

RIO GRANDE 1550 nm High Power Low Phase Noise Narrow Linewidth Laser Module

Data Sheet
July 2019

Key features

- Single longitudinal mode
- Center wavelength: 1545nm-1565nm,
ITU-T DWDM 100 GHz C-band or custom
- Very low phase noise
- Ultra low RIN
- Narrow linewidth
- High SMSR
- High OSNR
- Excellent wavelength stability over life and temperature
- SM and PM fiber options
- Easy to set-up and use
- Digital controller and firmware with RS-232
- ROHS compliant



Description

The RIO GRANDE devices are high power laser modules employing the RIO high-performance External Cavity Laser (ECL). This laser design is based on RIO's proprietary planar technology (PLANEX™) and consists of a gain chip and a planar lightwave circuit including waveguides with Bragg gratings, forming a laser cavity with significant advantages.

RIO high power narrow linewidth laser is integrated with high performance low noise EDFA. It provides narrow linewidth, low phase noise, ultra low RIN, high output power and exceptionally reliable performance. An integrated RS232 interface enables easy control, diagnostic functions and data acquisition. The RIO high power module is an ideal candidate for OEM commercial and military fiber optic sensing, such as interferometric and Brillouin sensing systems for oil & gas, security, and also for metrology, LIDAR and other applications.

Applications

- Acoustic & seismic interferometric fiber optic sensing
- Defense and security
- Oil & Gas – exploration and production
- LIDAR
- Metrology

Absolute Maximum Ratings

Operation of the device beyond these maximum conditions may degrade device performance, lead to device failure, shorten product lifetime, and invalidates the device warranty.

| Parameter | Min | Max | Unit |
|--|------|------|------|
| Storage temperature | - 40 | + 85 | °C |
| Module supply voltage | 11.5 | 12.5 | V |
| ESD-susceptibility | | 500 | V |
| Fiber bend radius | 35 | | mm |
| Tensile strength, fiber to the package | | 5 | N |
| Humidity (Non condensing) | 5 | 95 | % |

Optical and Electrical Specifications

At room temperature (25 °C) unless noted otherwise, after min 5 min warm up time

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|--|-------------------|--|--------------------------|------|------|----------------|
| Output Optical Power | P_{out} | CW, nominal | See ordering information | | | W |
| Power Stability (rms) | $dP_{out,s}$ | Over 8 hrs, room temperature (25 ± 1 °C) | | | 1 | % |
| Power Drift | $dP_{out,d}$ | From output power at room temperature, over case temperature range | -5 | | +5 | % |
| Center Wavelength (ITU grid) | λ | +/- 40 pm standard ¹ | 1545 | | 1565 | nm |
| Wavelength thermal tuning range ² | $\Delta\lambda_T$ | Setting via RS-232 interface | 30 ³ | | | pm |
| Output power adjustment range | P_{outT} | vs. rated output power | 10 | | 100 | % |
| Wavelength Stability | $d\lambda$ | Over case temperature range | | ± 10 | | pm |
| Relative Intensity Noise ⁴ | RIN | ≥100 Hz | | | -110 | dB/Hz |
| | | ≥10 kHz | | | -125 | |
| | | ≥ 800 kHz up to 50 MHz | | -157 | -155 | |
| Side Mode Suppression Ratio | SMSR | CW, at specified P_{out} | 40 | 50 | | dB |
| Optical S/N Ratio ⁵ | OSNR | From ASE levels at +/-1 nm from λ | 55 | | | dB |
| Beam quality | BQ | - | | | 1.1 | M ² |
| Polarization extinction ratio | PER | For PM option, polarization and connector key aligned to slow axis | 20 | | | dB |
| Optical Isolation | ISO | | 30 | | | dB |
| Voltage Supply | V_{cc} | | 11.5 | 12 | 12.5 | V |
| Frequency stability ⁶ | v_{t1} | Free running, over 1 hour | | ± 2 | ± 4 | MHz |
| | v_{t8} | Free running, over 8 hours | | ± 3 | ± 6 | |

