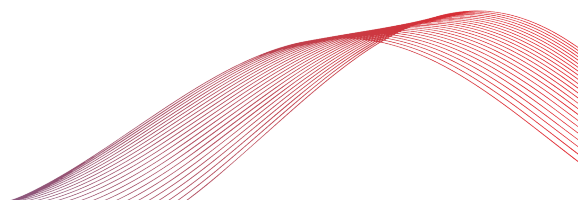




RLM Automated Return Loss Meter

User Manual



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1

COMPLIANCE

FDA-CDRH Compliance

Under the US Food and Drug Administration (FDA) Center for Devices and Radiological Health (CDRH), the unit complies with the Code of Federal Regulations (CFR), Title 21, Subchapter J, which pertains to laser safety and labeling. See following link for more information:

- <http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/CFRSearch.cfm?CFRPartFrom=1000&CFRPartTo=1050>

CSA / IEC Compliance

The unit complies with certain standards of the Canadian Standards Association (CSA) and the International Electrotechnical Commission (IEC).

The unit falls in the Installation Category (Overvoltage Category) II under IEC 664. IEC 664 relates to impulse voltage levels and insulation coordination. The category is defined as: local level, appliances, portable equipment, etc., with smaller transient overvoltages than Installation Category (Overvoltage Category) III.

The unit falls in the Pollution Degree 2 category under IEC 1010-1 and CAN/CSA-C22.2 No. 1010.1. The IEC standard on Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use relates to insulation coordination. The CSA standard is on Safety Requirements for Electrical Equipment for Measurement Control, and Laboratory Use, Part I: General Requirements. The Pollution Degree 2 category is defined as follows: “Normally only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation must be expected.”

CE Compliance

Electronic test equipment is subject to the EMC Directive in the European Union. The EN61326 standard prescribes both emission and immunity requirements for laboratory, measurement, and control equipment. This unit has undergone extensive testing according to the European Union Directive and Standards.

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GENERAL INFORMATION

RL1 Automated Return Loss Meter Overview

The RL1 Automated Return Loss Meter has been precisely designed for the most accurate mandrel-free insertion loss (IL) and return loss (RL) measurements available in the industry. The RL1 is capable of testing even the most challenging fiber-optic cable assemblies and components with smart integrated analysis settings adaptable to user requirements.



Figure 1: RL1 Automated Return Loss Meter

Applications

- IL/RL testing for fiber-optic cable assemblies
- QA and R&D
- Single-mode and multimode fibers
- Simplex, duplex and multifiber assemblies

Key Features

- Mandrel-free RL testing
- Fastest and most accurate in its class
- Wireless integrating sphere detector
- Up to 4 built-in wavelengths:
 - SM: 1310, 1490, 1550, 1625nm
 - MM: 850, 1300nm
- Self-calibration

- Barcode control available
- XN1 Server ready

Test & Measurement Standards

- IL conforms to IEC 61300-3-4 and IEC 61280-4-1
- Multimode IL launch conditions meet the IEC 61280-4-1 Encircled Flux standard
- RL conforms to IEC 61300-3-6

Included Accessories

- USB A to USB B cable (1.8m)
- Ethernet cable (1.8m)
- AC power cord (2m)
- SD00 slide detector cap
- SD01 slide FC detector adapter
- SM: FC/APC – FC/APC jumper (3m) and FC/APC – FC/UPC jumper (3m)
- MM: FC/UPC – FC/UPC jumper (3m) and FC/UPC – FC/APC jumper (3m)

Optional Accessories

- RD-S Wireless Remote-head Detector
- Remote-head detector M12 cable (1m)
- Slide detector adapters
- Barcode scanner
- 2U rubber bezels
- Rackmount kit
- Flip out feet

3

SAFETY INFORMATION




To avoid situations that could result in serious injuries or death, always observe the following precautions.

The safety instructions must be observed whenever the unit is operated, serviced, or repaired. Failure to comply with any of these instructions or with any precaution or warning contained in the user manual is in direct violation of the standards of design, manufacturing, and intended use of the unit. Santec Inc. assumes no liability for the customer's failure to comply with any of these safety requirements.

Safety Markings on the Unit

See Table 1 for symbols and messages that can be marked on the unit. Observe all safety instructions that are associated with a symbol.

Table 1: Safety symbols

	<p>Laser radiation may be present. Refer to the user manual for instructions on handling and operating the unit safely. Avoid looking into any ports near which this symbol appears.</p>
	<p>Frame or chassis terminal for electrical grounding within the unit.</p>
	<p>Protective conductor terminal for electrical grounding to the earth.</p>
<p>WARNING</p>	<p>Procedure can result in serious injury or loss of life if not carried out in proper compliance with all safety instructions. Ensure that all conditions necessary for safe handling and operation are met before proceeding.</p>
<p>CAUTION</p>	<p>Procedure can result in serious damage to or destruction of the unit if not carried out in compliance with all instructions for proper use. Ensure that all conditions necessary for safe handling and operation are met before proceeding.</p>

Classification

The RL1 consists of an exposed metal chassis that is connected directly to earth via a power cord and is therefore classified as a Class 1 instrument.

The laser (or lasers) contained in the RL1 is (are) Class 1M laser(s) as specified under the international standard IEC 60825-1 Ed. 3.0 b:2014 and ANSI Z136.1-2014.

Laser radiation
CLASS 1M
laser product

Important Safety Information

Laser Hazards

Warning



- Never look directly into the end of an optical cable connected to an optical output device that is operating. Laser radiation is invisible and direct exposure can severely injure the human eye.

Electrical Hazards

Warning



- Some of the circuits are powered whenever the unit is connected to the AC power source (line power). To ensure that all circuits are powered off, disconnect the power cord from either the power inlet on the unit's rear panel or from the AC line-power source (receptacle). The power cord must always be accessible from one of these points. If the unit is installed in a cabinet, the operator must be able to disconnect the unit from the line power by the system's line-power switch.
- Use only the type of power cord supplied with the unit. If you need to replace a lost or damaged cord, make sure to replace with a power cord of the same type.
- Connect the power cord only to a power outlet equipped with a protective earth contact. Never connect to an extension cord or any receptacle that is not equipped with this feature.
- If using a voltage-reducing autotransformer to power the unit, ensure that the common terminal connects to the earthed pole of the power source.
- Do not interrupt the protective earth grounding. Such action can lead to a potential shock hazard that can result in serious personal injury. Do not operate the unit if an interruption to the protective grounding is suspected.
- Do not operate the unit when its cover or panels have been removed.
- To prevent potential fire or shock hazard, do not expose the unit to any source of excessive moisture.
- Do not use the unit outdoor.

- Operating the unit in the presence of flammable gases or fumes is extremely hazardous.
- If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. Only technicians authorized by Santec Inc. should carry out repairs. In addition to voiding the warranty, opening the unit (even when unplugged) can expose you to potential shock hazards.
- Some of the unit's capacitors can be charged even when the unit is not connected to the power source.
- Do not perform any operating or maintenance procedure that is not described in the user manual.

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GETTING STARTED

Caution



- To avoid injury or death, always observe the precautions listed in SAFETY INFORMATION on page 4.

This manual contains complete operating instructions for safe and effective operation of the RL1 Automated Return Loss Meter. It is recommended that users of the RL1 familiarize themselves with contents of this manual before using the instrument.

The inspection report and a description of any customer-requested information may be found in the calibration document envelope included with the instrument.

Initial Inspection

Warning



- To avoid electrical shock, do not initialize or operate the unit if it bears any sign of damage. Ensure that the unit and any devices or cords connected to it are properly grounded.

- ✓ Inspect the package and contents for signs of damage.
- ✓ Ensure all contents are included.
- ✓ Read the user manual thoroughly and become familiar with all safety symbols and instructions to ensure that the unit is operated and maintained safely.
- ✓ If the initial inspection reveals any damage or missing components, immediately notify Santec Inc. and if necessary, the carrier.

Operational Requirements

For the unit to meet the warranted specifications, the operating environment must meet the conditions outlined in Table 2.

Table 2: Environmental requirements

Parameter	Specification
Altitude	Up to 2000m
Temperature	0 to 40°C

Humidity	Up to 95% RH (0 to 40°C)
Voltage	Main supply voltage fluctuations must not exceed $\pm 10\%$ of the nominal voltage

Product Overview

RL1 Front Panel

A front view of the RL1 meter is shown in Figure 2. It features a touchscreen which displays information such as references, measurements, test plans, setup and detectors.

The FC output panel (output and input panel in the case of a 2X configuration) is located on the front of the unit. The connections are FC/APC for single-mode and FC/UPC for multimode.



Figure 2: Front view of a dual output RL1

RL1 Rear Panel

A rear view of the RL1 meter is shown in Figure 3. See Table 3 for a detailed description.



Figure 3: Rear view of an RL1

Table 3: Detailed description of the RL1 rear panel components (see Figure 3)

Item #	Description
1	LAN/Reset <ul style="list-style-type: none"> Press once: reset network settings
2	Ethernet port <ul style="list-style-type: none"> Connection to LAN
3	USB B port <ul style="list-style-type: none"> Connection to PC
4	USB A ports <ul style="list-style-type: none"> Connections to peripherals such as SX1 switch, barcode scanner, etc. WARNING: do not connect USB powered devices such as cell phone chargers or inspection probes
5	M12 connector <ul style="list-style-type: none"> Connection to RD-S
6	Power input <ul style="list-style-type: none"> Contains user-replaceable fuse
7	IO switch <ul style="list-style-type: none"> On/off toggle

RD-S Wireless Remote-head Detector

The RL1 can be used with one or more RD-S Wireless Remote-head Detectors for more test setup flexibility. They are connected to each other in series. Figure 4 shows a front view of the RD-S. It uses a wide aperture integrating sphere cavity for maximum uniformity and is ideal for multifiber assemblies such as MPO or duplex LC. Figure 5 shows the rear of the RD-S (see Table 4 for a detailed description).



