hop-Free Power Range	$P_{Mode\text{-}Hop\text{-}Free}$	15 mW	-	100mW
SMSR in Mode-Hop-Free Range	SMSR	35 dB	50 dB	-
Threshold Current	-	-	15 mA	-
Slope Efficiency	$\Delta P/\Delta I$	-	0.27 W/A	-
Current Tuning Coefficient	$\Delta\lambda/\Delta I$	-	0.003 nm/mA	-
Laser Chip Temperature Tuning Coefficient	$\Delta\lambda/\Delta T$	-	0.08 nm/°C	-
Laser Chip Temperature Tuning Range	-	15 °C	-	35 °C
Temperature Tuning Range[d]	-	-	1.6 nm	-
Relative Intensity Noise (RIN)[e]	-	-	-150 dBc/Hz	-
Polarization Extinction Ratio (PER)	r_{ex}	-	25 dB	-
Output Isolation	ISO	-	25 dB	-

a. Measured at the bulkhead with pre-calibrated operating conditions from factory

b. Measured based on the Lorentzian definition. Please refer to Section **1.4.2** for details.

c. The DC current set-point is adjustable up to 450 mA. Applying a modulation input to the AC modulation port can add up to 50 mA of additional current modulation, up to a maximum current of 500 mA.

d. Mode-Hop-Free Single-Frequency Operation

e. Represents the typical value at 10 MHz frequency.

Fiber Specifications	
Output Fiber Type	PM1300
Output Fiber Connectors	FC/APC Compatible 2.0 mm Narrow Key

Typical External Modulation Specifications	
AC-Coupled Modulation Port Voltage to Current Conversion Rate	10 mA/V
AC-Coupled Modulation Laser Wavelength Tuning Range	±0.15 nm
AC-Coupled Modulation Laser Power Tuning Range	±10 mW
DC-Coupled Modulation Port Voltage to Current Conversion Rate	2 mA/V
DC-Coupled Modulation Laser Wavelength Tuning Range	±0.03 nm
DC-Coupled Modulation Laser Power Tuning Range	±1 mW
Voltage to Temperature Conversion Rate	Firmware Adjustable (Default = 0.2 °C/V)
Input Voltage Range (All Ports)	-5 V to 5 V
Input Impedance (All Ports)	1 kΩ
AC Current Modulation Frequency Range[a]	2 kHz to 20 MHz
DC Current Modulation Frequency Range[a]	DC to 5 MHz
Temperature Modulation Frequency Range	DC to 1 Hz

a. Specified bandwidth refers to the 3 dB electrical bandwidth of the modulation circuits. Laser response has a slow roll-off for frequencies above 1 MHz.

Absolute Maximum Ratings	
Absolute Maximum Output Power	145 mW
Operating Temperature	15 to 35 °C
Storage Temperature	-10 to 40 °C

General Specifications	
Input Voltage	12 V (from DS12 Power Supply)
Input Power	20 W (Max)
Dimensions (W x D x H)	10.00" x 5.31" x 2.94" (254.0 mm x 135.0 mm x 74.6 mm)
Weight	4.7 lbs (2.1 kg)
Laser Class	1M

1.4.2 Graphs

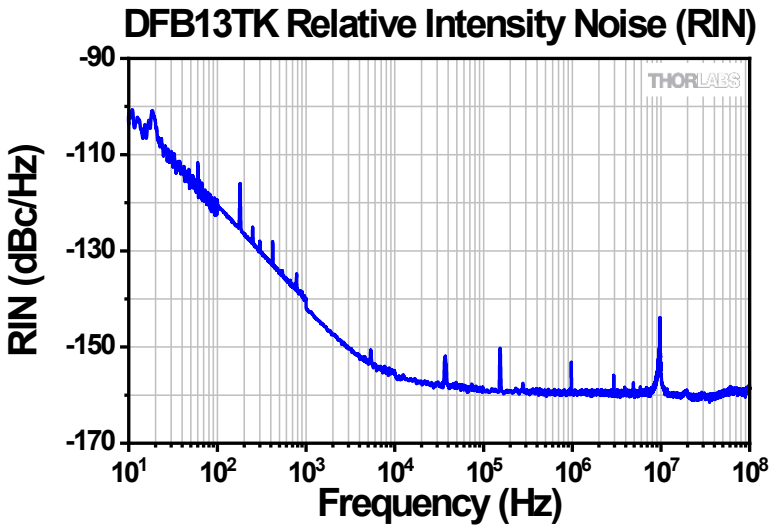


Figure 1 Typical Low-Frequency Relative Intensity Noise (RIN)

