

User Manual
Femtosecond fiber laser with a SHG unit
Model Buccaneer SHG

Version 1.02



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Contents:

General laser description	3
Introduction	3
General safety requirements	4
Specification	6
Package contents	7
Control, monitoring and indicators.....	8
Laser power supply monitoring and control elements	8
Laser head elements	11
SHG crystal oven control unit. Control elements.....	13
Laser operation	15
Switching on the SHG crystal oven control unit.....	15
Switching off the SHG crystal oven control unit	16
Switching on the laser	16
Turning the laser off.....	17
Using the service output	17
Maintenance	18
Cleaning of the external panels.....	18
Warranty	18
Troubleshooting	18
Test data.....	19
Test graphs	20

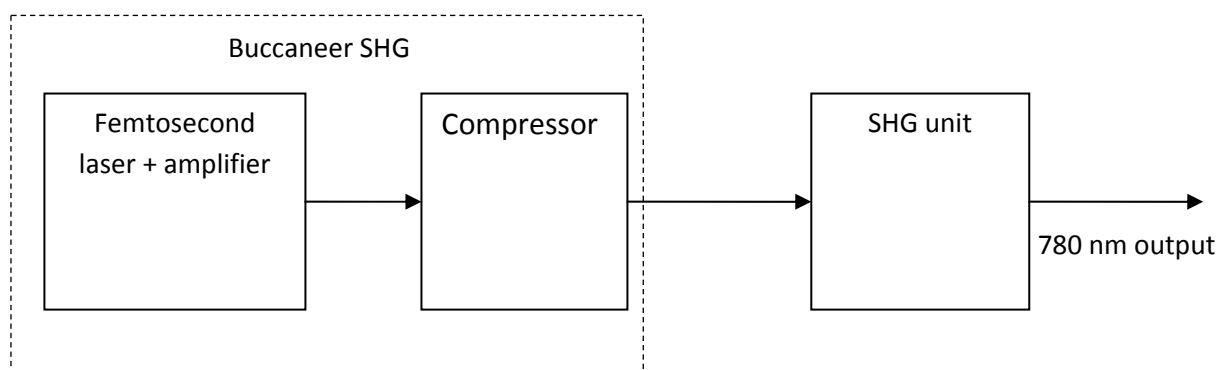
General laser description

Introduction

Femtosecond pulsed lasers are used in many fields of physics, biology, medicine and many other natural sciences and applications: material processing, multiphoton microscopy, «pump-probe» spectroscopy, parametric generation and optical frequency metrology. Femtosecond fiber lasers offer stable and steady operation without constant realignment.

The Buccaneer SHG laser comprises: a passively mode-locked ring fiber laser, providing pulses with repetition rate of 50 to 70 MHz and having duration of <150-300 fs, an amplifier based on Er³⁺ doped fiber waveguide with pumping by two laser diodes, a prism compressor for amplified pulse compression and a frequency doubling unit (SHG unit).

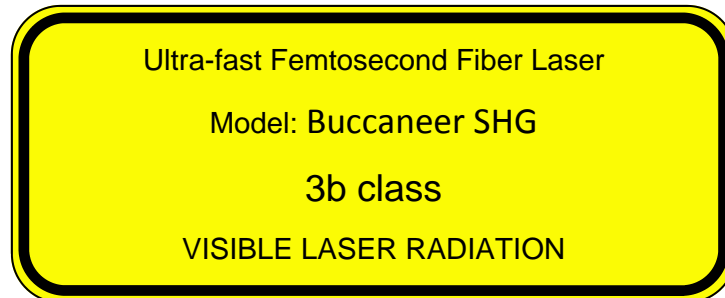
The SHG unit is based on a periodically poled lithium niobate crystal (PPLN).



General safety requirements

To ensure risk-free operation and optimal output of the device please follow the requirements and warnings given below.

!!!Attention!!!



“Buccaneer SHG” is a 3b class laser device.

Output wavelength: 800 nm.

Output optical power up to 100 mW.

Attention: Using an optical instrument while working with this device may lead to serious eye damage!!!

Never turn on the laser when the service optical output is open. Always turn off the device before connecting or disconnecting the fiber from the service optical output.

Do not open the device case because of high voltage shock possibility and invisible dangerous laser radiation.

Opening the case will void the warranty!

Avoid skin exposure to laser radiation!