Figure 4: Front view of an RD-S with an SD01 slide FC detector adapter

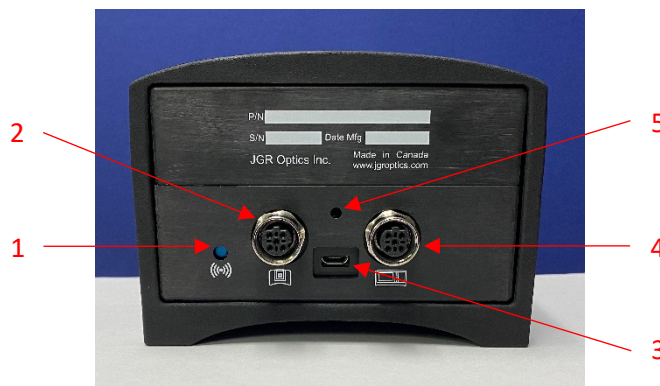


Figure 5: Rear view of an RD-S

Table 4: Detailed description of the RD-S rear panel components (see Figure 5)

Item #	Description
1	Power button <ul style="list-style-type: none"> • Press once: power on or put in pairing mode • Press and hold for 7 seconds: power off
2	M12 connector <ul style="list-style-type: none"> • Connection to next RD-S (if pairing multiple RD-S)
3	Micro-USB port <ul style="list-style-type: none"> • Charging port
4	M12 connector <ul style="list-style-type: none"> • Connection to RL1 (or preceding RD-S if pairing multiple RD-S)
5	LED indicator <ul style="list-style-type: none"> • Green: RD-S is paired to an RL1 • Orange: RD-S is not paired to an RL1 • Flashing: battery charge is low or zero • Red: error, contact Santec

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OPERATION

Before the RL1 meter can be used to make a measurement, the user must setup the meter and connect and reference a “test jumper” to the front panel.

Powering Up the Meter

To power up the meter:

1. Verify that the power switch is set to the “off” position (O). Connect the meter to an AC power supply using the power cord provided.
2. Toggle the power switch to the “on” position (I). The SANTEC logo will flash on the screen during the unit’s initialization.
3. Allow for a warm-up period of up to 30 minutes (SM) or 60 minutes (MM) to obtain an accurate reading.

Pairing a Detector

Swipe left on the touchscreen to access the *Detectors* page (farthest page to the right, see Figure 6). For normal operations, at least one detector must be paired to the RL1.

On start-up, the RL1 will automatically pair with its front panel detector, any wired RD-S and any RD-S it was connected to by wireless signal on shut-down.

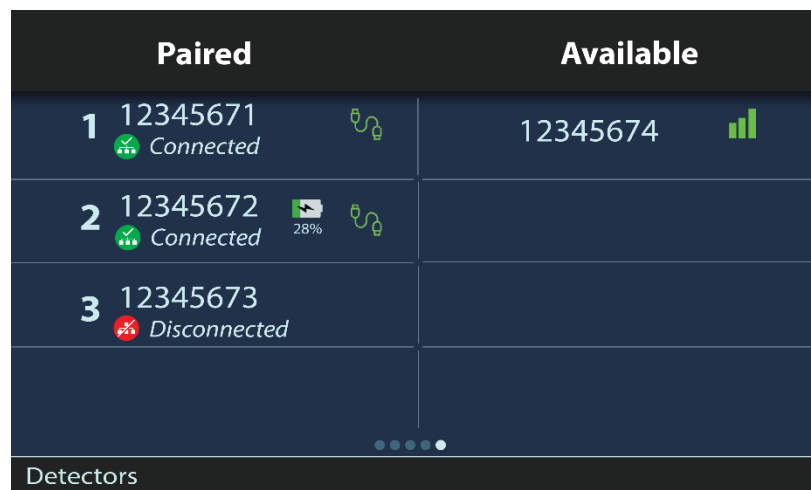


Figure 6: RL1 Detectors page

The *Paired* column displays the SN of detectors paired to the RL1. Figure 6 shows one front panel detector (wired symbol, no battery indicator) and one wired RD-S (wired symbol, battery charging icon) connected and ready to use. A third detector was paired but is no longer connected (ex: an RD-S using wireless signal was turned off).

The *Available* column displays any detectors which can be paired with the RL1 and not already paired to another RL1. In Figure 6, an RD-S is available through wireless connection. The 3 bars indicate the wireless signal strength and the battery icon will update if paired to the RL1.

Tapping on a detector in the *Paired* column will disconnect it. Tapping on a detector in the *Available* column will pair it. Pressing and holding anywhere on the screen will rescan for wired detectors.

Device Information and Settings

Swipe right to access the *Setup* page (Figure 7 and Figure 8). This page will display information about the unit, its connectivity status and test settings. See Table 6 for a detailed description.

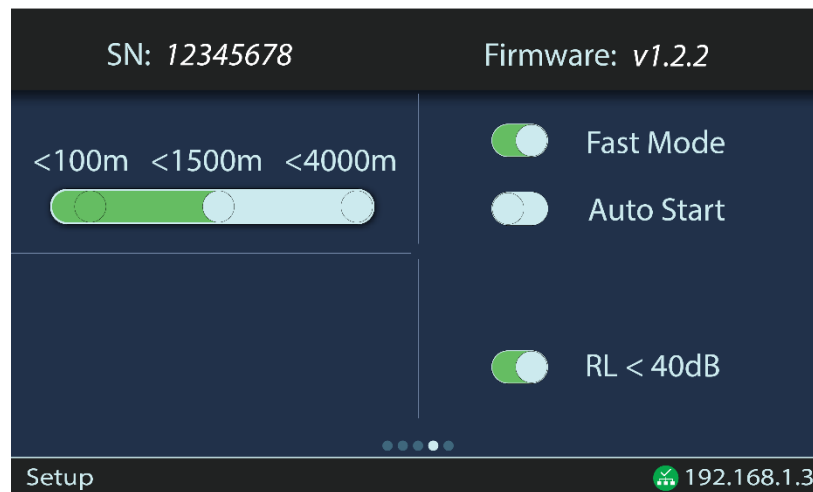


Figure 7: RL1 Setup page (SM)

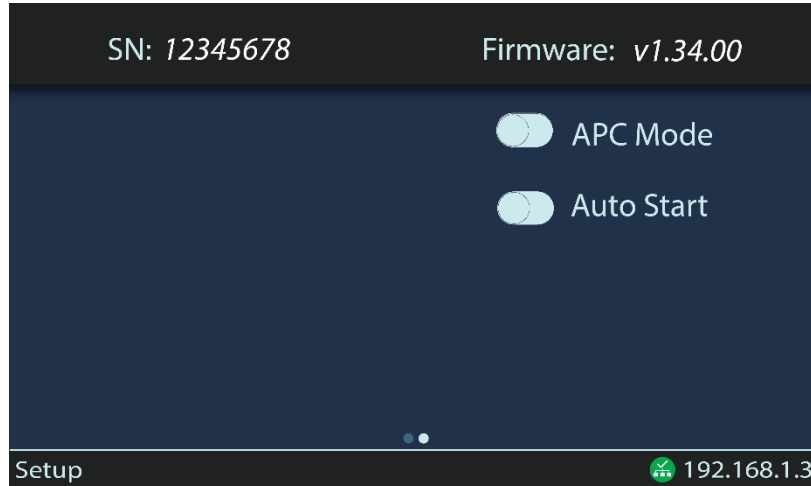


Figure 8: RL1 Setup page (MM)

Table 5: Device information




Parameter	Indicator
Network Status and IP address	<ul style="list-style-type: none"> If connected to a network via Ethernet, in the bottom right corner, the icon will show  as  with the IP address next to it. If not connected to a network, it will show .
Serial Number	<ul style="list-style-type: none"> The SN of the unit is displayed in the top left corner.
Firmware	<ul style="list-style-type: none"> The firmware version of the unit is displayed in the top right corner.

Table 6: Detailed description of the RL1 Setup page

Parameter	Description
<ul style="list-style-type: none"> ● <100m ○ <1500m ○ <4000m (SM only)	Slide the button to select your RL length bin: <ul style="list-style-type: none"> ● <100m: measure DUTs with length < 100 m (fastest) ● <1500m: measure DUTs with length < 1500 m ● <4000m: measure DUTs with length < 4000 m
Fast Mode (SM only)	Select your RL acquisition speed: <ul style="list-style-type: none"> ● If enabled: less than 1.5s per acquisition (recommended setting for most applications, RL limited to 75 dB). ● If disabled: increased dynamic range (RL up to 85 dB) and increased accuracy for RL > 70 dB.
Auto Start	Select your RL acquisition mode: <ul style="list-style-type: none"> ● If disabled: requires the user to tap on the <i>Measure</i> page to begin an acquisition. ● If enabled: the system monitors the IL on the first channel to automatically begin an acquisition when a DUT is connected.
RL < 40 dB (SM only)	Select your RL gain range: <ul style="list-style-type: none"> ● If disabled: measure DUTs with target RL between 40 and 85 dB (recommended setting for most applications). ● If enabled: measure DUTs with target RL between 30 and 40 dB.

APC Mode (MM only)	Select your reference method: <ul style="list-style-type: none"> • Disable if your DUT connector A is PC or UPC (most common for MM testing). <ul style="list-style-type: none"> ○ Stage 1: connect the test jumper to the detector then reference IL. ○ Stage 2: remove the test jumper from the detector then reference RL. • Enable if your DUT connector A is APC (or not a standard flat polish connector like an expanded beam connector). <ul style="list-style-type: none"> ○ Stage 1: connect a UPC reference cable to the output. This cable should have the same length as the test jumper that will be used to measure the DUT. The RL1 will measure the UPC cable loss. ○ Stage 2: remove the UPC cable from the detector then reference RL. ○ Stage 3: replace the UPC cable with the APC test jumper and reference IL.
-----------------------	--

Selecting a Test Plan

Swipe right to access the *Test Plan Information* page (Figure 9).

The IP address of the last XN1 server connected is displayed at the top of the page.

Scan an XN1 test plan barcode while on this screen to load the plan onto the RL1. Please refer to the *XN1 Server User Manual* for more information.

To operate the RL1 without a test plan, tap and select *Manual* from the dropdown menu.

The following settings (see Table 6) from the *Setup* page are set automatically by the XN1 test plans:

- RL acquisition speed
- RL length bin
- RL gain range

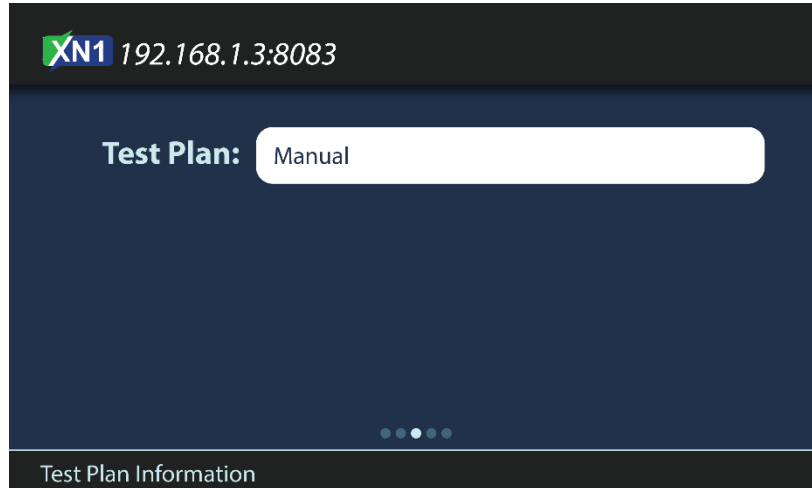


Figure 9: RL1 *Test Plan Information* page

Performing a Reference

Swipe right twice to access the *Reference* page. See Figure 10 and Table 7 for a detailed description. In the case of RL measurements, the test jumper length should be at least 3 meters.