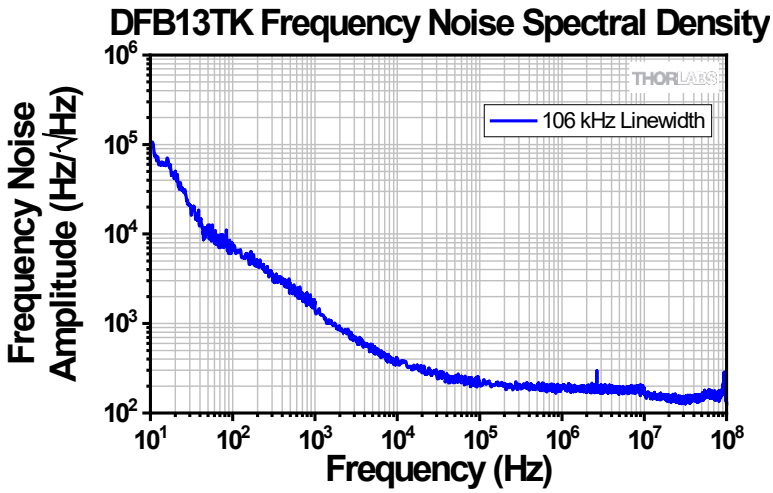


Figure 2 Example Frequency Noise

The Lorentzian / instantaneous linewidth may be estimated from the high-frequency white noise level of the noise plot, according to:

$$\text{Lorentzian Linewidth} = \pi \times (\text{White Noise Level})^2,$$

where the white noise level is measured in hertz/sqrt(hertz). The linewidth at longer integration times may be estimated using the method described in:

Gianni Di Domenico, Stéphane Schilt, and Pierre Thomann, "Simple approach to the relation between laser frequency and laser line shape", *Applied Optics*, vol. 49, no. 25, pp. 4801 - 4807, 2010.