Attention: Make sure the device is grounded through the power supply cable. The device should be used in normal conditions*.

*i.e. temperature $22\pm 5^{\circ}\text{C}$ and humidity $45\pm 15\%$

Warning: Before turning on the device please make sure the right voltage of power supply has been chosen. The usage of wrong voltage will damage the device.

High-power radiation at 1560 nm must not be fed to the SHG crystal without heating the crystal up to operation temperature (operation temperature is $>120^{\circ}\text{C}$), otherwise the SHG crystal might sustain damage.

Crystal temperature while heating or cooling must not change more than $10^{\circ}\text{C}/\text{min}$.

Specification

Optical data:

Central wavelength, nm	780
Average output power, mW	> 50
Pulse duration, fs	120
Repetition rate, MHz	50
Repetition rate stability, ppm	1
Spectrum width, nm	5-8
Output power stability (24h), 780 nm	<1%

Outputs:

Optical output	free- space, 780 nm
polarization	linear, horizontal
Service optical output	FC/APC (<1 mW, 1560 nm)
HF sync output	SMA connector
Pulsed mode indication	LED

General data:

Power supply voltage	110-230 V
Power supply frequency	50..60 Hz
Operating temperature	22±5°C
Storage temperature	0...+40°C
Warm-up time	up to 60 min

Dimensions	
Laser head	350x370x140 mm
Power supply unit	230x200x130 mm
SHG crystal oven control unit	290x150x80 mm

All specs have been obtained at $t=22\pm 5^{\circ}\text{C}$ and humidity $45\pm 15\%$.

Package contents

Laser head	1 pc.
Laser power supply unit	1 pc.
SHG crystal oven control unit	1 pc.
Power cord	2 pc.
Connection cable	1 pc.
HF cable SMA-BNC	1 pc.
Clamps	3 pc.

Control, monitoring and indicators.

Attention!

If this is the first time you operate the laser system please read the chapter “Laser operation” carefully before turning on the laser.