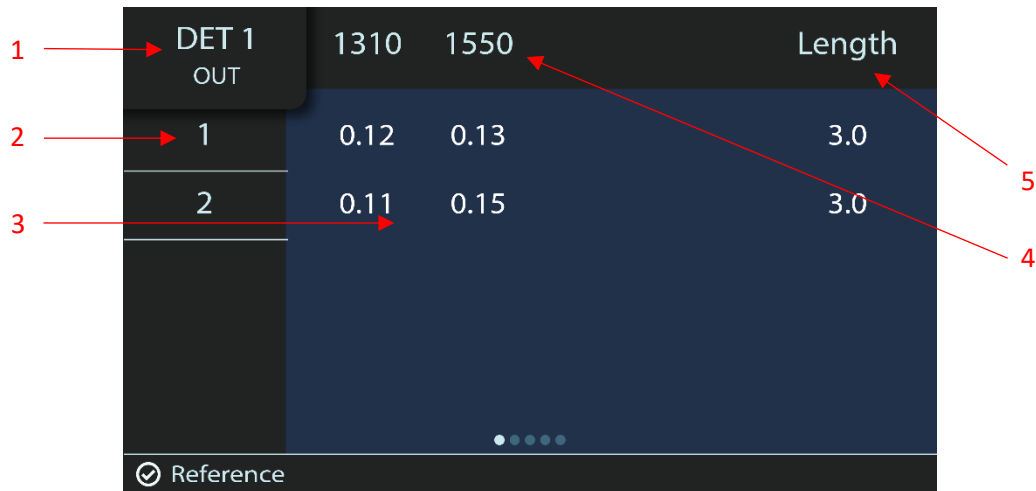


Figure 10: RL1 *Reference* page

Table 7: Detailed description of the RL1 *Reference* page (see Figure 10)

Item #	Description
1	Detector <ul style="list-style-type: none"> • Tap: go to the next detector • Press and hold: open scroll menu to select desired output
2	Channel <ul style="list-style-type: none"> • Tap: perform a full reference for that channel
3	Stored reference values

	<ul style="list-style-type: none"> • Tap: perform a full reference on all channels and wavelengths • Units are in dB and m for IL and length references respectively
4	Wavelength <ul style="list-style-type: none"> • Tap: perform an IL reference of all channels for that wavelength (SM only)
5	Length <ul style="list-style-type: none"> • Tap: perform a length reference for all channels (SM only)

Performing a Measurement

Swipe left to access the *Measure* page (Figure 11). See

Table 8 for a detailed description.

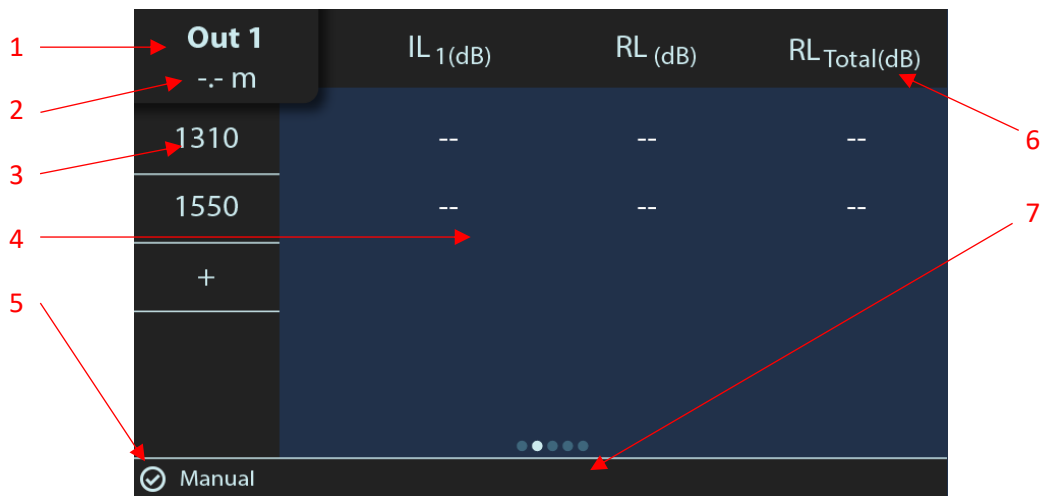








Figure 11: RL1 *Measure* page

Table 8: Detailed description of the RL1 *Measure* page (see Figure 11)

Item #	Description
1	Channel <ul style="list-style-type: none"> • Tap: go to the next output/channel • Press and hold: open scroll menu to select desired output or SX1 switch channel
2	Length <ul style="list-style-type: none"> • Only available when RL parameter is selected (RL_{DUAL} disables length display) • Units are in m
3	Wavelength <ul style="list-style-type: none"> • Tap on a number: open <i>Wavelength Modification</i> pop-out <ul style="list-style-type: none"> ○ Tap on a wavelength to replace the existing wavelength ○ Tap on "X" to remove that wavelength • Tap on "+": open <i>Wavelength Addition</i> pop-out <ul style="list-style-type: none"> ○ Tap on a wavelength to add that wavelength ○ Tap on "X" to close the pop-out • Press and swipe up/down: scroll through the wavelengths

4	<p>Current results</p> <ul style="list-style-type: none"> • Tap when status is <i>Complete</i> or <i>Paused</i>: enable real-time display (<i>Manual mode</i>) or IL monitoring (<i>Auto mode</i>) <ul style="list-style-type: none"> ◦ Note: real-time RL display uses <i>Fast mode</i> and has the same accuracy as defined in the specifications sheet (see page 40) • Tap when status is <i>Real-time (Manual mode)</i>: start a measurement • Press and hold when status is <i>Measuring</i>: pause the measurement • Press and hold when status is <i>Remote</i>: return to <i>Local mode</i>
5	<p>Current status and test plan name</p> <ul style="list-style-type: none"> • Symbols: <ul style="list-style-type: none">  aborted  paused  paused (<i>Auto mode</i>)  complete  real-time  real-time (<i>Auto mode</i>)
6	<p>Test parameter</p> <ul style="list-style-type: none"> • Tap on an existing parameter: open <i>Parameter Modification</i> pop-out <ul style="list-style-type: none"> ◦ Tap on a parameter to replace the existing parameter ◦ Tap on “X” to remove that parameter • Tap on “+”: open <i>Parameter Addition</i> pop-out <ul style="list-style-type: none"> ◦ Tap on a parameter to add that parameter ◦ Tap on “X” to close the pop-out • Test parameters (see Figure 12 for more information) <ul style="list-style-type: none"> ◦ IL_#: insertion loss (IL) in dB on detector # ◦ RL: connector return loss (RL) in dB at position A ◦ RL_{Total}: total return loss (ORL) in dB from the connector at position A to the end of the fiber excluding the final glass-to-air reflection ◦ RL_{Dual}: connector return loss (RL) in dB at positions A and B
7	<p>Additional information</p> <ul style="list-style-type: none"> • If a software is controlling the RL1, will display message “<i>Remote</i>” • If an XN1 test plan is loaded, will display the DUT SN after it is scanned

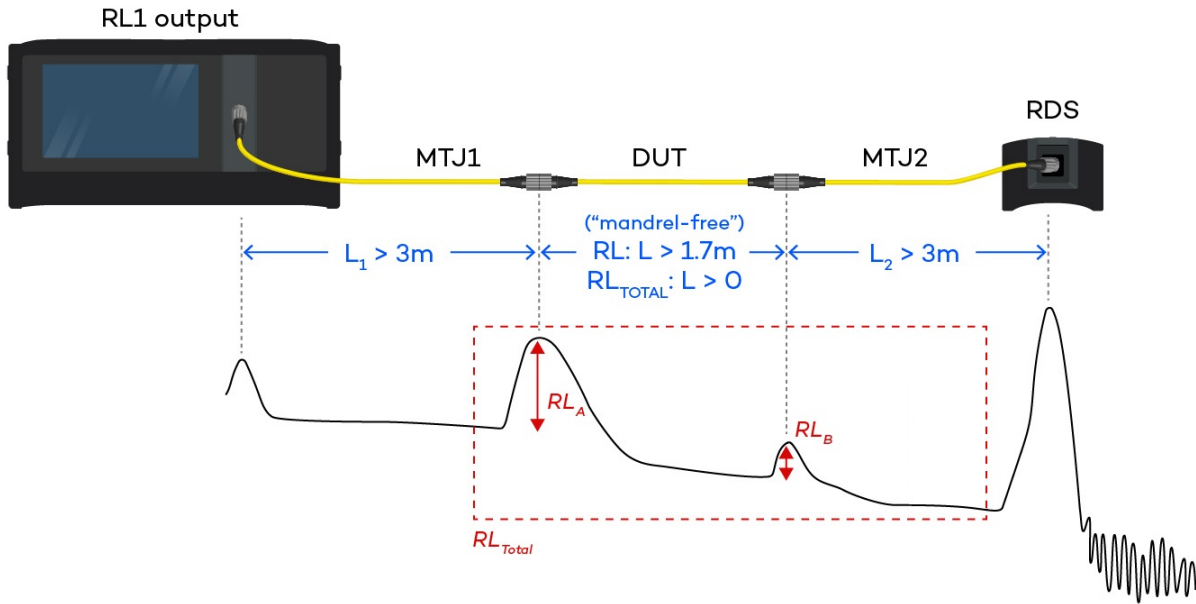


Figure 12: Sample trace showing RL and RL_{TOTAL}

Connecting an SX1 Switch

The RL1 can be used with a switch for multifiber or high throughput applications.

1. Connect the SX1 (USB B port) to the RL1 (USB A port).
2. On the RL1 *Setup* page, confirm the SX1 connectivity and, if the RL1 is a dual output, the switch assignment (see Figure 13).