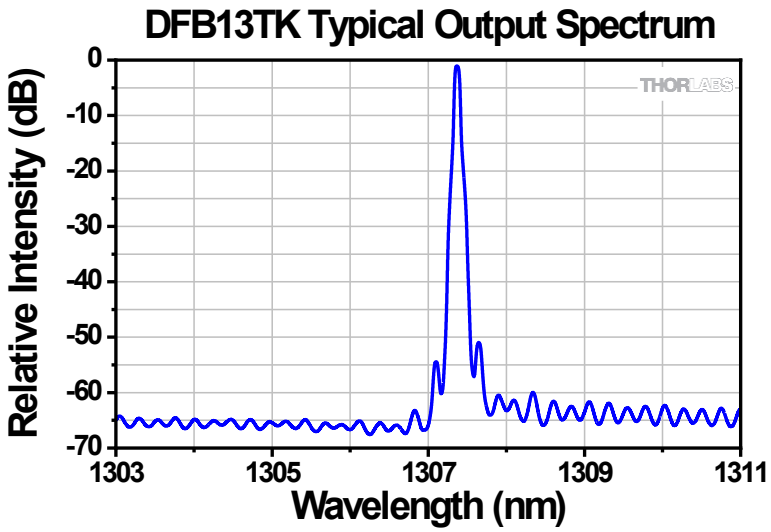


Figure 3 Typical Output Spectrum at Factory-Set Conditions

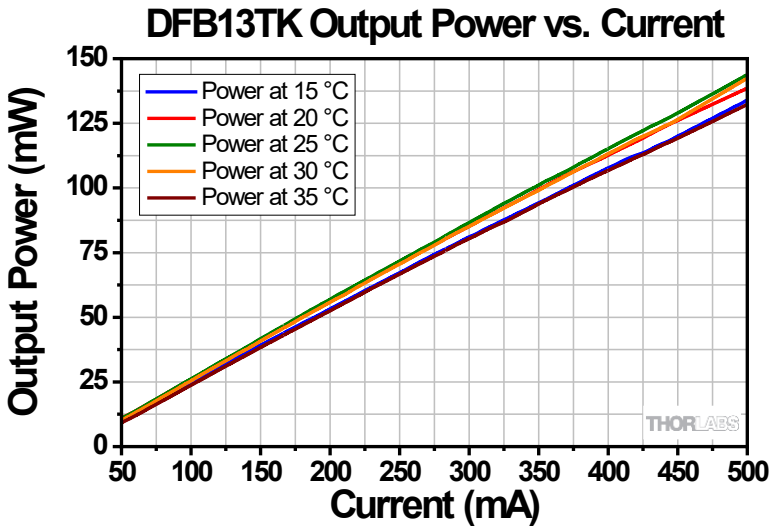


Figure 4 Example Output Power vs. Current

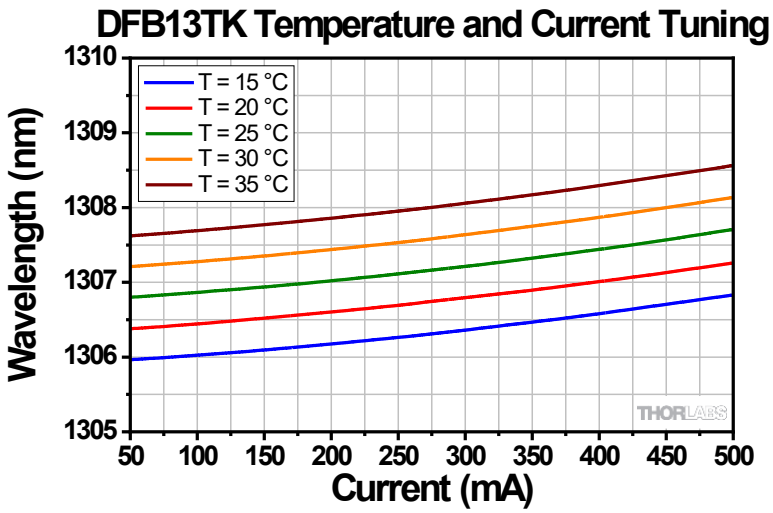


Figure 5 Example Temperature and Current Tuning

1.4.3 Mechanical Drawings

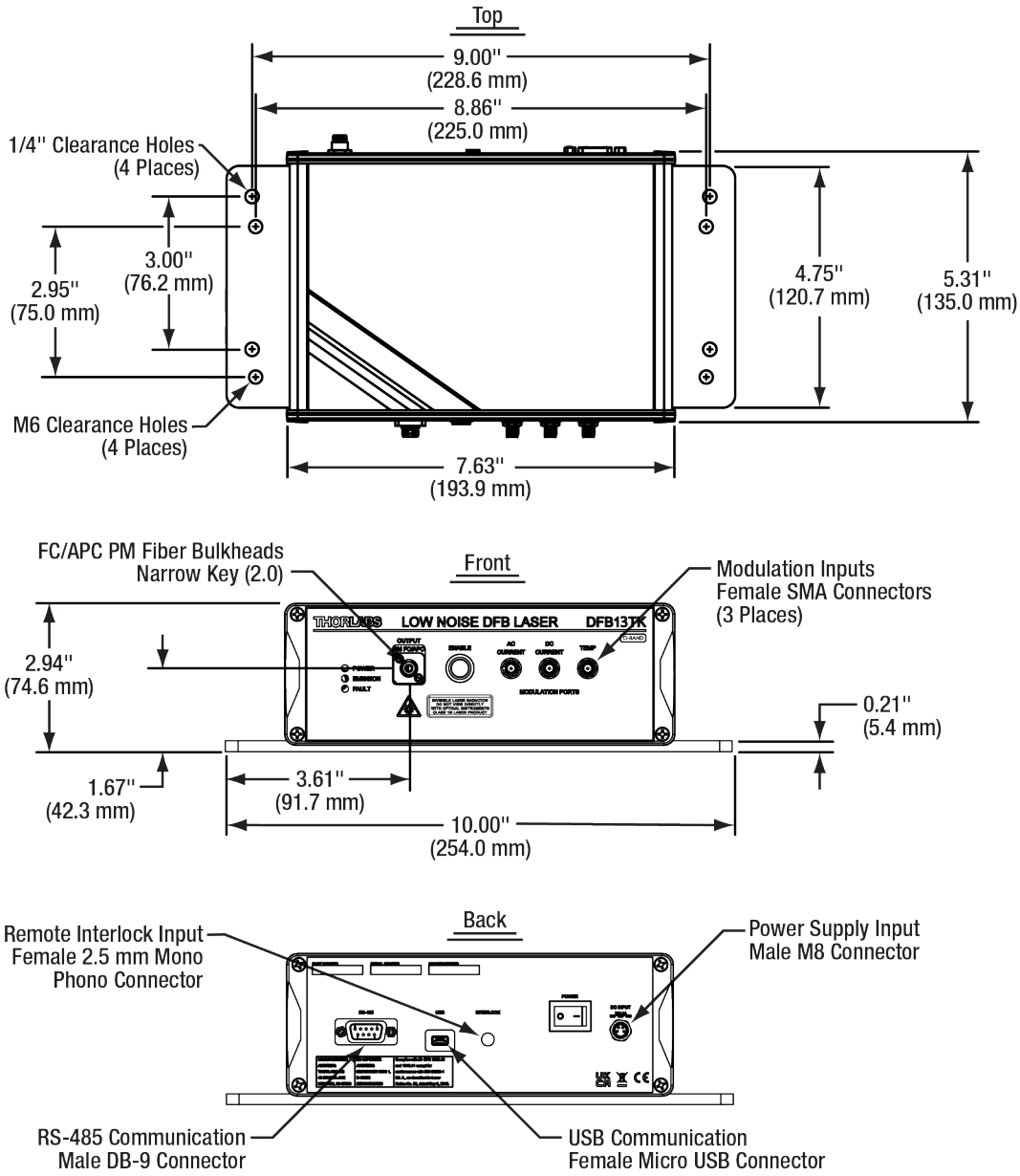
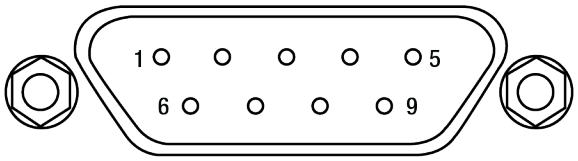


Figure 6 Mechanical Drawing

1.5 Pin Diagram

The DFB13TK can be interfaced via RS485 half-duplex (2-wire) according to the below pinout table. Pins 8 and 9 are for factory configuration use only. Do not connect to pins 8 and 9. Pins 3, 4, and 6 have no internal connections and should not be used.



D8-9/RS485 Pin Assignment	
Pin	**Output Signal**
1	RS-485 half-duplex T/R+
2	RS-485 half-duplex T/R-
3	NC
4	NC
5	GND
6	NC
7	GND
8	DO NOT CONNECT
9	DO NOT CONNECT

