

# Operating Instructions

## Raman Rxn4





## Table of Contents

<b>1 About this document.....</b>	<b>4</b>	5.7 Initial Raman RunTime set up .....	27
1.1 Warnings.....	4	<b>6 Electrical connection.....</b>	<b>30</b>
1.2 Symbols on the device.....	4	6.1 Port connections .....	30
1.3 U.S. export compliance .....	4	<b>7 Commissioning.....</b>	<b>31</b>
1.4 Glossary .....	5	7.1 Automation connection.....	31
<b>2 Basic safety instructions.....</b>	<b>7</b>	7.2 External circuit I/O panel.....	33
2.1 Requirements for the personnel.....	7	7.3 Raman Rxn4 hardware components.....	39
2.2 Designated use .....	7	<b>8 Operation .....</b>	<b>44</b>
2.3 Electrical safety .....	7	8.1 Raman RunTime embedded software.....	44
2.4 Operational safety.....	7	8.2 Calibrations.....	44
2.5 Lifting provisions for the Raman Rxn4 .....	8	8.3 Data collection.....	50
2.6 Product safety.....	8	8.4 Using models.....	57
2.7 Important safeguards .....	8	8.5 Data transfer .....	60
2.8 Health and safety considerations .....	8	8.6 Automatic connection .....	62
2.9 Safety and handling notice .....	9	8.7 Software security .....	63
2.10 Laser safety.....	9	<b>9 Diagnostics and troubleshooting.....</b>	<b>67</b>
<b>3 Product description .....</b>	<b>12</b>	9.1 Diagnostics .....	67
3.1 The Raman Rxn4 analyzer .....	12	9.2 Warnings and errors.....	70
3.2 Raman RunTime software overview .....	13	9.3 OPC connection troubleshooting.....	73
3.3 Product design .....	14	9.4 Restarting the system.....	73
3.4 Probe connectors.....	16	9.5 Raman Rxn4 system and power loss.....	73
<b>4 Incoming product acceptance and identification .....</b>	<b>17</b>	9.6 Recovery console .....	73
4.1 Incoming acceptance.....	17	<b>10 Maintenance.....</b>	<b>77</b>
4.2 Scope of delivery.....	18	10.1 Optimization.....	77
4.3 Certificates and approvals.....	18	10.2 Servicing the Raman Rxn4 analyzer .....	79
<b>5 Installation.....</b>	<b>19</b>	10.3 Support.....	81
5.1 Raman Rxn4 Analyzer with enclosure .....	19	<b>11 Repair .....</b>	<b>82</b>
5.2 Raman Rxn4 Analyzer mounted in a computer or server rack.....	20	11.1 Servicing and spare parts .....	82
5.3 Raman Rxn4 Analyzer on a cart or benchtop.....	21	<b>12 Technical data .....</b>	<b>84</b>
5.4 Initial analyzer setup .....	22	12.1 Specifications.....	84
5.5 Powering up the Raman Rxn4 .....	27	12.2 Hazard area rating (Probe type-dependent).....	85
5.6 Powering down the Raman Rxn4 system .....	27	<b>13 Index.....</b>	<b>87</b>

# 1 About this document

## 1.1 Warnings

Structure of Information	Meaning
<p> <b>WARNING</b></p> <p><b>Causes (/consequences)</b> If necessary, consequences of non-compliance (if applicable) ▶ Corrective action</p>	This symbol alerts you to a dangerous situation. Failure to avoid the dangerous situation can result in a fatal or serious injury.
<p> <b>CAUTION</b></p> <p><b>Causes (/consequences)</b> If necessary, consequences of non-compliance (if applicable) ▶ Corrective action</p>	This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or more serious injuries.
<p> <b>NOTICE</b></p> <p><b>Cause/situation</b> If necessary, consequences of non-compliance (if applicable) ▶ Action/note</p>	This symbol alerts you to situations which may result in damage to property.

Table 1. Warnings

## 1.2 Symbols on the device

Symbol	Description
	The Laser Radiation symbol is used to alert the user to the danger of exposure to hazardous visible laser radiation when using the Raman Rxn4 system.
	The High Voltage symbol that alerts people to the presence of electric potential large enough to cause injury or damage. In certain industries, high voltage refers to voltage above a certain threshold. Equipment and conductors that carry high voltage warrant special safety requirements and procedures.
	The ETL Listed Mark provides proof of product compliance with North American safety standards. Authorities Having Jurisdiction (AHJ) and code officials across the US and Canada accept the ETL Listed Mark as proof of product compliance to published industry standards.
	The WEEE symbol indicates that the product should not be discarded as unsorted waste but must be sent to separate collection facilities for recovery and recycling.
	The CE Marking indicates conformity with health, safety, and environmental protection standards for products sold within the European Economic Area (EEA).

Table 2. Symbols

## 1.3 U.S. export compliance

The policy of Endress+Hauser is strict compliance with U.S. export control laws as detailed in the website of the [Bureau of Industry and Security](#) at the U.S. Department of Commerce.