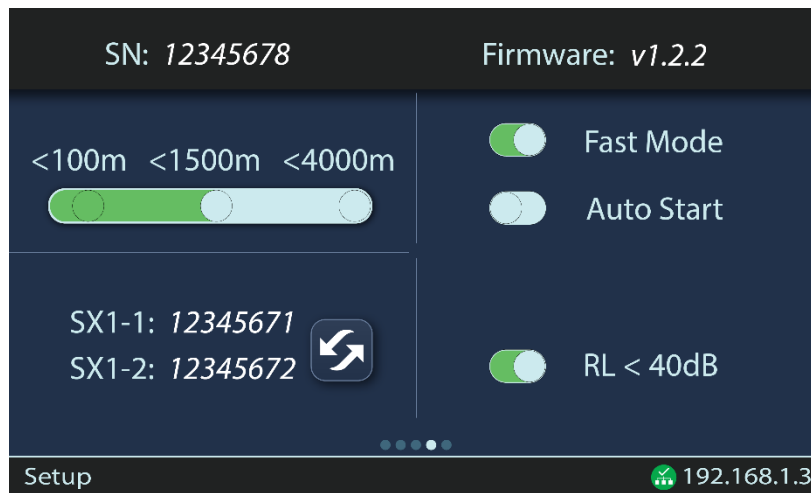


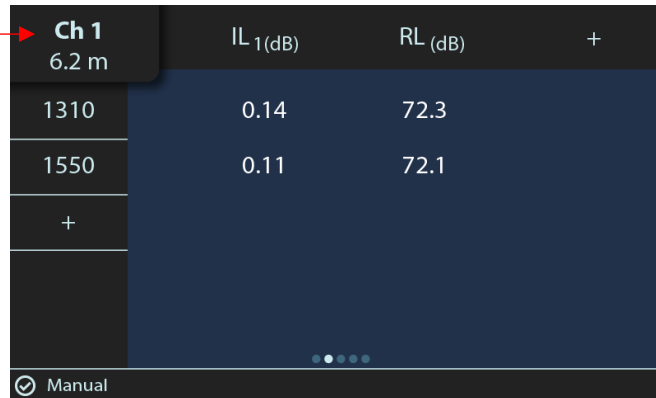
Figure 13: RL1 with SX1 – Setup page

3. Swipe right to the *Measure* page (see Figure 14). Press and hold in the top left corner to open the *Switch Selection* pop-out. From this pop-out, you can:
 - a. Activate or bypass the SX1 switch

b. Skip to the desired channel

Press and hold to open the *Switch Selection* pop-out.

Tap to go to the next channel.

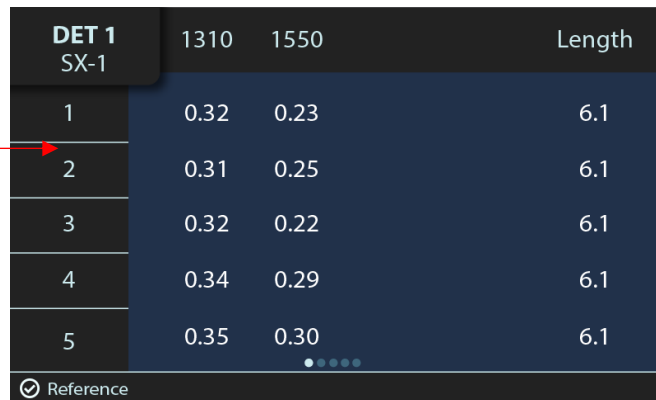


Ch 1 6.2 m	IL 1 (dB)	RL (dB)	+
1310	0.14	72.3	
1550	0.11	72.1	
+			

Figure 14: RL1 with SX1 – Measure page

4. Swipe right to access the *Reference* page (see Figure 15). References are displayed and managed based on the activated switch from step 3.

Press and move up/down to scroll through all channels



DET 1 SX-1	1310	1550	Length
1	0.32	0.23	6.1
2	0.31	0.25	6.1
3	0.32	0.22	6.1
4	0.34	0.29	6.1
5	0.35	0.30	6.1

Figure 15: RL1 with SX1 – Reference page

6

RL1 WEBPAGE

To access the RL1 webpage, connect the meter to a network and on any computer or tablet on the same network, open a web browser (recommended: Google Chrome or Microsoft Edge) and enter the RL1's IP address (see Device Information and Settings on page 12) in the URL bar.

Dashboard

The *Dashboard* tab shows the factory calibration report and up to the last 3 user self-calibration reports (Figure 16).

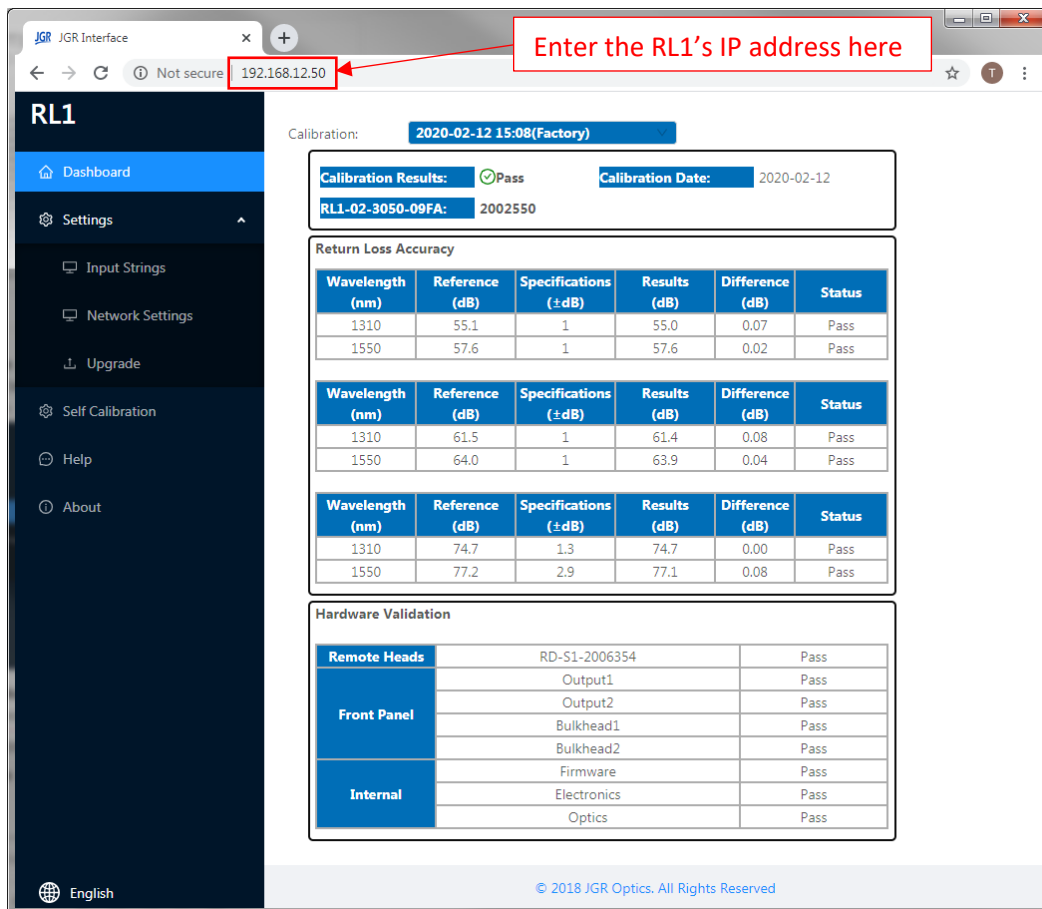


Figure 16: RL1 webpage – *Dashboard* tab

Settings

Click on the *Settings* tab to expand.

Input Strings

You can assign a Human Interface Device (HID) input string from the *Settings > Input Strings* tab (Figure 17). Note: the HID must be USB 2.0 or higher.

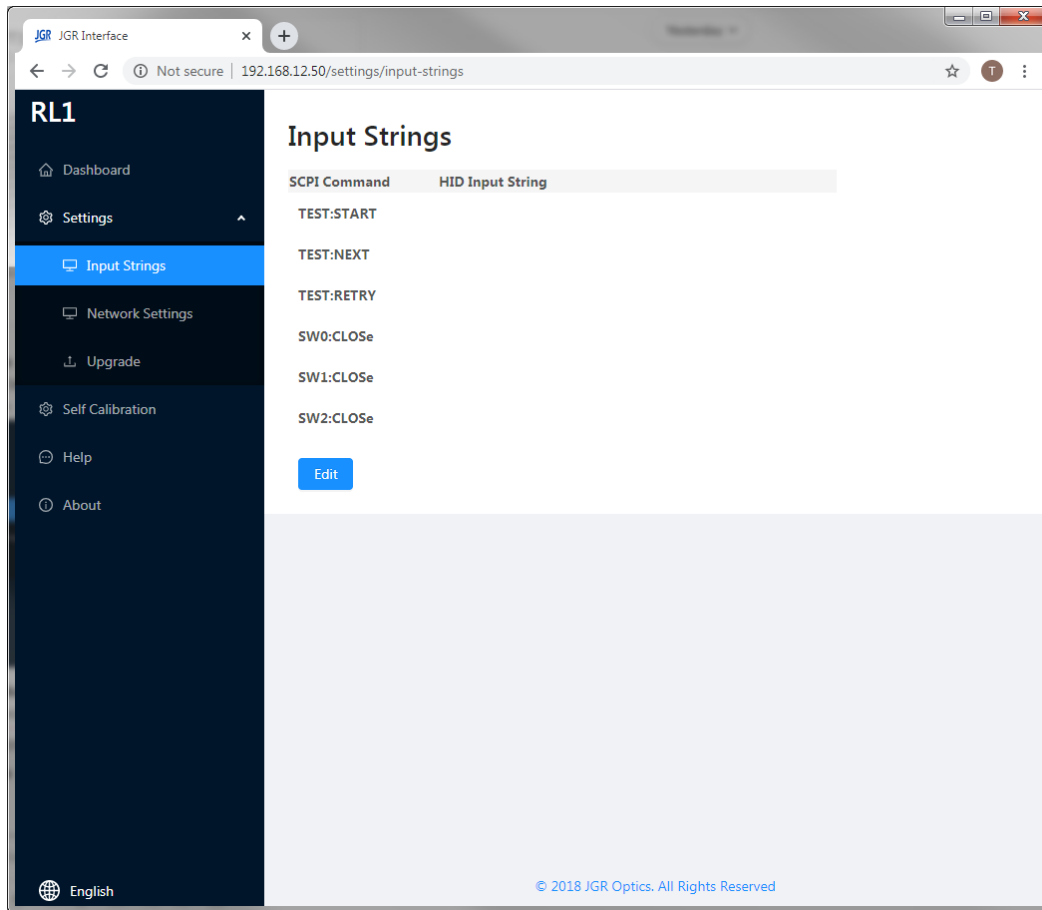


Figure 17: RL1 webpage – *Input Strings* tab

Table 9: Description of HID input string SCPI commands

SCPI Command	Description
TEST:START	Begin a measurement.
TEST:NEXT	If an XN1 test plan is loaded, after a test is completed, go to next DUT.
TEST:RETRY	If an XN1 test plan is loaded, after a test is completed, re-measure the DUT.
SW0:CLOSe	Go to the next output (internal RL1 switch).
SW1:CLOSe	Go to the next channel on switch 1 (external SX1 switch).
SW2:CLOSe	Go to the next channel on switch 2 (external SX1 switch).