1. Customized center wavelength within 1530 to 1565 nm range, including ITU-T C-band is available
2. Phase continuous wavelength tuning by changing TEC temperature settings. Some performance parameters will change over tuning range
3. Tuning range is not symmetric around center wavelength, 30pm range is +10pm to -20pm as a minimum
4. Measured at 2 mW input power to OE converter
5. 0.05 nm resolution
6. After 1 hour stabilization, tested with heterodyning of two lasers at constant case temperature

Modulation Specifications: Low Frequency [LF] (for both option RIO11XX- & RIO13XX-)

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|---|-------------|---------------------------------|-----|-----|-----|-------|
| Frequency modulation bandwidth ¹ | f_{mL} | Sinusoidal modulation | DC | | 100 | kHz |
| Frequency tuning efficiency ^{1, 2} | η_{mL} | Sinusoidal modulation at 10 kHz | 25 | 50 | | MHz/V |
| Tuning voltage magnitude ¹ | V_{tuneL} | | -4 | | +4 | V |

1. Via pin17 of RIO GRANDE D-25 connector, frequency modulation will lead to modulation of output power
2. Tuning efficiency will vary over modulation bandwidth. Contact RIO for more information.
3. Frequency will lead to modulation of output power.

Modulation Specifications: High Frequency [HF] (for option RIO13XX- only)

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|---|-------------|---------------------------------------|------|-----|-----|-----------|
| Frequency modulation bandwidth ¹ | f_{mH} | Sinusoidal modulation, AC coupled | 0.01 | 100 | 200 | MHz |
| Frequency tuning efficiency ^{1, 2} | η_{mH} | Sinusoidal modulation at 20 kHz | 100 | 200 | | MHz/V |
| | | Sinusoidal modulation at 500 kHz | 25 | 50 | | |
| | | Sinusoidal modulation at 20 – 200 MHz | 50 | 100 | | |
| Tuning voltage magnitude ¹ | V_{tuneH} | AC coupled | | | 1 | V_{p-p} |

1. Via 50 Ω , SMC connector, frequency modulation will lead to modulation of output power
2. Tuning efficiency will vary over modulation bandwidth. Contact RIO for more information.
3. Frequency will lead to modulation of output power.

Linewidth and Phase Noise Specifications

| Parameter | Symbol | Conditions | Grade 1 | Grade 3 | Grade 4 | Grade 5 | Unit |
|--|-------------------|------------|-----------|----------|----------|----------|---|
| Spectral Linewidth, FWHM ¹ | $\Delta\lambda_L$ | | ≤ 15 | ≤ 5 | ≤ 2 | ≤ 1 | kHz |
| Phase Noise Typical Values ² | PhN | @ 10 Hz | 123 | 41 | 20 | 10 | $\mu\text{rad}/\text{rt-Hz}$ 1 m OPD |
| | | @ 200 Hz | 22 | 8 | 4 | 2 | |

1. Value based on Lorentzian linewidth model.
2. As measured with RIO's interferometric phase noise test setup, 1m OPD in the SM fiber.

Thermal Specifications

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|---|-----------|---|-----|-----|------|--------------------|
| Operating temperature range (case) | T_c | | -10 | | + 70 | $^{\circ}\text{C}$ |
| Power Dissipation @ 1W output power | P_{dt} | At 50 $^{\circ}\text{C}$ case temperature | | 20 | | W |
| Power Dissipation over case temperature range | P_d | Output power 0.2 W | | | 15 | W |
| | | Output power 1 W | | | 25 | |
| | | Output power 2 W | | | 40 | |
| Total current | I_{max} | Over case temperature range | | | 4 | A |

