PEM-400

Polarization Extinction Ratio Meter

User Manual

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

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.

2

GENERAL INFORMATION

PEM-400 Polarization Extinction Ratio Meter Overview

The PEM-400 is an instrument developed for high-volume testing of the polarization extinction ratio (PER) for polarization maintaining (PM) components such as fiber array units (FAU) and external laser small form-factor pluggables (ELSFP).

Figure 1: PEM-400 Polarization Extinction Ratio Meter

Applications

- High-volume production testing
- PER/angle/IL of FAU
- PER/angle/absolute power of ELSFP
- Incoming inspection
- QA and R&D testing

Key Features

- Built-in multichannel PM source
- Wide-area detector to capture PER on an entire multifiber connector or FAU
- 30 dB PER dynamic range

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
- ISO 17025 NIST-traceable calibration report

Optional Accessories

- Slide detector adapters
- Barcode scanner
- Rackmount kit

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.

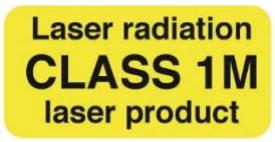
Table 1: Safety symbols

	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.
	Frame or chassis terminal for electrical grounding within the unit.
	Protective conductor terminal for electrical grounding to the earth.
WARNING	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.
CAUTION	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.

Classification

The PEM-400 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 PEM-400 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.



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.

4

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 PEM-400 Polarization Extinction Ratio Meter. It is recommended that users of the PEM-400 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 ± 10% of the nominal voltage

Product Overview

PEM-400 Front Panel

A front view of the PEM-400 meter is shown in Figure 2. It features a touchscreen which displays information such as references, measurements and setup.

The FC/APC outputs are located on the front of the unit.

Figure 2: Front view of a 16 channel PEM-400

PEM-400 Rear Panel

A rear view of the PEM-400 meter is shown in Figure 3. See Table 3 for a detailed description.

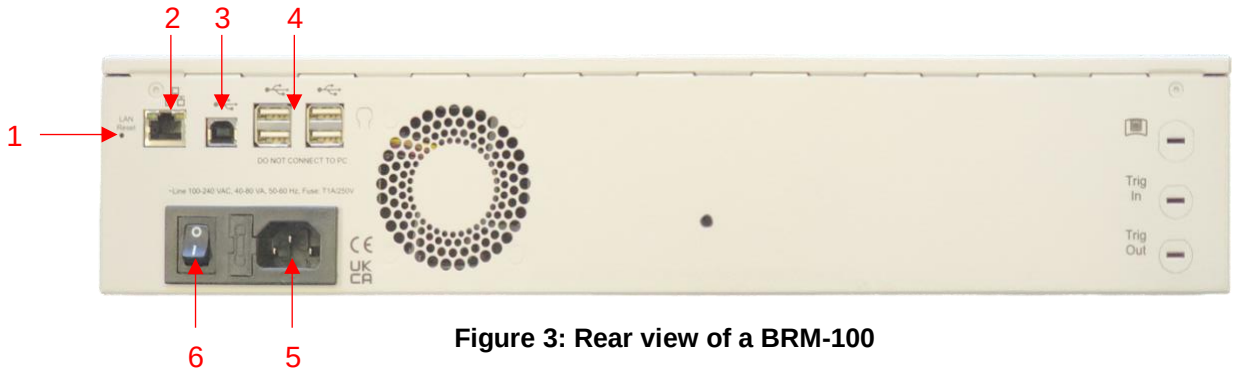


Figure 3: Rear view of a BRM-100

Table 3: Detailed description of the BRM-100 rear panel components (see Figure 3)

Item #	Description
1	LAN/Reset • Press once: reset network settings
2	Ethernet port • Connection to LAN
3	USB B port • Connection to PC
4	USB A ports • Connections to peripherals for future functionality (no current usage)
5	Power input • Contains user-replaceable fuse
6	IO switch • On/off toggle

5

OPERATION

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 to obtain an accurate reading.

Device Information and Settings

Swipe left to access the *Setup* page (Figure 4). This page will display information about the unit, its connectivity status and test settings. See Table 4 for a detailed description.