Laser power supply monitoring and control elements

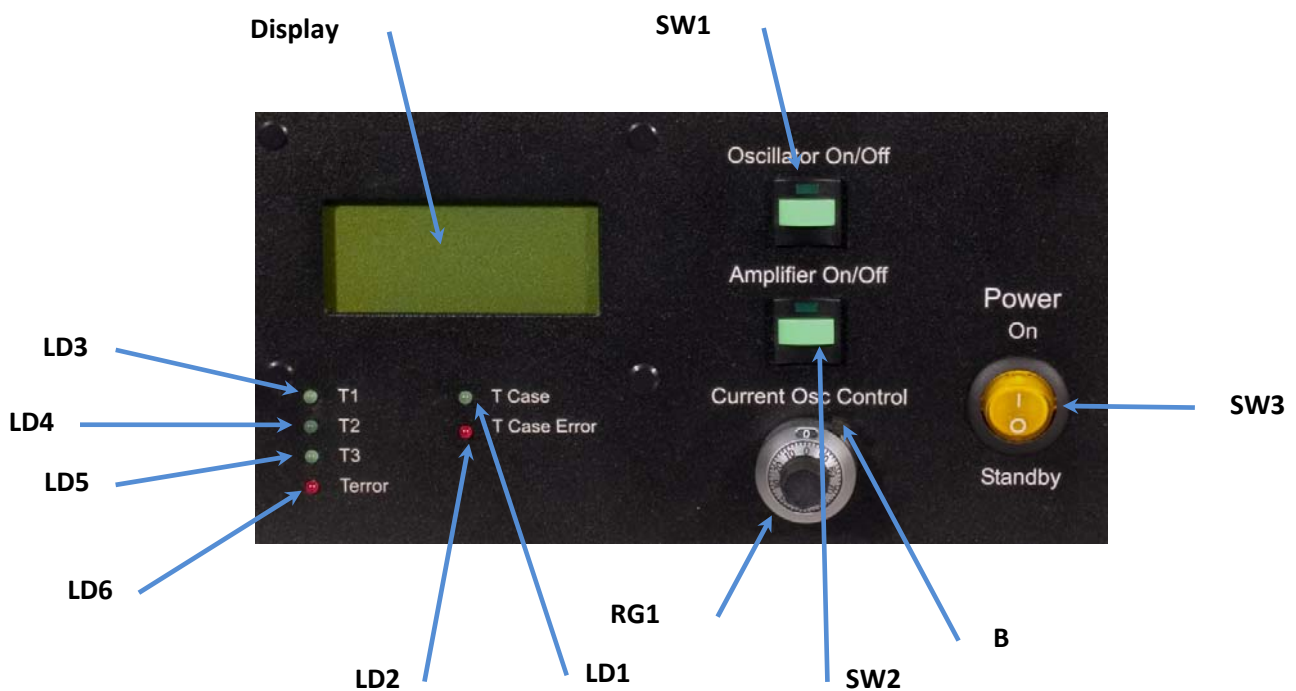


Fig. 1. Laser power supply front panel.

Display - shows the information about the current flowing through the oscillator and amplifier laser diodes.

LD1 – T Case. Lights green when the system reaches the operating regime – the laser head case is thermally stabilized. Warm-up time may reach 60 min in some cases.

LD2 – T Case Error. Lights red if there is a malfunction in the thermal stabilization system of the laser head case.

LD3 – T1 - temperature indicator of the oscillator pump diode. It lights green at turning the switch **SW4** (fig. 2) – pump diode is thermally stabilized.

LD4 – T2 - temperature indicator of the amplifier pump diode 1. It lights green at turning the switch **SW4** (fig. 2) – pump diode is thermally stabilized.

LD5 – T3 - temperature indicator of the amplifier pump diode 2. It lights green at turning the switch **SW4** (fig. 2) – pump diode is thermally stabilized.

LD6 – Terror – thermostabilization system error indicator.

SW1 – Laser 1 On/Off - oscillator pump diode switch. When the oscillator pump diode is turned on, it lights green.

SW2 - Amplifier On/Off - amplifier pump diodes switch. When the amplifier pump diode 1 is turned on, it lights green.

SW3 – On/Off - the switch turns the laser system on and off. Switch positions: ON and OFF.

RG1 - current regulation knob for the oscillator pump diode. Smoothly feeds the pump diode with current. In pre-tuned femtosecond generation regime the knob is blocked by the stopper B shown in the Fig. 1.

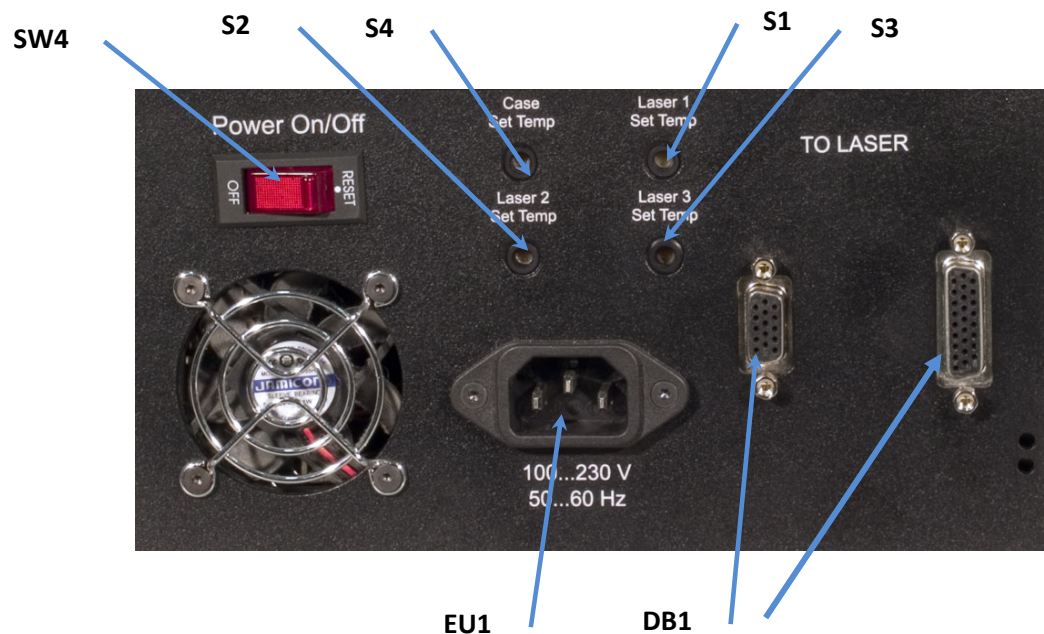


Fig. 2. Power supply rear panel.