Network Settings

You can view, edit or reset the network settings of the RL1 from the *Settings > Network Settings* tab (Figure 18).

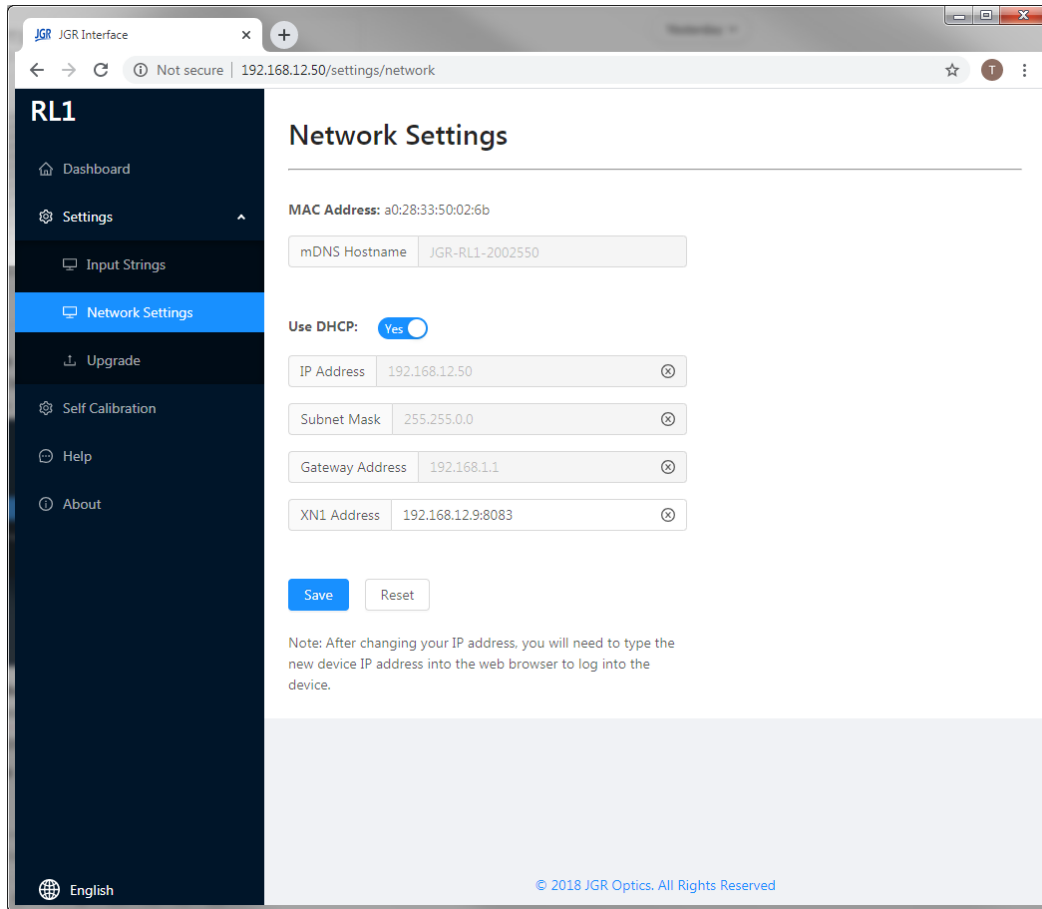


Figure 18: RL1 webpage – Network Settings tab

Upgrade

Go to *Settings > Upgrade* to view the version of, upgrade or re-install the firmware of the RL1 and power meters (Figure 19).

Notes:

1. Please contact support@jgropics.com before performing a firmware upgrade for additional instructions.
2. The power meter firmware is contained within the RL1 firmware. If a power meter upgrade is required, it will be indicated on the *Upgrade* page.
3. *Internal* refers to the power monitoring, internal detector. A paired RD-S wireless remote-head detector will show up on the power meter list with its serial number.

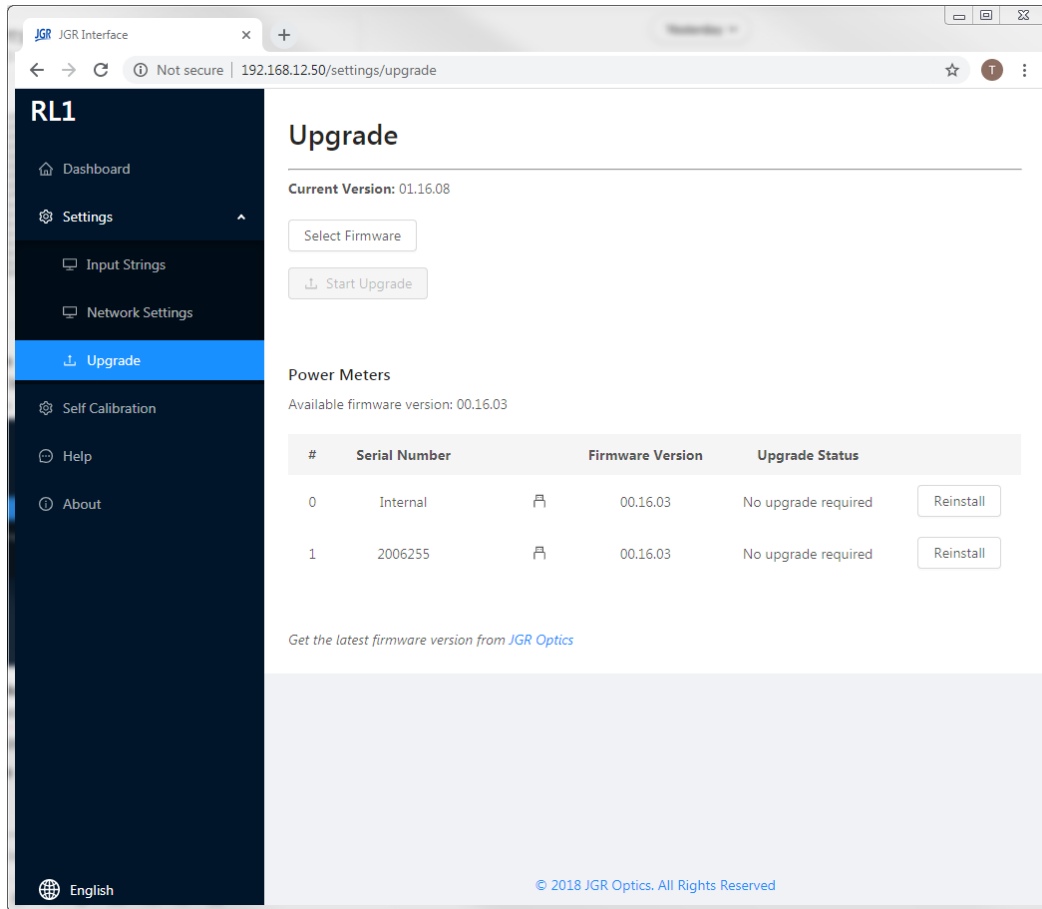


Figure 19: RL1 webpage – Upgrade tab

Self-calibration

See detailed SELF-CALIBRATION section on page 26.

Help

Click on the *Help* tab (Figure 20) where you have links for:

- Technical Support: online form to contact our technical support team. We always respond within 24h, typically within a few hours.
- Debug Log: download the RL1’s debug log. We may ask you to do this to help us troubleshoot any technical issues.
- Sales: online form to contact our sales team. We always respond within 24h, typically within a few hours.
- XN1 Server: link to our website’s downloads section.

Alternatively, email support@jgroptics.com for technical support or info@jgroptics.com for all other inquiries.

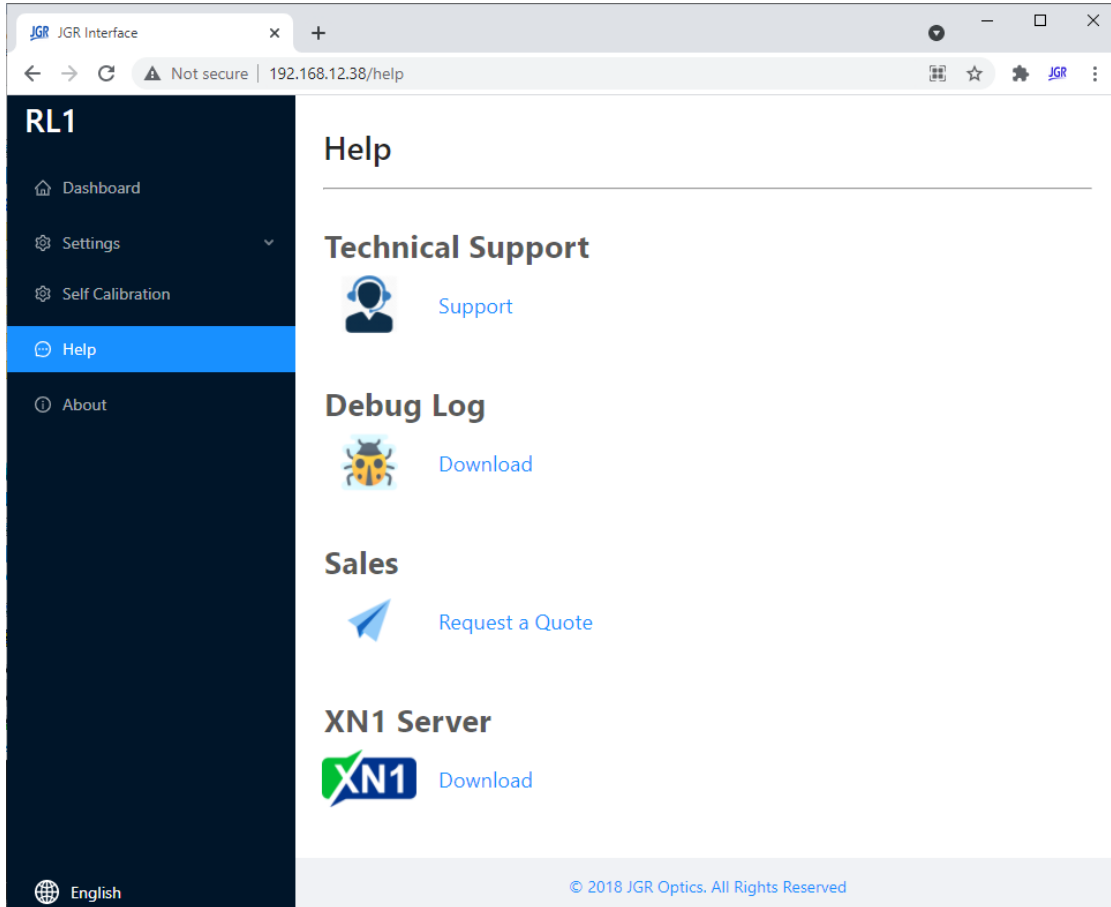


Figure 20: RL1 webpage – *Help* tab

About

The *About* tab (Figure 21) displays the unit's firmware version, model and serial number. *Advanced* mode is reserved for SANTEC technicians and SANTEC-approved service centers.