1.6 Components

1.6.1 Front and Back Panel Overview

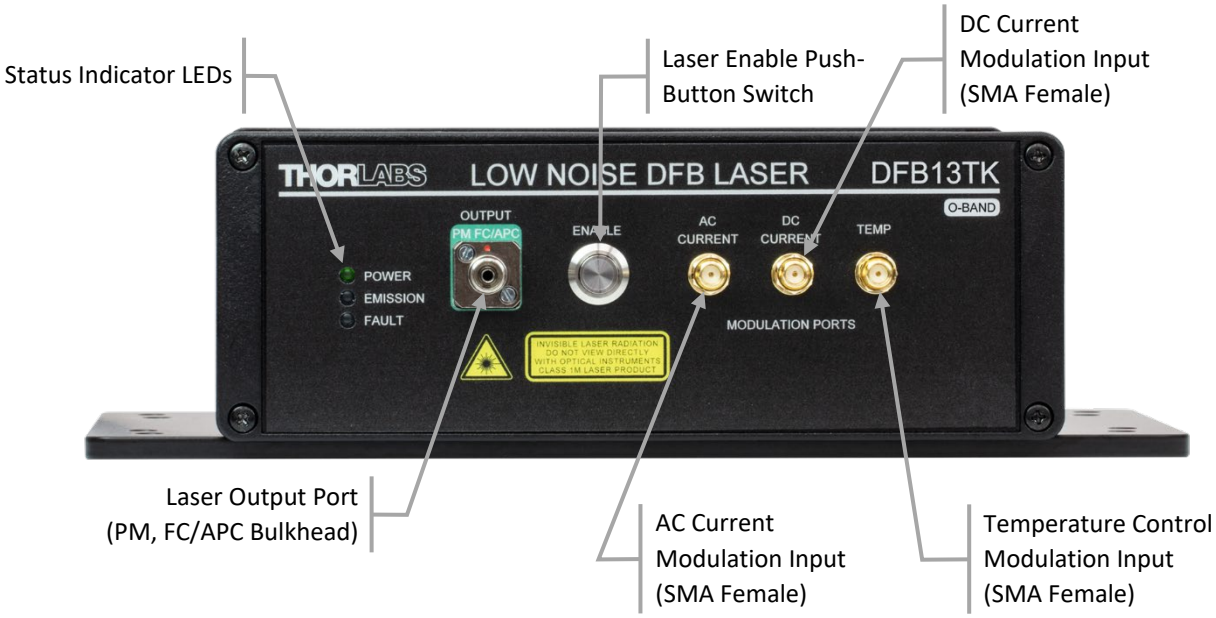


Figure 7 Front Panel of the DFB13TK Laser System

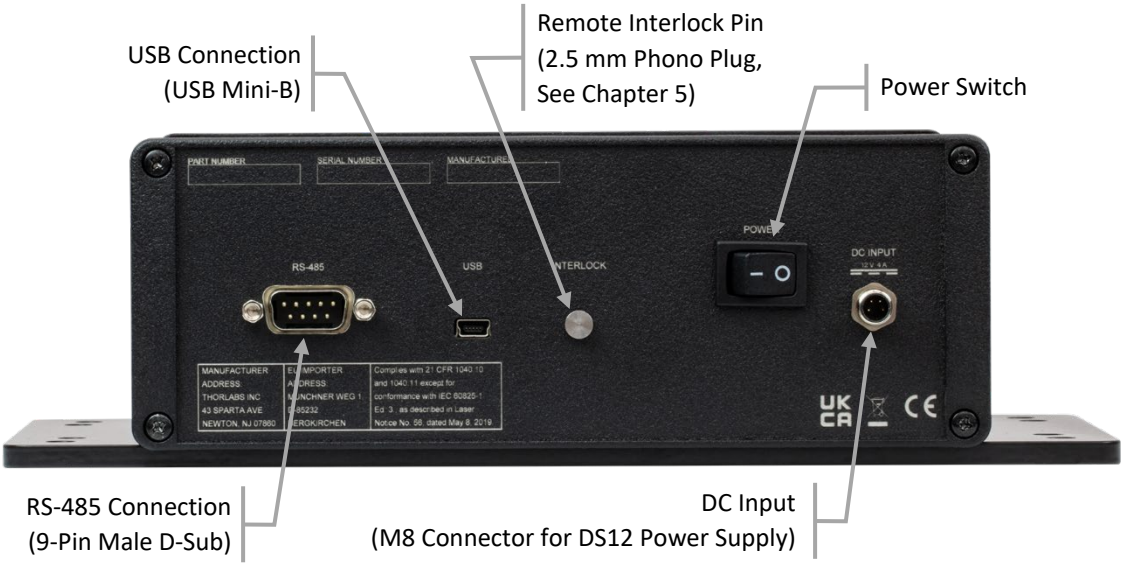


Figure 8 Rear Panel of the DFB13TK Laser System

1.7 Simplified Declaration of Conformity

The full text of the EU declaration of conformity is available at the following internet address:

https://www.thorlabs.com/newgrouppage9.cfm?objectgroup_id=16787

1.8 FCC Designation

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures: Reorient or relocate the receiving antenna.—Increase the separation between the equipment and receiver.—Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.—Consult the dealer or an experienced radio/TV technician for help.

Chapter 2 Safety

Explosion Warning
This instrument must not be operated in an explosion endangered environment.