SW4 – the switch turns the thermal stabilization of the diodes and case on and off. Switch positions ON and OFF are shown in Fig.2.

S1 - oscillator diode temperature setting. Factory preset. Please do not change.

S2 - amplifier diode 1 temperature setting. Factory preset. Please do not change.

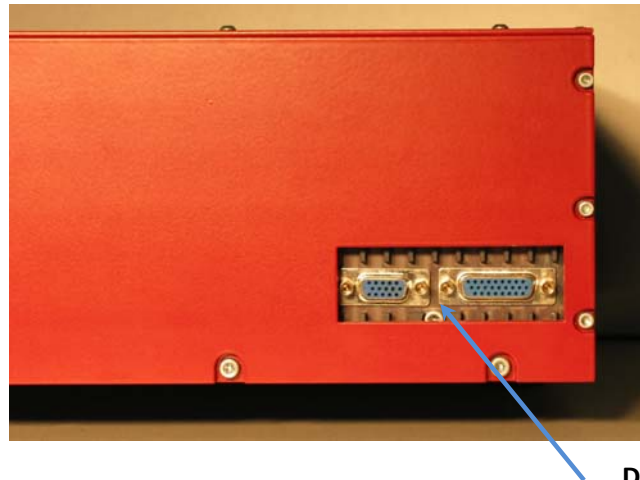
S3 - amplifier diode 2 temperature setting. Factory preset. Please do not change.

S4 - case temperature setting. Factory preset.

DB1 - laser head and electronic unit interface cable connector.

EU1 - Euro-standard power supply cable. The supply cable should **!always!** have proper grounding connection.

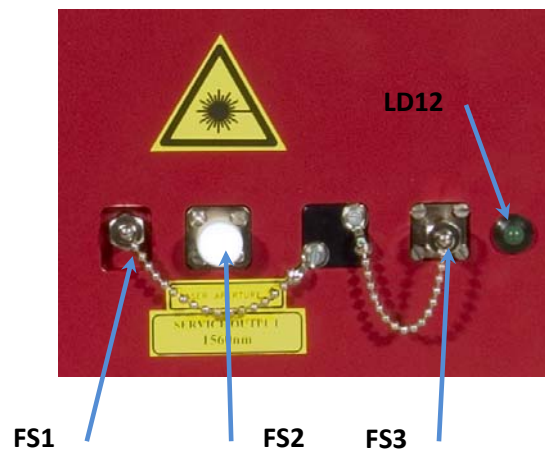
Laser head elements



DB2

Fig. 3. Rear panel of the laser head.

DB2 - laser head and control unit interface cable connector.



FS1

FS2

FS3

LD12

Fig. 4 Laser head service output panel.

FS1 – HF SMA connector for displaying the pulse train and synchronizing any external devices.

LD12 – pulsed mode indicator.

FS2 - service output (<1 mW). Output standard is FC/APC. It serves for easy output radiation spectrum monitoring and femtosecond regime detection.

FS3 – HF SMA for pulsed mode monitoring (On/Off).

!!!Please use only FC/APC connectors!!!