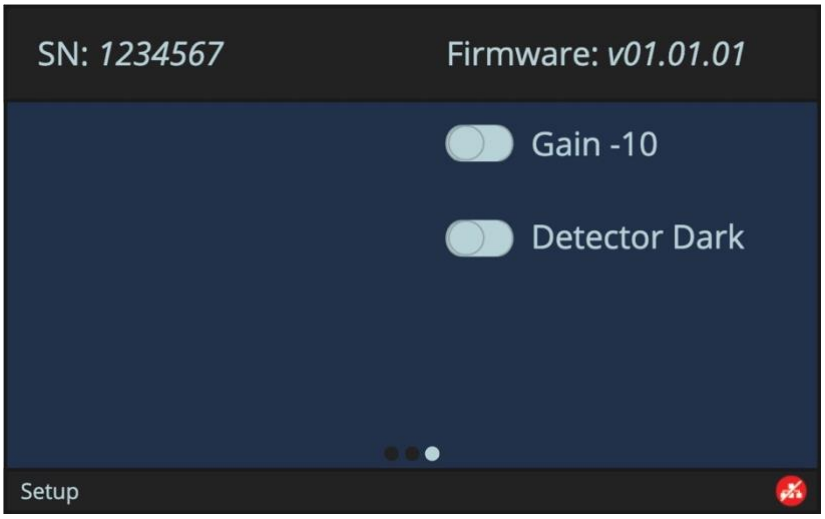


Figure 4: PEM-400 *Setup* page

Table 4: Detailed description of the PEM-400 *Setup* page (Figure 4)

Parameter	Description
SN:	• The unit serial number (“1234567”) as stored on the unit.
Firmware:	• The unit’s firmware version (“v01.01.01”).
IP address	• When connected to a network via Ethernet, the unit’s IP address will be displayed in the bottom right corner with a green LAN icon.

	Use this IP address to access the PEM-400 webpage or to connect to it via software. • If not connected to a network, the LAN icon will display as red.
Gain -10	• If disabled, the PEM-400 will use the smallest gain range. This setting should be used if the power after the DUT is > -10 dBm. • This setting should be enabled if the power after the DUT is < -10 dBm. Note: if possible, the power should be adjusted to be between 8 and -2 dBm or between -10 and -20 dBm to be at the top of the gain range.
Detector Dark	• Cap all outputs and detectors then enable to measure the dark current. This will allow measurements for the entire power range of the unit (configuration dependent). • Disable to remove the stored dark current value.

Performing a Reference

A reference is only required for measuring insertion loss (IL). If you are measuring PER and angle only, this step can be skipped.

Swipe right twice to access the *Reference* page.

In Figure 5:

1. tap a row header to reference that channel
2. tap in the center to reference all channels

Figure 5: PEM-400 *Reference* page – no stored references

The reference page (Figure 6) will display the stored values in dBm. These readings can help determine the correct gain setting to choose.

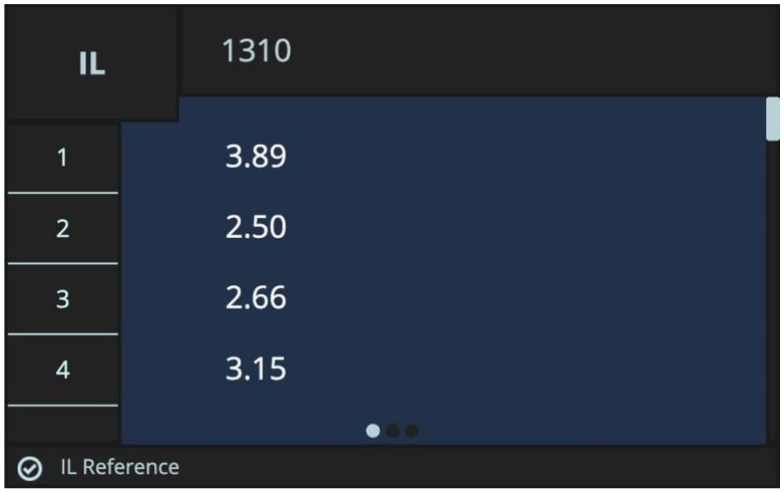


Figure 6: PEM-400 *Reference* page – stored values

Performing a Measurement

Swipe left to access the *Measure* page. Tap on a channel to display a live reading (Figure 7).

Figure 7: PEM-400 *Measure* page – live reading

Tap in the center to perform a full measurement on all wavelengths and channels (Figure 8).