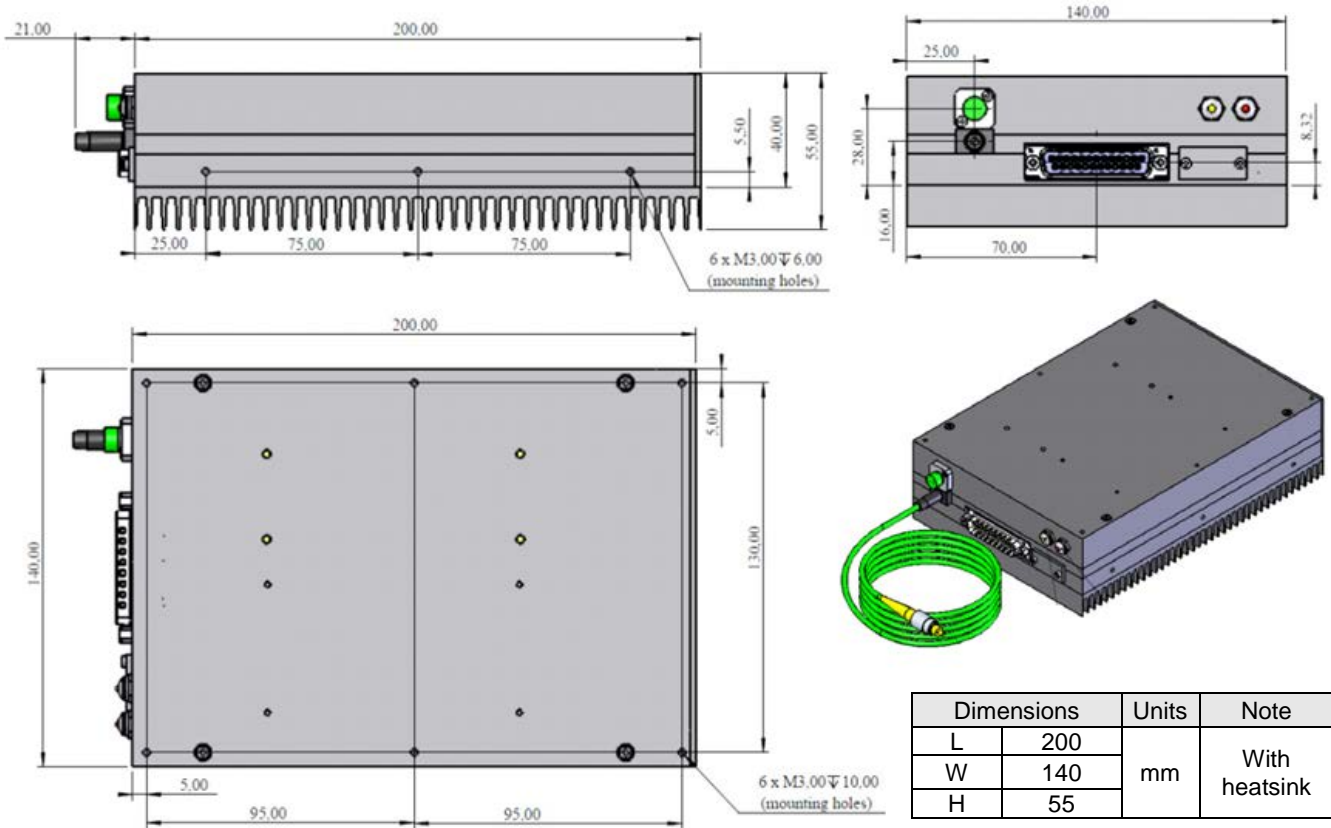
Connectors

| # | Description |
|---|--|
| A | Optical FC/APC connector on output fiber (fiber length 1 meter, 3 mm diameter). Other connectors-optional. |
| B | Mating sleeve for FC/APC connector on monitor output, 20 dB below typ. from output optical power |
| C | DB25 Interface connector. Data interface RS-232 |
| D | Option for RIO13XX-, RF connector (SMC female), 50 Ω impedance |