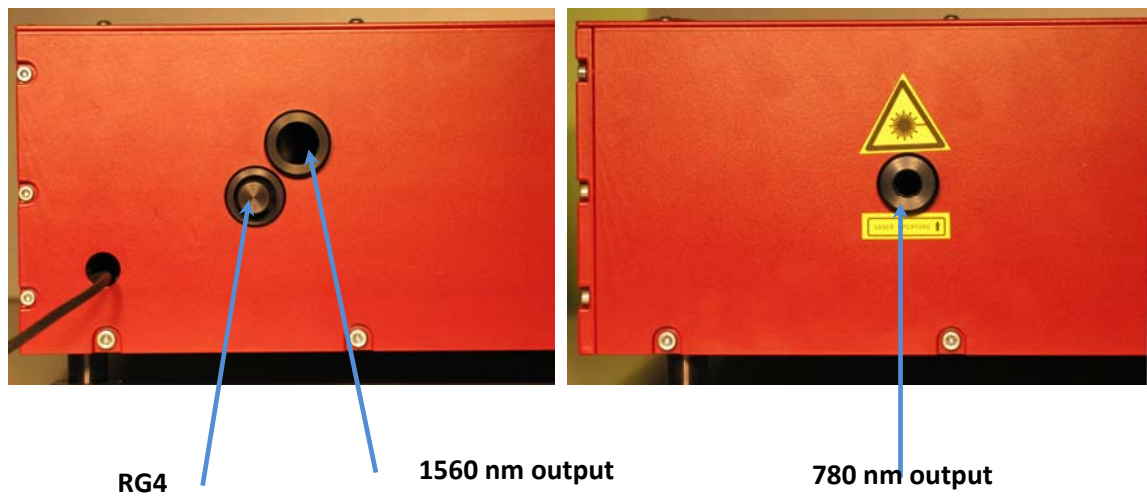


Fig. 5 Laser head main output panel (1560 nm output is optional and should be mentioned when ordering)

RG4 – power switch lever for switching to 1560 nm output.

SHG crystal oven control unit. Control elements.

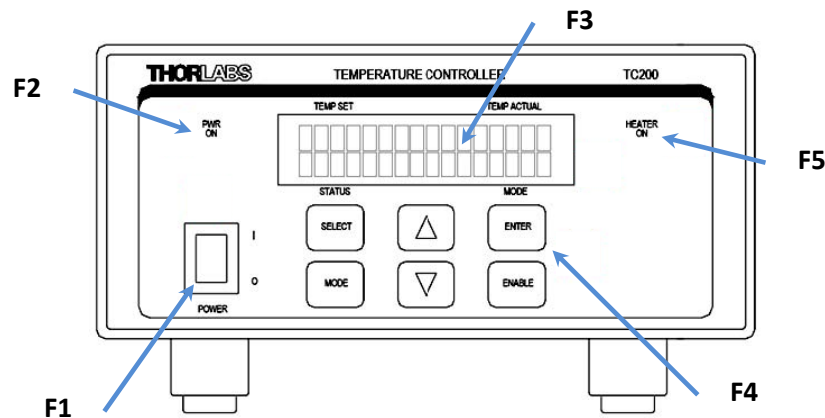


Fig. 6. Front panel of the SHG oven control unit.

F1 – POWER – on/off switch for the SHG crystal oven. Switch positions ON and OFF.

F2 - PWR ON – power indicator.

F3 - LC display – displays information about temperature and operating mode. Also shows information about the different oven setups when pressing button "MODE".

F4 - Buttons – are used for setting the necessary temperature (Temp Set), for turning the heating on/off and for navigating in different setups when pressing button "MODE".

F5 – HEATER ON – heating mode indicator. Lights when the heater is on.

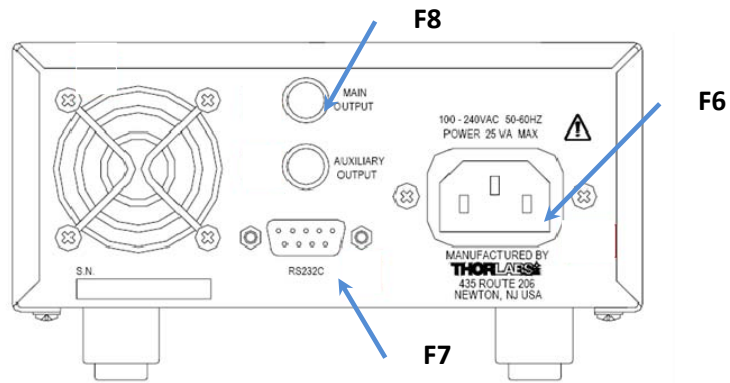


Fig. 7 Rear panel of the SHG oven control unit.

F6 - AC Input Connector - Euro-standard power supply cable. The supply cable should **!always!** have proper grounding connection.

F7 - RS232C DB9 Connector – PC connection.

F8 - Main Output – SHG oven main connection.

Laser operation

High-power radiation at 1560 nm must not be fed to the SHG crystal without heating the crystal up to operation temperature (operation temperature is $>120^{\circ}\text{C}$), otherwise the SHG crystal might sustain damage.

Crystal temperature while heating or cooling must not change faster than $10^{\circ}\text{C}/\text{min}$.