Figure 8: PEM-400 *Measure* page – measurement complete

Software

The PEM-400 is compatible with Santec's free GMS software (Figure 9), available for download from our website:

- https://inst.santec.com/resources/software-downloads

VISA drivers are required for USB communication such as *National Instruments:*

- https://www.ni.com/en/support/downloads/drivers/download.ni-visa.html?srsltid=AfmBOoowzhLNq08Z7mVQ521ySwPAccRsNODajmJbzvtjUMpd3JcvbYcK#544206

GMS has been used by hundreds of customers globally in both production and lab environments for over a decade. Key features include:

- create test plans
- set pass/fail criteria
- save data to Excel automatically
- automatically generate customizable reports

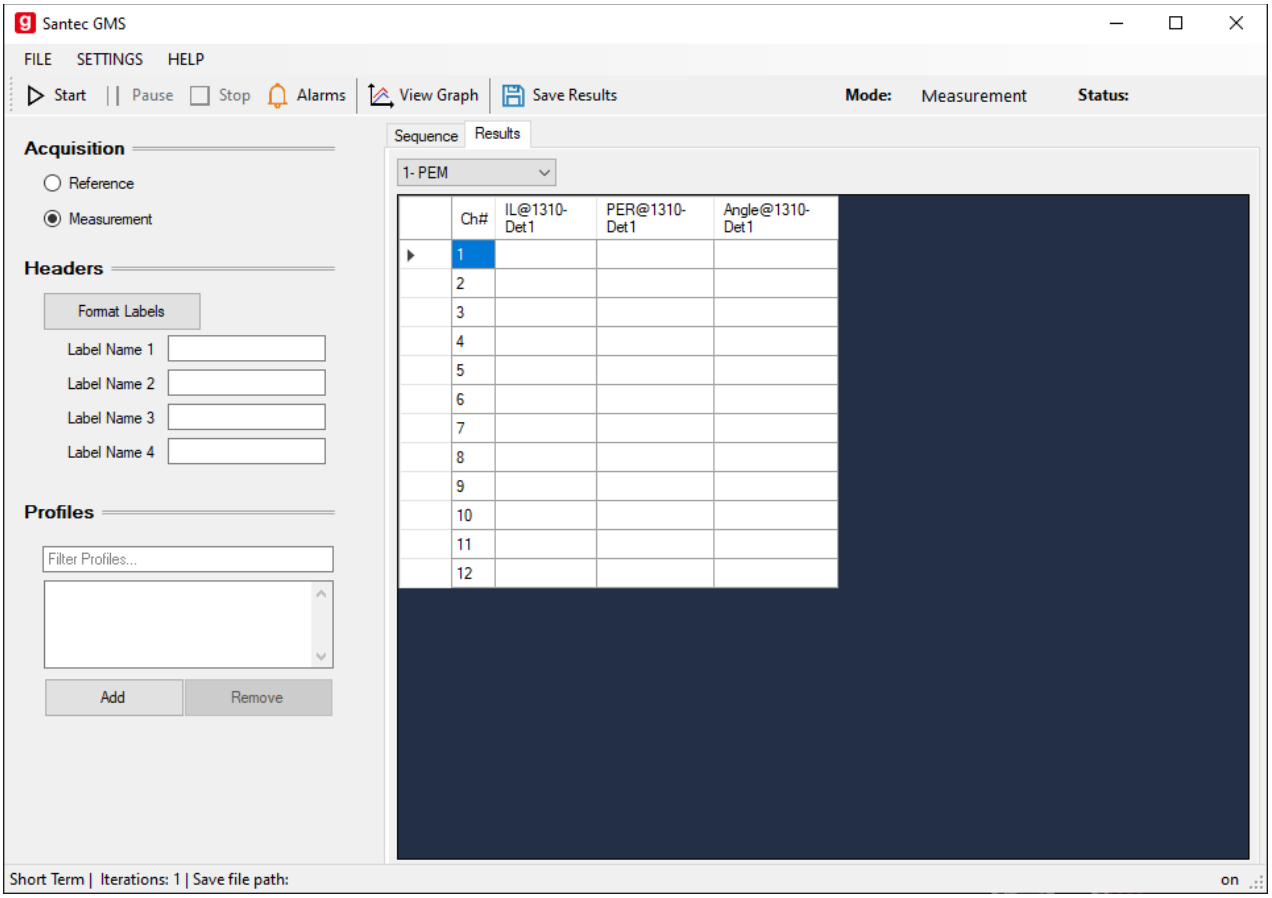


Figure 9: GMS Software

6

PEM-400 WEBPAGE

To access the PEM-400 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 *Firefox*) and enter the PEM-400's IP address (see Device Information and Settings on page 10) in the URL bar.