Laser Warning
Avoid Exposure – Radiation Emitted from apertures. Do not look into the laser aperture while the laser is on. Injury to the eye may result. Laser should not be turned on unless there is an optical fiber connected to the laser output port. Caution – Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

NOTICE

This instrument should be kept clear of environments where liquid spills or condensing moisture are likely. It is not water resistant. To avoid damage to the instrument, do not expose it to spray, liquids, or solvents.

2.1 Laser Safety

Chapter 3 Installation

3.1 Warranty Information

This precision device is only serviceable if returned and properly packed into the complete original packaging including the complete shipment plus the cardboard insert that holds the enclosed devices. If necessary, ask for replacement packaging. Refer servicing to qualified personnel.

3.2 Packing List

The DFB13TK laser system consists of the following components:

- Low-Noise DFB Laser System
- DS12 Power Supply (12 V, 4 A)
- USB-AB-72 USB 2.0 Type-A to Mini-B Cable, 72" (1.83 m) Long
- FBC250 Connector and Bulkhead Cleaner

Chapter 4 Operation

⚠CAUTION

Caution
Prior to using the DFB systems, it is highly recommended to clean the output bulkhead as well as the connector facets to be connected to the bulkhead. Failure to clean the connectors can result in damage to the internal connector.
When cleaning the connectors, ensure that the laser is powered off by turning off the push-button switch. Never inspect optical connectors unless all light sources in your setup have been switched off.

4.1 Operating the Laser

1. Please consult with your organization's laser safety officer regarding proper operation of the laser at your institution.
2. It is highly recommended to secure the laser to an optical table or metal breadboard. This improves heat dissipation from the laser housing and its long-term thermal stability. The laser housing includes two sets of mounting holes (4x) designed for Imperial and Metric breadboards.
3. Ensure the interlock pin is fully installed[a,b].
4. Connect the DC power supply (DS12) via the M8 connector on the back panel of the system.
5. Turn on the power switch on the back panel of the system. The Power indicator on the front panel should be illuminated.
6. Connect any applicable modulation signals to the appropriate SMA modulation ports.
7. Remove the output fiber connector bulkhead cap and connect to the desired instrument using an PM1550-XP FC/APC fiber patch cable.
8. The Laser is ready to be turned on and can be turned on by toggling the Enable push-button[c]. The Emission indicator will blink for 5 seconds then remain solid at which point the laser emission is on. The laser emission is not on during the blinking stage of the Emission indicator. Please note that the laser may require up to 10 minutes of warm-up time after it has been enabled to reach its specified linewidth.
9. Laser emission can be turned off with another toggle of the Enable push-button.
10. At any time, if the DFB13TK system detects a fault, the status indicator will light up solid and the laser will be shut off.
11. To change the laser operating conditions, connect to the USB mini-B connector to configure settings for the system. A list of commands and parameters are listed in Section **4.3 Software Communications**.

4.2 External Modulation Ports

There are three modulation ports located on the front panel of the DFB13TK. Two ports are allocated for modulating the current of the laser around the current set-point. The AC current modulation port is AC-coupled

[a] An improperly installed interlock pin will not allow the laser to turn on, but will not be indicated as an error by the Error indicator.
[b] If the DFB system is powered on without the interlock pin, it must be power-cycled (unplugged from DC power supply and reconnected) before the laser can be turned on.
[c] For safety, a firm, deliberate button press is required.

and supports modulation frequencies from 2 kHz to 20 MHz. The DC current modulation port is DC-coupled and supports frequencies from 0 Hz to 5 MHz. For both current modulation ports, the input voltage range is from -5 V to +5 V. The AC modulation port modulates the current at a rate of 20 mA/V around the current set-point. The DC modulation port modulates the current at a rate of 2 mA/V around the current set-point. A third modulation port is included for modulating the temperature of the laser around its set-point. The chip temperature can be controlled through the analog voltage input applied to this port (-5 V to +5 V). This port has a bandwidth of 1 Hz and is designed for slow modulation of the laser temperature for applications that require locking the laser frequency. The temperature modulation port is disabled by default and can be enabled to control the chip temperature through a command sent via the USB or RS-485 connection on the back panel of the laser. The rate of temperature change versus voltage can also be set through a command. Please see Section **4.4** for details on the commands for setting up the temperature modulation input. All modulation ports have an input impedance of approximately 1 kOhm.