Switching on the SHG crystal oven control unit

1. Turn on the control unit by the “Power” switch.

2. By pressing button “Mode” select the mode which will look like:

<u>Normal mode</u>
Cycle mode

3. By pressing “Select” button choose “Cycle mode”.

4. Activate “Cycle mode” by pressing “Enter”.

5. Press “Mode” again.

6. To turn the oven press “Enable”.

The oven control unit is set to run in cycle mode. The cycle has five intervals as follows:

1. $23^{\circ}\text{C} \rightarrow 100^{\circ}\text{C}$	20 min
2. $100^{\circ}\text{C} \rightarrow 145^{\circ}\text{C}$	20 min
3. $145^{\circ}\text{C} \rightarrow 170^{\circ}\text{C}$	10 min
4. $170^{\circ}\text{C} \rightarrow 100^{\circ}\text{C}$	10 min
5. $100^{\circ}\text{C} \rightarrow 23^{\circ}\text{C}$	15 min

Operating mode is interval 3 or 4

Temperature should be around 150°C to 160°C

At reaching this temperature press «Enter» and the system will work in «Pause» mode, i.e. maintain the chosen temperature.

Switching off the SHG crystal oven control unit

If the SHG crystal oven control unit was turned off in full compliance with the “Switching on the SHG crystal oven control unit” paragraph, then to turn it off one will need to press “Enter” again and the unit will resume the cycle and after running “step 4” and “step 5” it will decrease the crystal temperature to room level.

If the SHG crystal oven control unit was not turned off in full compliance with the “Switching on the SHG crystal oven control unit” paragraph or is in not in “Cycle mode” (i.e. in “Normal” mode) then it is necessary to manually decrease the temperature of the SHG crystal to room level by using buttons «↓» and «↑». It is worth remembering at this point that crystal temperature must not change faster than 10°C/min.

Switching on the laser

1. Fix the laser head on the optical table with clamps.
2. Connect the electronic unit with the laser head by means of interface cable.
3. Turn on the laser head and diodes thermal stabilization by turning the key (**SW4**) (Fig. 2). The “Temp” indicators **LD3**, **LD4**, **LD5** should light green. In approx. 60 min. the indicator “Temp” **LD1** should light green.
4. Turn on the pump diodes by switching the **SW3** from position **off** into position **on**.
5. Turn on the oscillator pump diode by switching the “Oscillator on/off” (**SW1**). **SW1** switch should light green.
6. Turn on the amplifier pump diodes by switching the “Amplifier on/off” (**SW2**). **SW2** switch should light green.
7. The operation regime can be monitored and controlled via the service output (**FS3** Fig. 5).

Turning the laser off

1. Turn off the amplifier pump diodes by pressing **SW2**.
2. Turn off the oscillator pump diode by pressing **SW1**.

!!!Turning the laser head off by the switch SW4 is possible only when the oscillator and amplifier diodes have been turned off!!!

Using the service output

Specification:

Output type FC/APC

Output power ~ 1 mW.

Output spectrum - identical to the power output of the fiber seed oscillator.

The output may be used for:

- Measuring of laser generation spectrum
- External synchronization with any device using a fast photodiode (photodiode bandwidth > 500 MHz)
- Controlling the output signal in time domain. Use fast photodiode and fast oscilloscope (~500 MHz). The oscilloscope input should have 50 Ohm. In this case, the pulse width and shape are determined by the photodiode's output voltage rise time and do not represent the actual optical pulse parameters.

!Please use only FC/APC connectors!

!Use only clean FC/APC connectors to prevent optical damage during laser operation!

Maintenance

Any service of your Buccaneer SHG laser should be carried out by qualified staff authorized by the manufacturer.

The only routine maintenance procedure is cleaning the external panels of the laser.

Cleaning of the external panels

The unit can be cleaned with a cloth dampened with water or weak soap solution.

Please do not use excessively wet sponges or cloth.

Do not use abrasives or dissolvents as they might damage the paint.

Warranty

The warranty period for this device is 12 months from the moment of purchase. Should any malfunction due to bad manufacturing arise during the warranty period the manufacturer is to conduct free repairs or replace the device free of charge.

Troubleshooting

LEDs «Terr1», «Terr2», «Terr3» or «T Case Error» light red.	Please check cable connection between the control unit "DB1" and laser head "DB2"
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Test data

Output power, @776 nm	>50 mW
Pulse duration (FWHM), @776 nm	120 fs
Spectrum width (FWHM), @776 nm	≈5-6 nm
Repetition rate	50 MHz
Service output average power	~900 μW
Operating temperature	22 ± 5 °C

Test graphs