Dashboard

The *Dashboard* tab shows the last calibration date of the meter (Figure 10).

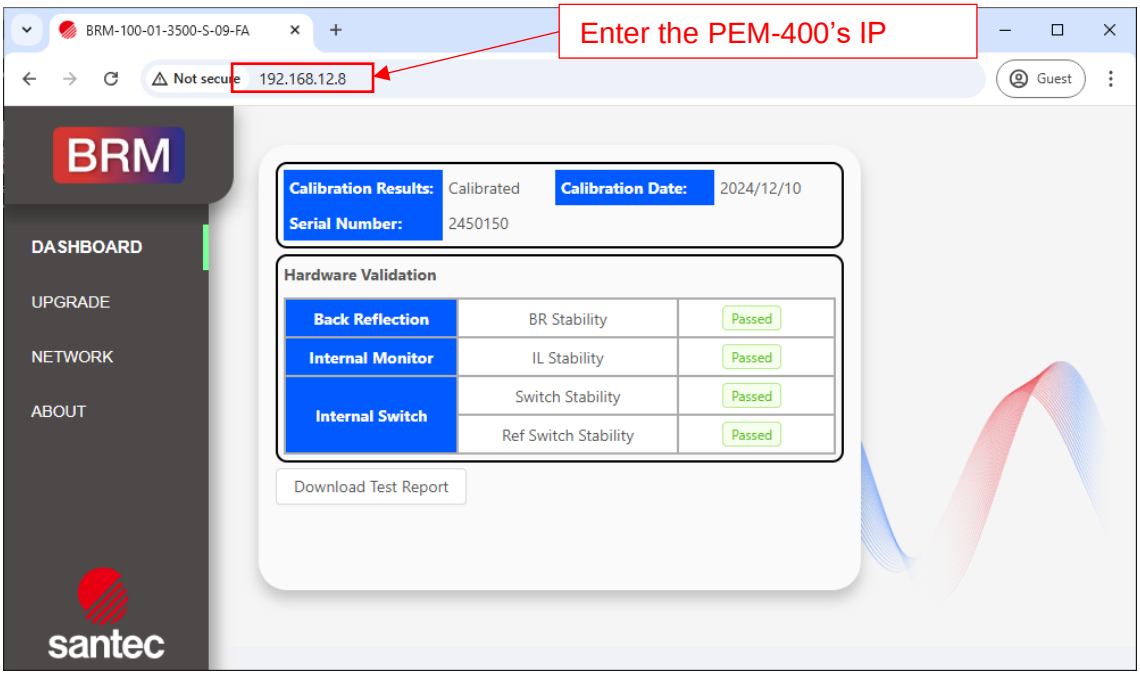


Figure 10: BRM-100 webpage – *Dashboard* tab

Upgrade

Go to *Upgrade* to view the version of, upgrade or re-install the firmware of the PEM-400 (Figure 11). Please contact support.inst@santec.com before performing a firmware upgrade for additional instructions.