4.3 Software Communications

Each device is equipped with an USB mini-B style connector for USB communication with a host device. The device will enumerate as a Virtual COM port on the host device. For Windows PCs running Windows 10 or later, no special driver is required. For Windows PCs prior to Windows 10, the driver included as part of the firmware update utility is required.

All communication queries must be terminated by a single carriage return character (\r) or a combined carriage return and newline (\r\n). Communications originating from the device will be terminated by one or more combined carriage return, newline pairs (\r\n). A connected host should not attempt to send additional queries until a response has been received from the device. Most queries will result in a response within 10ms. Queries requesting the saving of configuration parameters will result in longer response times.

The commands sent from the USB interface enable the following functions:

- Turning the laser on or off
- Reading status of the laser, and values of the laser temperature set-points
- Adjusting the temperature set-points for the chip
- Adjusting the drive current of the laser
- Setting the external temperature modulation port function. The default for this port is to be disabled, but it can be changed to adjust the chip temperature based on the analog voltage applied to this port.

In addition to the USB port, a RS-485 port has also been included on the back panel of the system. This port, a 9-pin D-Sub, can be used with the same command set outlined in this chapter through the RS-485 communication protocol. Please refer to the last sub-section in this chapter to see the pin-out of the D-Sub connector.

4.3.1 Command/Response Structure

All commands are text based with the basic format as follows:

command [param1 [param2..[paramN]]]

Proper syntax will be specified for each command in the following subsections. Each command will be followed by a corresponding response with the following format:

Response_code:Response_Text[command_response]

Note that all commands and parameters are lower-case letters.

4.4 List of Commands

See corresponding subsections for details.

Command	Descriptions
laser *[state]*	Set the user requested state of the laser.
write_param *[tag] [value]*	Write a parameter to the device
read_param *[tag]*	Read a parameter from the device
save_param *[tag]*	Immediately write a parameter to EEPROM.
read_string *[name]*	Read a string value from the device
savecfg	Save all parameters on the main and optics boards to non-volatile memory.
get_clock	Gets the currently set time and date.
update	Places the system into a mode where it can accept firmware updates from the PC.
reset	Reset the system. Note that this will drop the USB connection.
firmware_version	Read the current firmware version number.

4.4.1 List of States

Corresponding to the ‘laser’ command

Command	Descriptions
on	Set the requested state to on. When system failures are cleared and interlock indicates OK, the laser till turn on. When system errors occur or when interlock is lost, the laser is tuned off.
off	Laser is turned off.

4.4.2 List of Tags

Corresponding to the ‘write_param,’ ‘read_param,’ and ‘save_param’ commands

Name	Type	Default Value	Access	Descriptions
Laser Configuration				
laser_state	Int.	N/A	R	60 = Laser on 61 = Laser off (Normal) 62 = Laser off because of interlock 63 = Laser off because of one of the following faults: • Laser TEC in error mode • AUX TEC timeout 64 = Laser state is unknown 65 = Laser is starting (flashing LED)
laser.current	Float	0	R/W	Nominal open-loop laser current (A)
Laser TEC Control System				
laser_tec_ctrl.temperature	Float	N/A	R	Laser temperature reading in Celsius.
laser_tec_ctrl.setpoint	Float	25	R/W	Set point for the laser TEC control system. (deg C)
External TEC Setpoint Adjustment				
tec_adj.select	Int	120	R/W	The selected TEC control on which tec_adj acts: 120: None 121: Laser TEC
tec_adj.range	Float	1	R/W	The full-scale range of the TEC setpoint adjustment +/- (deg C)
tec_adj	Float	N/A	R	The active tec setpoint adjustment applied to the selected TEC (deg C)

4.4.3 List of Names

Corresponding to the ‘read_string’ command

Name	Descriptions
oem	OEM string
module_sn	Module serial number
main_board_sn	Main board serial number
laser_sn	Laser serial number