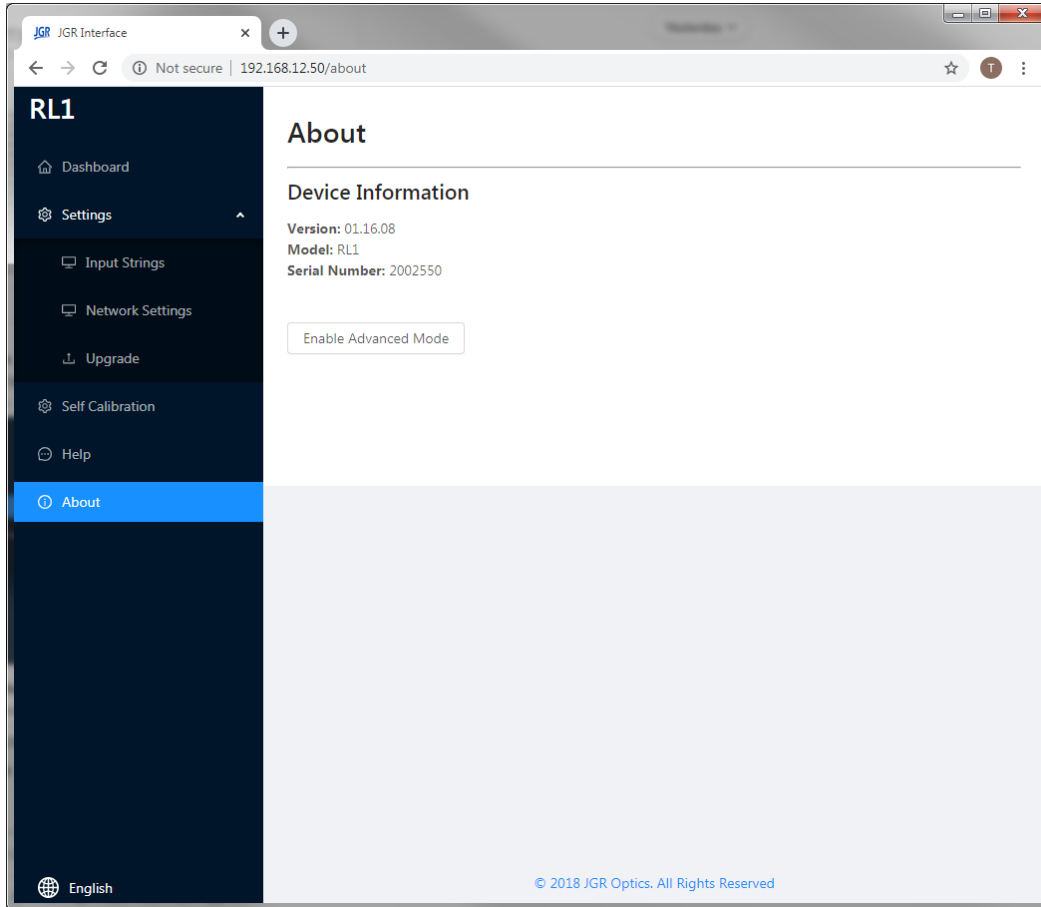


Figure 21: RL1 webpage – About tab

7

SELF-CALIBRATION

The RL1 uses a new, patent pending calibration process which relies on the intrinsic properties of the fiber inside the instrument. As such, it does not require any external artifacts for calibration. For more information on this method, please visit our website or contact us at support@jgoptics.com.

The self-calibration process requires basic fiber optics knowledge and training for proper handling such as connector end-face inspection and cleaning (see the MAINTENANCE section on page 36) and fiber management. It does not require any additional calibration training. However, Santec can provide this type of training upon request as well as video and PDF tutorials.

Equipment and Environmental Conditions

The following equipment is used during self-calibration:

1. Computer or tablet connected to a LAN
2. 3m FC/APC – FC/UPC (SM) or 3m FC/UPC – FC/UPC (MM) test jumper (included in the original shipment)
3. SD01 slide FC detector adapter (included in the original shipment)
4. Connector end-face inspection scope such as SANTEC's EFI-100
5. Cleaning material such as lint-free wipes and isopropyl alcohol (IPA)
6. Optional but recommended:
 - a. FC/APC bulkhead inspection probe
 - b. Heat gun for fiber management
 - c. Polishing equipment if an output lead has some scratches or pits
 - d. Filtered compressed air or dusting gas for clearing dust and small debris

It is recommended to perform the self-calibration in the following environmental conditions:

- Temperature (°C): 25 ± 5
- Relative Humidity (%): 15 to 60

Accessing the Self-calibration RL1 Webpage

1. Connect the RL1 and computer to the same LAN
2. Open a web browser (recommended: Google Chrome or Microsoft Edge) from a computer or tablet on the same network
3. Enter the RL1's IP address in the search bar
4. Click on the *Self Calibration* tab (see Figure 22)

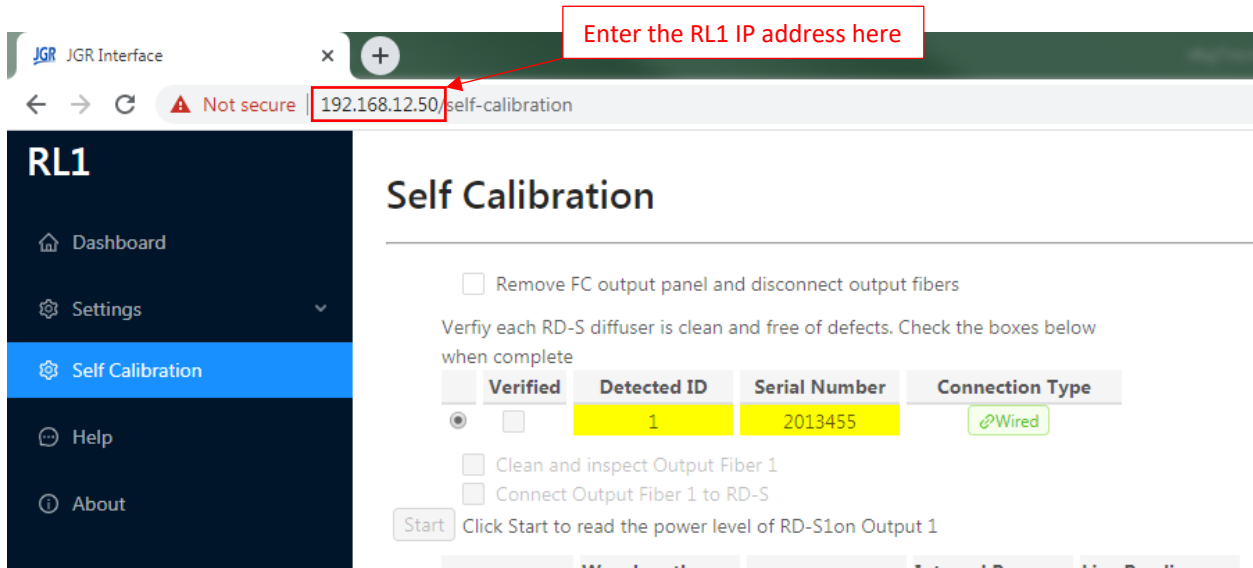


Figure 22: Accessing the RL1 self-calibration tab of the webpage

5. Perform each task as described then check the box before proceeding to the next step
6. If one of the steps fails, see the Troubleshooting section on page 28
7. Once the self-calibration is completed and each step was successful, click *Save* to store the report on the RL1
8. The saved reports can be viewed from the *Dashboard* tab of the RL1 webpage (see Figure 23)

Calibration: **2020-02-12 15:08(Factory)**

2020-02-12 15:08(Factory) Date: 2020-02-12 15:08

2020-05-07 15:16

Not Available

Return Loss At

Not Available

Wavelength (nm)	Reference (dB)	Specifications (±dB)	Results (dB)	Difference (dB)
1310	55.1	1	55.0	0.07
1550	57.6	1	57.6	0.02

Wavelength (nm)	Reference (dB)	Specifications (±dB)	Results (dB)	Difference (dB)	Status
1310	61.5	1	61.4	0.08	Pass
1550	64.0	1	63.9	0.04	Pass

Wavelength	Reference	Specifications	Results	Difference	Status
			74.7	0.00	Pass
			77.1	0.08	Pass

06354	Pass
t1	Pass
Output2	Pass
Bulkhead1	Pass
Bulkhead2	Pass
Firmware	Pass
Electronics	Pass
Optics	Pass

Front Panel

Internal

The Factory calibration can only be performed by Santec or one of its approved service centers/technicians. Its report cannot be overwritten by the self-calibration reports. If any repairs are performed on the unit, a new factory calibration will likely be required.

Click here to expand the calibration reports dropdown menu

The last 3 saved self-calibration reports are stored on the RL1

Figure 23: Viewing the calibration reports stored on the RL1

Troubleshooting

When troubleshooting the self-calibration process, it is important to rule out external factors before investigating issues with the unit itself. Generally, the main causes of failure are:

- poor fiber management
- connection contamination (ex: dust, dirt, water droplets, residues)
- damage such as connector end-face scratches and pits or micro-cracks in the fiber

Table 10 gives a description of each step and some common issues to investigate before contacting Santec.