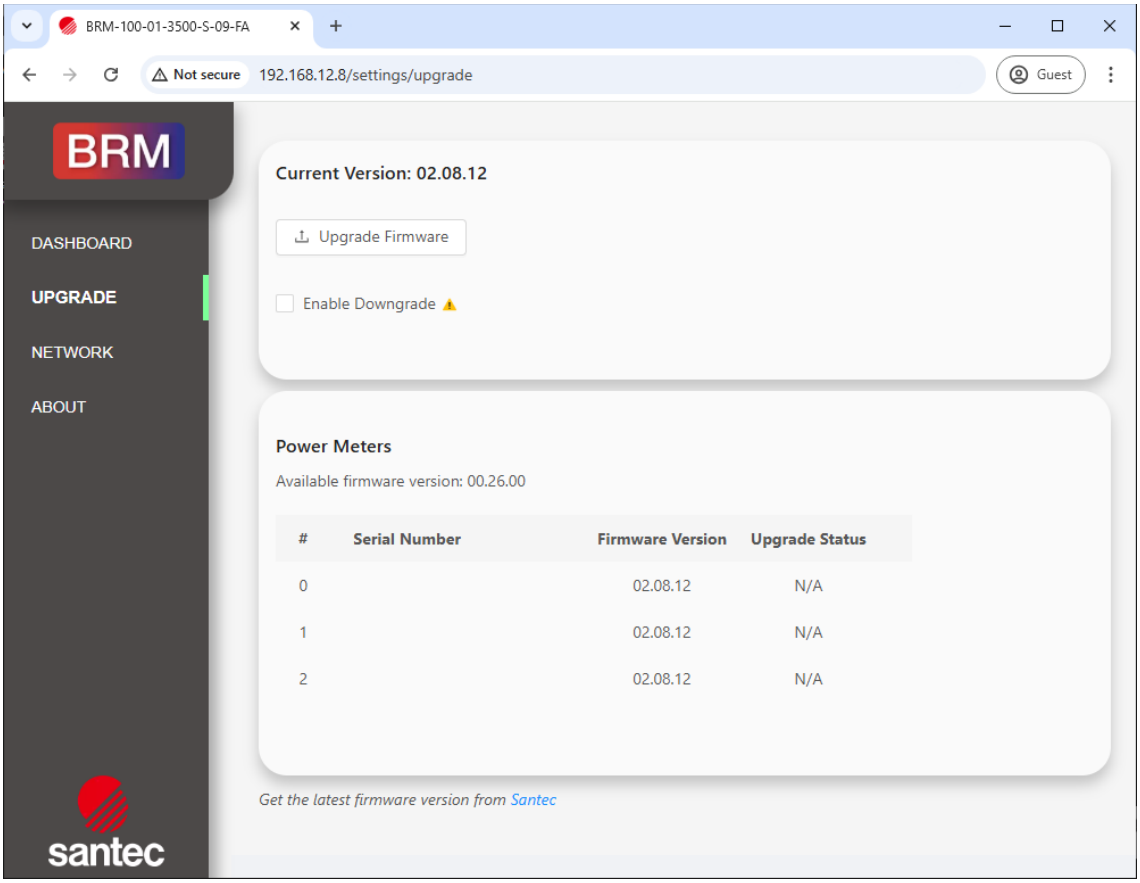


Figure 11: PEM-400 webpage – *Upgrade* tab

Network

You can view, edit or reset the network settings of the PEM-400 from the *Network* tab (Figure 12).