4.5 List of Responses

Value	Descriptions
000: OK	Command executed successfully
100: Unknown command	Executed command is unknown
101: Syntax error	Incorrect number of parameters or the formatting of the parameters is incorrect.
102: Invalid parameter	One of the specified parameters is out of range of allowable values.
103: Unknown Tag	A command that takes a tag as a parameter was given a string that it could not find in the system.
104: Not Writeable	An attempt was made to write a tag value that cannot be modified either because it is read only or the user does not have the appropriate permission.
105: Unknown Response	This is an internal failure of the device. This should generally only be returned if there is a software defect.
106: Device Error	An error was encountered in the hardware while attempting to execute the command. NOTE: When this failure happens, the unit may be in an undefined state. For example, tag values that are written by a command may not reflect actual hardware settings when the tag is read.
111: Response Too Large	Occurs when a command has a variable length response, and that response is too large to be sent back to the host.

4.6 Making Safety Interlock Connections

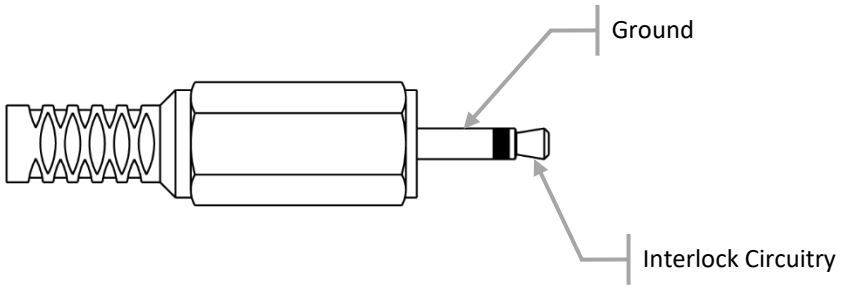
The DFB13TK is equipped with a remote interlock connector located on the rear panel. In order to enable the laser, a short circuit must be applied across the terminals of the Remote Interlock connector. This connection is made available to allow the user to connect a remotely actuated switch to the connector (i.e. an open-door indicator).

The switch that is connected to this interlock must be normally open (N.O.), meaning that it must be closed in order for the unit to be enabled. If the switch is changed to an open state, the amplifier will automatically shut down.

All units shipped from Thorlabs are configured with a shorting device installed in the interlock connector. If you are not going to use this feature then you can leave the shorting device installed and the unit will operate normally, as described throughout this manual. If you wish to make use of the interlock feature you will need to acquire the appropriate mating connector (e.g., a 2.5 mm mono jack, available at most electronics stores) and wire it your remote interlock switch.

The electrical specifications for the interlock input are shown in the following table.

Specification	Value
Mating Connector	2.5 mm Mono Phono Jack
Open Circuit Voltage	Internal Pull Up to 5 VDC
Short Circuit Requirements	1.0 mA DC
Interlock Switch Requirements	Must be N.O. Dry Contacts Under No Circumstances Should Any External Voltages be Applied to the Interlock Input



Chapter 5 Maintenance and Cleaning

Always clean fiber optic connectors that will be inserted into the system and install the dust cap whenever the source is not being used. Allowing dust and dirt onto the fiber end faces will degrade coupling efficiency and possibly damage the fiber patch cables, both inside and outside.

Chapter 6 Troubleshooting and Repair

Below are a few checks to help in troubleshooting problems that may arise. Please contact your local Thorlabs Technical Support office with any questions.

If the unit does not appear to turn on correctly, please check the following items:

- Ensure that the main AC receptacle is powered.
- Ensure that main power cable is fully seated at both ends.
- Ensure that rear power switch is in the “I” position.

LED Indicator	Description
POWER solid green	Laser system powered and ready to use
EMISSION blinking green	Laser emission on has been toggled. Laser output is about to be active
EMISSION solid green	Laser emission is on
FAULT briefly red during start up	Laser system showing functional LED indicator
FAULT solid red	Fault detected in laser system

6.1 Laser Will Not Enable

Possible Solution	Directions
Interlock not installed correctly	Install the interlock pin/remote interlock. Turn off the laser system via the rear power switch. Turn the laser system back on.
System entered a fault condition; FAULT indicator is solid red	Laser TEC in a fault state. Turn off laser system.

Chapter 7 Disposal

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

Chapter 8 Thorlabs Worldwide Contacts

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

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