Table 10: Troubleshooting failed steps during self-calibration

Step	Description	Common issues and how to resolve them
------	-------------	---------------------------------------

Hardware Validation	Verifies key hardware elements	<p>Temperature sensitive components are not within their specified ranges:</p> <ul style="list-style-type: none"> ➤ verify the environmental conditions meet those recommended on page 26 ➤ leave the unit turned on for 30 min and try again
Power Level	Measures the power of each output	<p>Obstructed detector adapter:</p> <ul style="list-style-type: none"> ➤ carefully inspect the adapter for dust or small debris ➤ as needed: use compressed air <p>Contaminated or damaged RD-S diffuser:</p> <ul style="list-style-type: none"> ➤ carefully inspect the diffuser ➤ as needed: clean with a lint free wipe, IPA and/or compressed air <p>Contaminated or damaged output lead connector:</p> <ul style="list-style-type: none"> ➤ inspect output lead connector end-face ➤ as needed: clean and/or polish
Return Loss Accuracy	Calibrates RL	Contact Santec
Optical Performance Validation	Performs a series of self-diagnostic tests to ensure it meets all established specifications	<p>Poor fiber management:</p> <ul style="list-style-type: none"> ➤ verify the output lead and the test jumper do not have any sharp twists or bends (see Figure 24) ➤ as needed: use a heat gun to help relax the fiber <p>Contaminated or damaged RD-S diffuser:</p> <ul style="list-style-type: none"> ➤ carefully inspect the diffuser ➤ as needed: clean with a lint free wipe, IPA and/or compressed air <p>Contaminated or damaged connectors:</p> <ul style="list-style-type: none"> ➤ inspect all connector end-faces (output lead and test jumper) ➤ as needed: clean, polish and/or replace test jumper <p>Damaged mating adapter:</p> <ul style="list-style-type: none"> ➤ try a different FC mating adapter <p>Damaged test jumper:</p> <ul style="list-style-type: none"> ➤ try a different test jumper



Figure 24: Example of good test jumper fiber management

8

PROGRAMMING GUIDE

Establishing Communication

The RL1 follows the *SCPI* (Standard Commands for Programmable Instruments) message-based programming standard. It conforms to the *USBTMC* (USB Test and Measurement) standard.

USB

VISA drivers are required for USB communication.

- Recommended: *Rohde and Schwarz*
 - https://www.rohde-schwarz.com/gr/applications/r-s-visa-application-note_56280-148812.html
- Alternatives: *National Instruments, Keysight, etc.*

Ethernet

Each RL1 is factory pre-set to use DHCP. To connect the RL1:

- Connect the RL1 to the network via an Ethernet cable
- Swipe on the front panel touchscreen to the *Setup* page to view the RL1's IP address

The TCP/IP libraries provided by most operating systems are sufficient.

Note: any *VISA* implementation is capable of controlling the RL1 via TCP/IP on port 5025.

Step-by-step Guide

This section will provide a step-by-step programming guide in a *.NET* programming environment such as *C#* or *VB.NET*.

1. Install *VISA* drivers on the development system
2. Connect the RL1 via its USB B port to the development system
3. Add a reference to *Ivi.Visa.dll* in your project:

C:\Program Files (x86)\IVI Foundation\VISA\Microsoft.NET\Framework32\v2.0.50727\VISA.NET Shared Components 5.11.0\Ivi.Visa.dll

4. Use the *IVI.Visa.GlobalResourceManager* to find all USB instruments on your system:

```
Public Overrides Function GetAllAddresses() As String()  
Try  
Dim nameList As New List(Of String)  
nameList = GlobalResourceManager.Find("USB?*INSTR")
```

```
Return nameList.ToArray()  
Catch ex As Exception  
Return Nothing  
End Try  
End Function
```

5. Open an *IMessageBasedSession* to the desired device using an address from the *nameList* in the previous step:

```
Private visa As IMessageBasedSession
```

```
visa = GlobalResourceManager.Open(addr)
```

6. Use the *Write* method to send SCPI commands and the *Read* method to retrieve results:

```
Public Overrides Function Read(ByVal readableOnly As Boolean) As String  
Dim response As String = String.Empty  
response = visa.RawIO.ReadString()  
If response = String.Empty Then  
Throw New Exception("Read from device failed")  
End If  
Return response  
End Function
```

```
Public Overrides Sub Write(ByVal strCommand As String)  
visa.RawIO.Write(strCommand)  
End Sub
```

Write commands require termination with the linefeed character `\n`.

Notes

1. Some commands (ex: *READ:RL?* in the 4km length bin with *Standard* mode) can take upwards of 10 seconds to return. The *Read* timeout should be increased to at least 15000 ms using *visa.TimeoutMilliseconds*
2. The RL1 runs SCPI commands synchronously. An **OPC?* command can be sent and a *1* will be returned when all operations have been completed:

```
Query("LAS:ENAB " + iWavelength.ToString() + ";OPC?" + vbCrLf)
```

Commands Lists





See Table 11 and Table 12 for SCPI required and RL1 commands respectively.

Table 11: Standard SCPI required commands list

*CLS
*ESE #
*ESE?
*ESR?
*IDN?
*OPC
*OPC?
*OPT?
*RCL "filename"
*RST
*SAV "filename"
*SRE #
*SRE?
*STB?
*TST?
*WAI
:STATus:OPERation:CONDition?
:STATus:OPERation:ENABle <byte>
:STATus:OPERation:ENABle?
:STATus:OPERation[:EVENT]?
:STATus:QUEStionable:CONDition?
:STATus:QUEStionable:ENABle <byte>
:STATus:QUEStionable:ENABle?
:STATus:QUEStionable[:EVENT]?
:STATus:PRESet
:SYSTem:ERRor[:NEXT]?
:SYSTem:VERSion?
:SYSTem:COMMunicate:LAN:ADDRess <ip/dhcp>

Table 12: RL1 commands list

Command	Description
LASer:DISABle	Disable all lasers (equivalent to LASer:ENABLE 0).
LASer:ENABLE #	Turn on laser at <nominal wavelength> in IL mode.
LASer:ENABLE?	Return nominal wavelength of enabled laser.
LASer:INFO?	Return a list of supported nominal laser frequencies.
FIBER:INFO?	Return the type of fiber (SM or MM).
READ:RL? #	Return RL _A , RL _B , RL _{TOTAL} and Length at <nominal wavelength>.
READ:RL? #,#,#	Return RL _A , RL _B , RL _{TOTAL} and Length at <nominal wavelength, reference length A, reference length B> .
REF:RL	Measure and set the length of MTJ1 for the current channel (use output and/or switch commands to set the current channel).
REF:RL #,[#]	Manually set <length>, <length> of MTJ1 and MTJ 2 (optional) respectively for the current channel (use output and/or switch commands to set the current channel).
REF:RL?	Return MTJ1 length stored in the RL1 for the current channel (use output and/or switch commands to set the current channel).
POW:det#:INFO?	Return serial number, calibration date, FW version, battery level, and connection type for paired detector <#>.
POW:NUM?	Return total number of connected power meters.
READ:POW:det#? #	Return power meter reading for detector <#> at <nominal wavelength>.
READ:POW:MON? #	Return internal reference power meter reading at <nominal wavelength>.
READ:IL:det#? #	Return IL from detector <#> at <nominal wavelength>.
REF:IL:det# #,#	Set IL reference for detector <#> at <nominal wavelength, value>.
REF:IL:det#? #	Return IL reference for detector <#> at <nominal wavelength>.
READ:FACTory:POWer? #,#	Return factory stored absolute power values at <output, nominal wavelength>.
RL:SENSitivity #	Set RL sensitivity: <fast> or <standard>.
RL:SENSitivity?	Return RL sensitivity.
RL:POSB #	Set where RL _B position is defined from <eof> (backward from end of fiber) or <zero> (forward from position zero).
RL:POSB?	Return where RL _B position is defined (default: eof).
RL:GAIN <low,normal>	Set the RL gain mode to low (<40 dB) or normal (40 to 85 dB).
RL:GAIN?	Return the RL gain mode.
DUT:LENGTH #	Set DUT length bin (<#> = 100, 1500 or 4000).
DUT:LENGTH?	Return DUT length bin.
DUT:IL #	Set <DUT IL>. RL _B will be compensated by this value.
DUT:IL?	Return the set value for DUT:IL. Note: this is not a measured value.
OUT:CLOSe #	Set the internal switch (SW0) to channel <#>.
OUT:CLOSe?	Return current internal switch (SW0) channel.
SW#:INFO?	Return the type of switch number <#> (SW0 for internal).

SW#:CLOSe #	Set switch number <#> to channel <#>.
SW#:CLOSe?	Return current channel of switch number <#>.
LCL #	Set local interaction mode: <1> (enabled) or <0> (disabled).
LCL?	Return local interaction mode status.
AUTO:ENABle #	Set auto-start mode: <1> (enabled) or <0> (disabled).
AUTO:ENABle?	Return auto-start mode status.
AUTO:TRIGger?	Return 1 if auto-start conditions have been met, 0 otherwise.
AUTO:TRIGger:RST #,#	Start looking for auto-start conditions on specified <nominal wavelength, detector #>.
READ:BARCode?	Return a string with the contents of the last barcode scanned.
TEST:NOTIFY# "string"	<p>Push a <notification> to the RL1 touchscreen display. # indicates the icon to be displayed:</p> <ul style="list-style-type: none"> • 0 =  • 1 =  • 2 =  • 3 = 
TEST:RETRY	Retry the current XN1 test plan.
TEST:NEXT	Save results to the XN1 Server and prepare for the next DUT.

9

MAINTENANCE

Warning



- Devices with malfunctioning lasers must be returned to the manufacturer for repair.

Cleaning the Unit

1. Unplug the unit from the line power.
2. Clean the enclosure with a damp cloth.
3. Do not plug the unit back in until it is completely dry.

Cleaning the Output

Warning



- Connecting contaminated or damaged connectors to the RL1 can damage the unit and affect its performance.
- Damaging the output fiber during maintenance can affect the performance of the unit.

1. Inspect all connectors before each mating and if needed, clean with a lint-free wipe and/or IPA. Figure 25 shows a dirty connector requiring cleaning. Figure 26 shows a clean connector ready to be mated.
2. Loosen the front panel thumbscrews.
3. Gently remove the output panel. Ensure a clear line of sight to the fiber to prevent any stress on the output fiber.
4. Remove the connectors from the mating sleeves. For multiple output RL1's, a marking is visible on the fiber to distinguish which fiber is used for which output.
5. Clean the connectors and mating sleeves in accordance with the section Cleaning Jumper Connectors on page 37.
6. Reinstall the connectors into the mating sleeves.
7. Reinstall the output panel with the thumbscrews. To avoid damaging the fibers, keep a clear line of sight to the fiber as it spools back inside the unit. It should lay flat and spool back in without resistance or twisting. Figure 27 shows an exposed view of good output fiber management. Figure 28 shows poor fiber management.