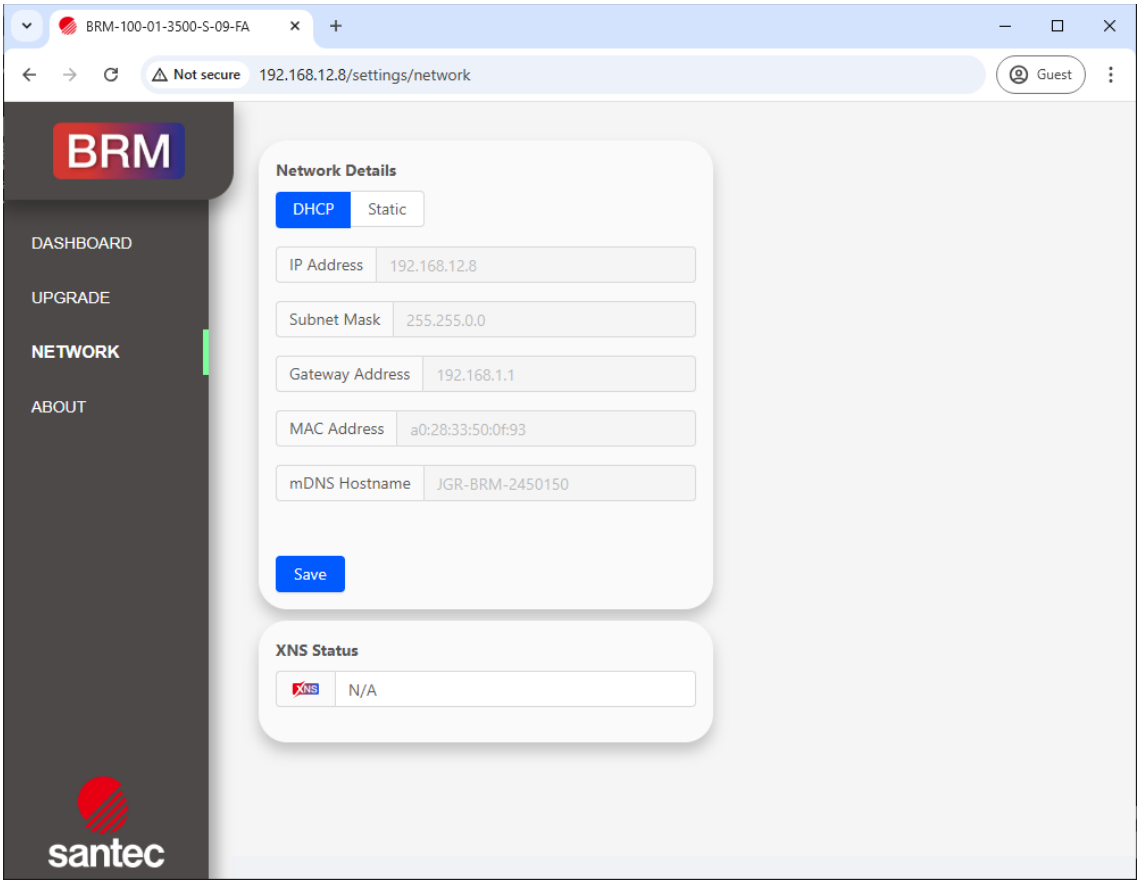


Figure 12: PEM-400 webpage – *Network* tab

About

The *About* tab (Figure 13) displays the unit's firmware version, model and serial number. Error logs can be downloaded from this page for troubleshooting. *Advanced* mode is reserved for Santec technicians and Santec-approved service centers.