Connector C

| Function | I/O | DB25 | Note |
|-------------------------|-----|--------------|--|
| 11.5 to 12.5 VDC Input | I | Pin 1,2,3,4 | Power supply |
| GND | I | Pin 14,15,16 | - |
| Output Power Monitor | O | Pin 5 | Analog Output : 0 to 4 VDC. |
| Seed Power Monitor | O | Pin 6 | Analog I output: 0 to 4 VDC. Voltage proportional to seed laser power expressed in mW. 1V@ 3.16 mW (+5 dBm). |
| EDFA Temperature Alarm | O | Pin 7 | TTL output : Low -> Normal operation. High -> EDFA Temperature >70°C or <0°C. Alarm ON and pump currents are shut down. |
| Output Power Alarm | O | Pin 8 | TTL output : Low -> Normal operation. High -> output power is below factory setting value. Alarm is ON and pump currents are shut down. |
| Diode Current Alarm | O | Pin 9 | Output TTL: Low -> Normal operation. High -> diode current above EOL value. Alarm is ON and pump currents are shut down. |
| Diode Temperature Alarm | O | Pin 10 | Output TTL: Low -> Normal operation. High -> Diode temperature different from settings by +/-5°C. Alarm is ON and pump current are shut down. |
| Case Temperature | O | Pin 11 | Analog output of 10mV/°C. 750 mV@25°C. |
| Seed RS-232Rx | I | Pin 12 | Serial input RS232 for wavelength control |
| Diode Current Monitor | O | Pin 13 | Analog Output. Voltage proportional to diode current. |
| Direct modulation | I | Pin 17 | Analog input for wavelength fast tuning/modulation |
| EDFA RS-232 TX Output | O | Pin 18 | Serial output RS232 for power control |
| Seed Power Alarm | O | Pin 19 | TTL output : Low – Normal operation. High – Input power is below user setting value (IPT). Alarm is ON and pump currents are shutdown |
| Output Power Disable | I | Pin 21 | Low – Normal operation. High – Module is switched OFF. Alarm is ON and pump currents are shutdown – Pull up |
| EDFA RS-232 RX Input | I | Pin 22 | Serial input RS232 for power control |
| Reset Manual | I | Pin 23 | Microcontroller resets Low: Reset |
| Seed RS-232Tx | O | Pin 24 | Serial output RS232 for wavelength control |
| Factory reserved | I | Pin 25 | - |