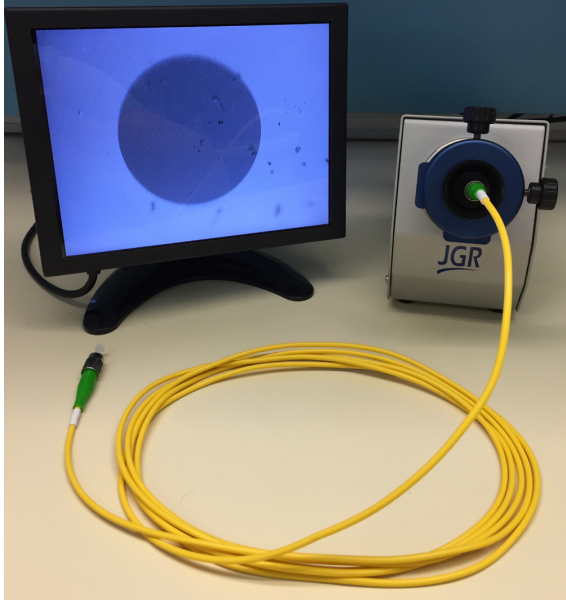


Figure 25: Dirty connector end-face inspection using SANTEC's EFI-100

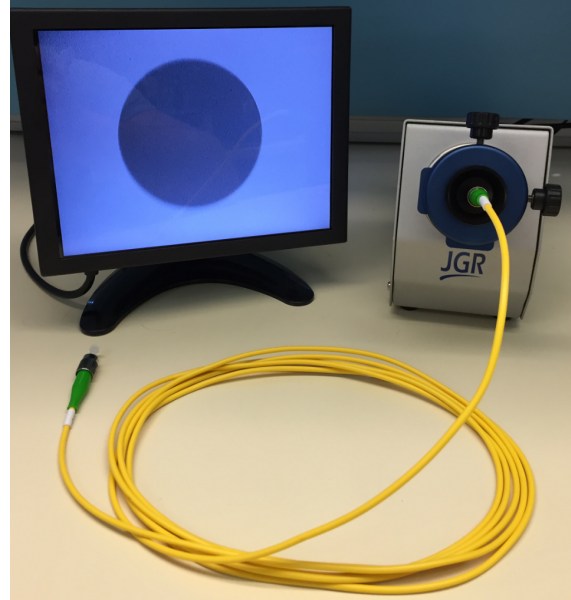


Figure 26: Clean connector end-face inspection using SANTEC's EFI-100

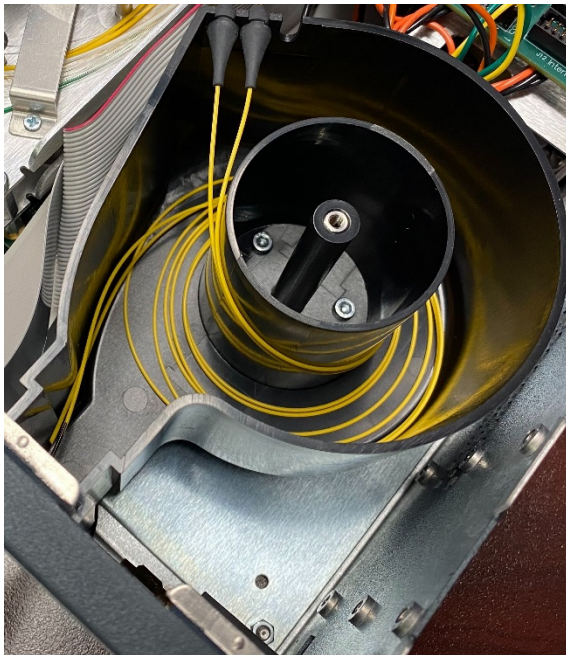


Figure 27: Exposed view of good output fiber management

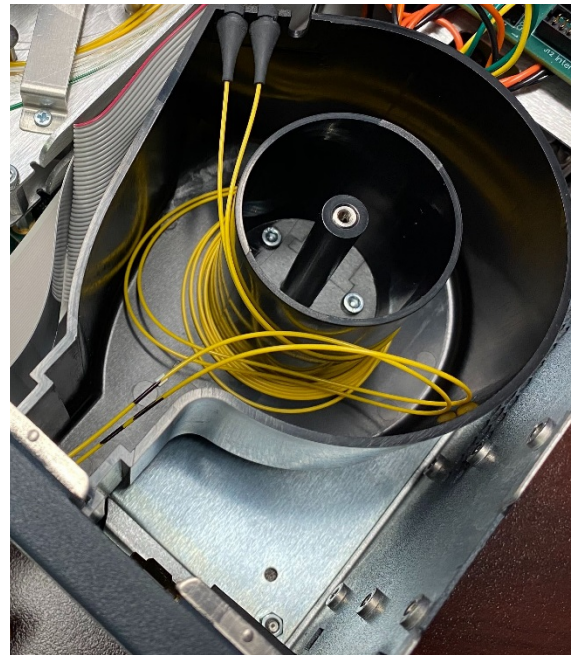


Figure 28: Exposed view of poor output fiber management

Note: the exposed views are only for instructional purposes. **The RL1 chassis should not be opened during normal maintenance.**

Cleaning Jumper Connectors

Warning



- Using contaminated or damaged jumpers can affect the performance of the unit.
- Never force an optical connector mating. Some connectors have a ceramic ferrule that can be easily broken.

Optical cable ends need to be inspected before each mating to ensure they are free of contamination or damage. An inspection scope such as SANTEC's EFI-100 is required.

If they are contaminated, they must be cleaned. The following items are required.

- Filtered compressed air or dusting gas
- Lint-free swabs and lint-free wipes
- Optical grade isopropyl alcohol (IPA) or optical grade 200° ethanol (**do not use rubbing alcohol** which can contain up to 30% water)

To clean the connectors:

1. Blow the sleeve with compressed air.
2. Apply the alcohol to a small area of the lint-free wipe and rub the end of the ferrule over the wet area.
3. Wipe the ferrule on a dry area of the lint-free wipe.
4. Blow the end of the ferrule with compressed air.
5. Apply the alcohol to a lint-free swab to clean the remaining parts of the connector.
6. With the other end of the swab, dry the areas cleaned.
7. Blow the areas cleaned with compressed air.

10

STORAGE AND SHIPPING

Damage can occur from improper handling. Make sure to maintain the unit within the specified temperature range during storage or shipping. Please follow the recommendations below to minimize the possibility of damage:

- If possible, pack the unit in its original packing material when shipping.
- Avoid high humidity or large temperature fluctuations that could generate condensation within the unit.
- Avoid unnecessary shocks and vibrations.

Returning Instruments to Santec

As indicated above, please ship the returned material in the original shipping box and packing material. If these are not available, follow the guidelines below:

1. Contact Santec to obtain an RMA number.
2. Cover the front panel with foam to prevent damage.
3. Wrap the unit in anti-static packaging. Use anti-static connector covers.
4. Pack the unit in a strong enough shipping box considering the unit's weight.
5. Use enough shock-absorbing material (10 to 15 cm) to cushion the unit and prevent it from moving inside the box. Pink poly anti-static foam is recommended.
6. Seal the shipping box securely.
7. Clearly mark FRAGILE on at least 3 of the 4 sides of the box.
8. Always provide the model and serial number of the unit and, if applicable, the RMA number on any accompanying documentation. If possible, indicate the RMA number on the box itself to facilitate identification.

Contact Information

Santec Inc.
160 Michael Cowpland Drive
Ottawa, Ontario, Canada
K2M 1P6

Phone: +1-613-599-1000
Fax: +1-613-599-1099
Email: info@jgoptics.com
Website : www.jgoptics.com

11

SPECIFICATIONS

Table 13: RL1 optical and electrical specifications sheet

Parameter	Specification		
	Single-mode	Multimode	
Fiber Type (μm)	9/125	50/125 and/or 62.5/125	
Encircled Flux Standard	N/A	IEC 61280-4-1	
Operating Wavelengths (nm)	1310 / 1490 / 1550 / 1625 / 1650	850 / 1300	
Return Loss Range (dB)	30 to 85	10 to 50	
Return Loss Accuracy (dB)	± 1.0 (30 to 70)	± 1.4 (10 to 30)	
	± 1.3 (70 to 75) ¹	± 1.9 (30 to 40)	
	± 2.9 (75 to 80) ²	± 2.2 (40 to 43)	
	± 3.9 (80 to 85) ²	± 4.7 (43 to 50)	
Detector Type	Wide area integrating sphere wireless remote-head		
Insertion Loss Accuracy (dB)	± 0.03 (< 5 dB loss)		
	± 0.15 (> 5 dB loss)		
Remote Interface	USB / Ethernet		
Testing Time (s) ³	< 1.5 per wavelength		
	Fast Mode		
	Standard Mode	< 5 per wavelength	N/A
Cable Assembly Length (m)			
	RL mode	< 4000 ⁴	< 500 ⁴
	RL _{TOTAL} mode	< 4000 ⁵	N/A
Input Voltage	100 to 240 V AC, 50 to 60 Hz		
Power Consumption (VA)	60 maximum		
Display	5" (13 cm) touchscreen		

Notes:

¹ add ± 0.4 dB in "Fast Mode"

² "Standard Mode" only

³ 100m length bin

⁴ mandrel-free length > 1.7m

⁵ receive test jumper required for <1.7m cable assemblies

Table 14: RL1 mechanical and environmental specifications sheet

Parameter	Specification
Unit Dimensions W x H x D (cm)	
RL1	23.5 x 12 x 32.5 (2U half rack)
RD-S	11 x 9.2 x 8.6
Shipping Box Dimensions W x H x D (cm)	36.5 x 39 x 53
Unit Weight (kg)	8
Total Shipment Weight (kg)	9
Operating Temperature (°C)	0 to 40
Humidity (Non-condensing)	Max 95% RH from 0 to 40°C



In the event of any trouble with this product, turn the unit off in accordance with the procedures to shut off the power described in this operation manual, disconnect the power source cord, make sure the product name and serial number described on the name plate of the product, and then contact our dealer at your place or directly contact us at Santec Photonics Laboratories. Our telephone number and facsimile number are shown below. However, we are not responsible for any trouble arising from your own repair or modification on this product.

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