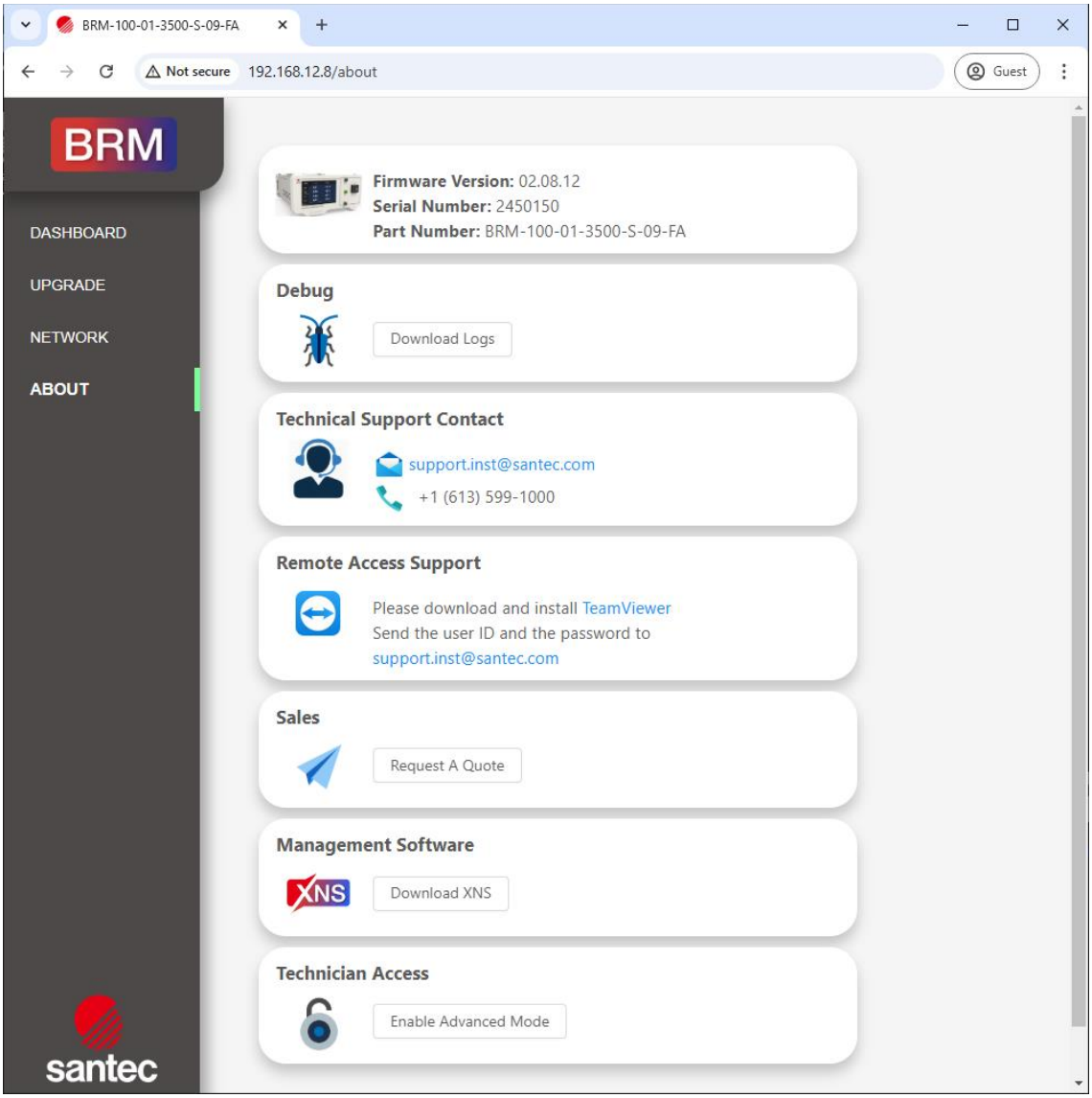


Figure 13: PEM-400 webpage – *About* tab

7

PROGRAMMING GUIDE

Establishing Communication

The PEM-400 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: *National Instruments*
  - https://www.ni.com/en/support/downloads/drivers/download.ni-visa.html?srsltid=AfmBOoowzhLNq08Z7mVQ521ySwPAccRsNODajmJbzvtjUMpd3JcvbYcK#544206

Ethernet

Each PEM-400 is factory pre-set to use DHCP. To connect the PEM-400:

- Connect the PEM-400 to the LAN via an Ethernet cable
- Swipe on the front panel touchscreen to the *Setup* page to view the PEM-400's IP address