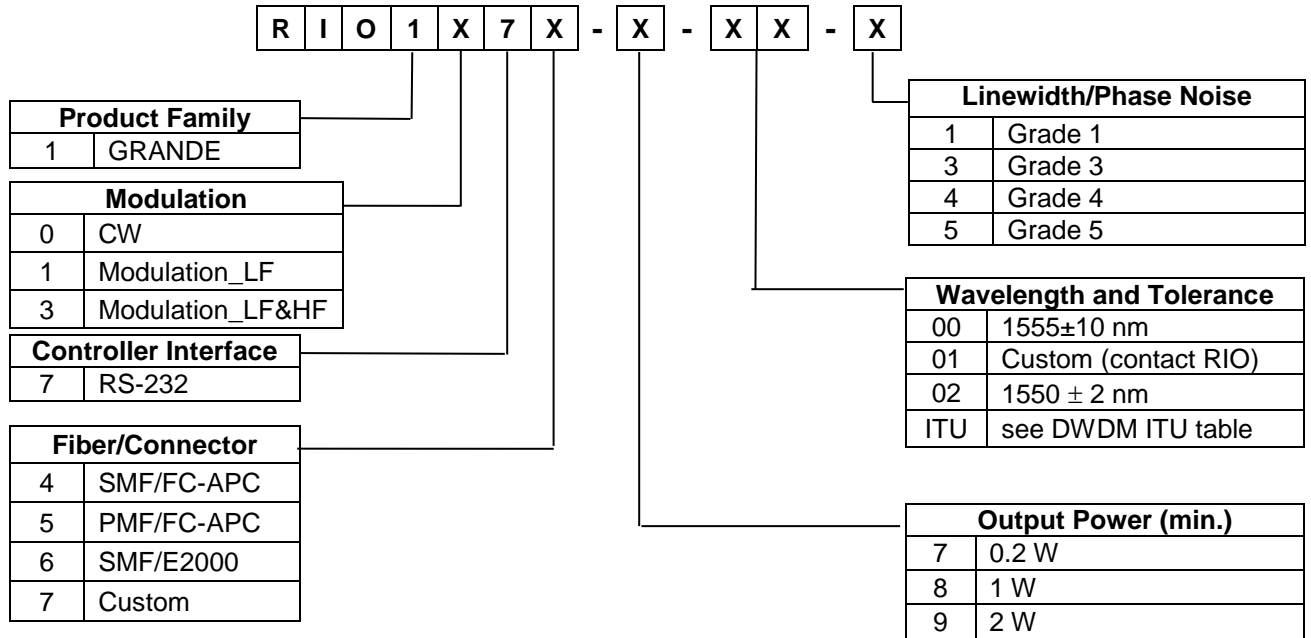
Mechanical Diagram



| Optical Fiber | Fiber Pigtail Length | Fiber Pigtail Diameter | Note |
|---------------|----------------------|------------------------|--|
| SMF-28 | 1 meter typ. | 3 mm | Optional PMF PANDA, Connector key aligned to slow axis |

Note: SMC connector for RIO13XX- option is not presented in the mechanical drawing

Ordering Information



Accessories

| Accessory PN | Description |
|--------------|--|
| RIO10XX-KIT | Flash Drive w/ GUI & RS232 interface cable |
| RIO11XX-KIT | Flash Drive w/ GUI & RS232 interface cable (w. BNC port) |
| RIO13XX-KIT | Flash Drive w/ GUI & RS232 interface cable (w. BNC port) & SMC-SMA cable |

DWDM ITU Wavelength¹

| ITU channel number | ITU Frequency THz | Wavelength nm | ITU channel number | ITU Frequency THz | Wavelength nm | ITU channel number | ITU Frequency THz | Wavelength nm |
|--------------------|-------------------|---------------|--------------------|-------------------|---------------|--------------------|-------------------|---------------|
| 16 | 191.60 | 1564.68 | 24 | 192.40 | 1558.17 | 32 | 193.20 | 1551.72 |
| 17 | 191.70 | 1563.86 | 25 | 192.50 | 1557.36 | 33 | 193.30 | 1550.92 |
| 18 | 191.80 | 1563.05 | 26 | 192.60 | 1556.55 | 34 | 193.40 | 1550.12 |
| 19 | 191.90 | 1562.23 | 27 | 192.70 | 1555.75 | 35 | 193.50 | 1549.32 |
| 20 | 192.00 | 1561.42 | 28 | 192.80 | 1554.94 | 36 | 193.60 | 1548.51 |
| 21 | 192.10 | 1560.61 | 29 | 192.90 | 1554.13 | 37 | 193.70 | 1547.72 |
| 22 | 192.20 | 1559.79 | 30 | 193.00 | 1553.33 | 38 | 193.80 | 1546.92 |
| 23 | 192.30 | 1558.98 | 31 | 193.10 | 1552.52 | 39 | 193.90 | 1546.12 |
| | | | | | | 40 | 194.00 | 1545.32 |

1. Standard wavelength tolerance is +/-40pm

Laser Safety Information

The RIO GRANDE laser module is classified as FDA/CDRH Class IVb laser products per CDRH, 21 CFR 1040 laser safety requirements, and complies as Class 4 laser product per international standard IEC 60825-1, 2014.

DANGER

INVISIBLE LASER RADIATION

AVOID OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION

$\lambda=1.53\sim 1.57 \mu\text{m}$, P=5W max.
CLASS IVb LASER PRODUCT
 PER CDRH, 21 CFR 1040
CLASS 4 LASER PRODUCT
 PER IEC 60825-1, 2014

LASER APERTURE

AVOID EXPOSURE
 Invisible laser radiation is emitted from end of fiber or connector