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

Note: any *VISA* implementation can control the PEM-400 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 PEM-400 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 can take several seconds to return. The *Read* timeout should be increased to at least 5000ms using *visa.TimeoutMilliseconds*
2. The PEM-400 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?" + vbLf)
```

Commands Lists

See Table 5 and Table 6 for SCPI required commands and BRM-100 commands respectively.

Table 5: SCPI required commands list

Command	Description
*CLS	Clears the status byte.
*ESE #	Sets the <*value*> of the Standard Event Status Enable Register.
*ESE?	Returns the value of the Standard Event Status Enable Register.
*ESR?	Returns the value of the Standard Event Status Register.
*IDN?	Returns the instrument's identification (model, serial number, firmware version).
*OPC	Sets bit 0 in the Standard Event Status Register when all pending operations have finished.
*OPC?	Returns the ASCII character 1 when all operations have finished.
*OPT?	Returns a comma-separated list of all of the instrument options.
*RCL "filename"	Recalls a configuration from <*filename*>.
*RST	Resets most functions to factory-defined conditions.
*SAV "filename"	Saves configuration to <*filename*>.
*SRE #	Sets the <*value*> of the Service Request Enable Register.
*SRE?	Returns the value of the Service Request Enable Register.
*STB?	Returns the value of the status byte including the MSS.
*TST?	Initiates the internal self-test and returns the results: 0 if all tests passed and 1 if at least one failed.
*WAI	Causes instrument to wait until all commands are completed.

Table 6: PEM-400 commands list

Command	Description
LAS:INFO?	Returns list of supported nominal laser frequencies.
FIBER:INFO?	Returns the type of fiber
READ:PER:DET1? #	Returns IL,PER,Angle for the wavelength <#>
SW1:CLOSe #	Changes channel to <#>
REF:IL:DET1 #	Measure and store IL reference at wavelength <#>
REF:IL:DET1? #	Return IL reference at nominal wavelength. <#>
READ:BARCode?	Returns a string with the contents of the last barcode scanned.
TEST:NOTIFY# "string"	Push a <*notification*> to the BRM-100 touchscreen display. <#> indicates the icon to be displayed: • 0 = ✔ • 1 = ✖ • 2 = ℹ • 3 = ⚠

8

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 Outputs

Warning

- Connecting contaminated or damaged connectors to the PEM-400 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 14 shows a dirty connector requiring cleaning. Figure 15 shows a clean connector ready to be mated.
2. A visual inspection probe to inspect inside the front panel FC mating adapters is recommended.
3. Use a push-type cleaner on contaminated outputs. If permanent damage is note such as scratches or pits that cannot be removed, please contact support.inst@santec.com for more assistance.

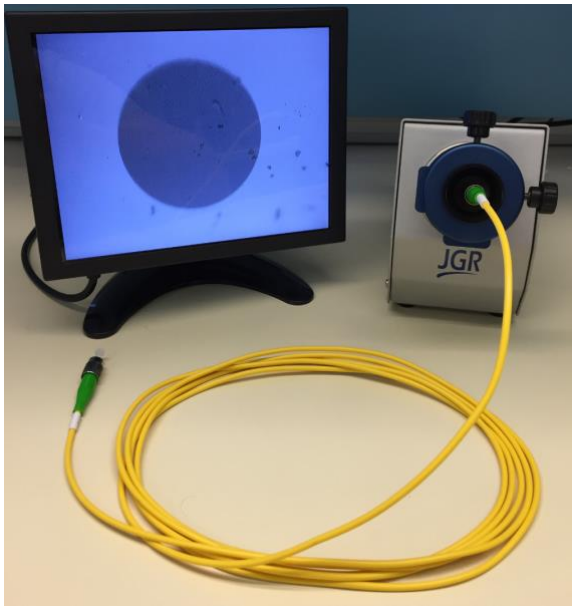


Figure 14: Dirty connector end-face inspection using Santec's EFI-100

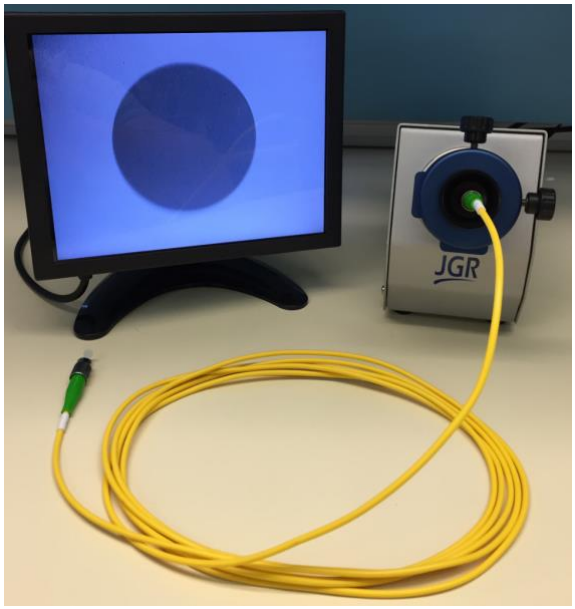


Figure 15: Clean connector end-face inspection using Santec's EFI-100

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.

9

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

Phone: +1-613-599-1000
Email: support.inst@santec.com
Website : inst.santec.com

10

SPECIFICATIONS

Table 7: Optical and Electrical Specifications

Parameter	Specification
Output Fiber Type	PM
Output Wavelength (nm)	1310, 1550 or external input
PER Dynamic Range (dB)	> 30
PER Accuracy (dB)	± 0.3
PER Resolution (dB)	0.01
Angle Accuracy (deg)	± 1
Angle Resolution (deg)	0.15
IL Accuracy (dB)	± 0.05
IL Resolution (dB)	0.01
Absolute Power Accuracy (dB)	± 0.25 [1]
Absolute Power Resolution (dB)	0.01
Measurement Time (s)	< 2.5
Remote Interface	USB or Ethernet
Display	5" touch screen
Input Voltage	100 - 240 V AC, 50 - 60 Hz
Power Consumption (VA)	60 maximum

[1] at -10 dBm

Table 8: Mechanical and Environmental Specifications

Parameter	Specification	
Chassis Size	2U half rack (single or no outputs)	2U full rack (multichannel)
Unit Dimensions W x H x D (cm) [1]	22.5 x 9 x 32.5	45 x 9 x 32.5
Unit Weight (kg)	8	12
Shipping Box Dimensions W x H x D (cm)	36.5 x 39 x 53	
Volumetric Weight (kg) [2]	15	
Operating Temperature (°C)	0 to 40	
Storage Temperature (°C)	-40 to 70	
Humidity (Non-condensing)	Maximum 95% RH from 0 to 40°C	

[1] excluding removable rubber bezels. Add 1.5 cm to W and 3.5 cm to H with the removable rubber bezels.

[2] W*H*D / 5000

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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