## 1.4 Glossary

Term	Description
AC	Alternating Current
ALT	Alternate
ANSI	<a href="#">American National Standards Institute</a>
API	Active Pharmaceutical Ingredient
ATX	Advanced Technology eXtended
ATEX	Atmosphere Explosible
AWG	American Wire Gauge
°C	Celsius
CAL	Calibration
CDRH	<a href="#">Center for Devices and Radiological Health</a>
CFR	<a href="#">Code of Federal Regulations</a>
cm	Centimeter
COLL	Collection
CSM	Calibration Switching Module
CSV	Comma Separated Value
DC	Direct Current
EMC	Electromagnetic Compatibility
EO	Electro-Optical
EPL	Equipment Protection Level
EU	<a href="#">European Union</a>
EXC	Excitation
FC	Ferrule Connector
GLP	Good Laboratory Practice
GMP	Good Manufacturing Practice
HCA	Raman Calibration Accessory
Hz	Hertz
I/O	Input/Output
IEC	<a href="#">International Electrotechnical Commission</a>
INTLK	Interlock
IP	Internet Protocol
IPA	Isopropyl Alcohol
IQ/OQ	Installation Qualification/Operational Qualification
IS	Intrinsically Safe
LED	Light Emitting Diode
LVS	Low Voltage Safety
mm	Millimeter
MPE	Maximum Permissible Exposure

Term	Description
MT	Mechanical Transfer
mW	Milliwatt
NA	Numerical Aperture
NAT	Network Address Translation
nm	Nanometer
NOHD	Nominal Ocular Hazard Distance
OPC	<a href="#">Open Platform Communications</a>
QbD	Quality by Design
p/n	Part Number
PAT	Process Analytical Technology
PCM	Power Control Module
PDF	Portable Document Format
RTU	Remote Terminal Unit
SOP	Standard Operating Procedure
SPC	Spectrum
TCP	Transmission Control Protocol
UA	Unified Architecture
UDP	User Datagram Protocol
UPS	Uninterruptible Power Supply
USB	Universal Serial Bus
V	Volt
W	Watt
WEEE	<a href="#">Waste Electrical and Electronic Equipment</a>

Table 3. Glossary

## 2 Basic safety instructions

### 2.1 Requirements for the personnel

- Installation, commissioning, operation, and maintenance of the measuring system may be carried out only by specially trained technical personnel.
- The technical personnel must be authorized by the plant operator to carry out the specified activities.
- The technical personnel must have read and understood these Operating Instructions and must follow the instructions contained herein.
- The facility must designate a laser safety officer who ensures staff are trained on all Class 3B laser operating and safety procedures.
- Faults at the measuring point may only be rectified by properly authorized and trained personnel. Repairs not described in this document must be carried out only directly at the manufacturer's site or by the service organization.

### 2.2 Designated use

The Raman Rxn4 analyzer is recommended for use in the following applications:

- **Chemical:** Reaction monitoring, blending, feed, and final product monitoring
- **Polymer:** Polymerization reaction monitoring, polymer blending
- **Pharmaceutical:** Active Pharmaceutical Ingredient (API) reaction monitoring, crystallization, polymorph, drug substance production unit operation
- **Oil and Gas:** Any hydrocarbon analysis

Use of the device for any purpose other than that described, poses a threat to the safety of people and of the entire measuring system and invalidates any warranty.

### 2.3 Electrical safety

As the user, you are responsible for complying with the following safety conditions:

- Installation guidelines.
- Electromagnetic compatibility according to locally applicable standards and regulations.
- The product has been tested for electromagnetic compatibility in accordance with the applicable international standards for industrial applications.
- The electromagnetic compatibility indicated on equipment or in documentation applies only to a product that has been properly connected.

### 2.4 Operational safety

Before commissioning the entire measuring point:

1. Verify that all connections are correct.
2. Ensure that electrical cables and optical fiber connections are not damaged.
3. Do not operate damaged products, and protect them against unintentional operation, e.g., disconnected from power sources.
4. Clearly label damaged products as defective.

During operation:

1. If faults cannot be rectified: products must be taken out of service and protected against unintentional operation, e.g., disconnected from power.
2. Keep the door closed and properly sealed on the optional enclosure when not carrying out service and maintenance work.

#### CAUTION

**Activities while the analyzer is in operation introduce potential risk of exposure to hazardous materials.**

- ▶ Follow standard procedures for limiting exposure to hazardous chemical or biological materials.

- ▶ Follow workplace policies on personal protective equipment including wearing protective clothing, goggles, and gloves and limiting physical access to analyzer location.
- ▶ Clean any spills using the appropriate site policies on cleaning procedures.

**⚠ CAUTION****Risk of injury from analyzer door stop mechanism**

- ▶ If the optional analyzer enclosure needs to be opened, always open the enclosure door fully to ensure the doorstop engages properly.

## 2.5 Lifting provisions for the Raman Rxn4

The Raman Rxn4 is not provided with integrated handles intended to support the entire weight of the base unit. The front mounted rack handles are only meant for use in sliding the base unit in and out of the rack in which it is installed. The rear mounted fiber strain relief brackets are NOT intended for use as lifting handles. The base unit is intended to be lifted and moved in its horizontal orientation, by two people. One person should be on either side of the base unit, each supporting the base unit with two hands along the bottom edge of the base unit.

**⚠ CAUTION**

- ▶ Two people are required to lift and move the Raman Rxn4 instrument.

The Raman Rxn4 is designed to be lifted and moved in its horizontal orientation, by two people, one on either side of the analyzer, lifting from only the bottom edge of the base unit.

**⚠ CAUTION**

- ▶ Disconnect fiber cables from the Raman Rxn4 whenever moving the base unit.

## 2.6 Product safety

The product is designed to meet local safety requirements for the intended application, and has been tested accordingly, leaving the factory in a condition in which it is safe to operate. All applicable regulations and international standards have been observed. Devices connected to the analyzer must also comply with the applicable safety standards. See *Laser safety* for additional details on laser safety.

## 2.7 Important safeguards

- Do not use the Raman Rxn4 for anything other than its intended use.
- Do not drape the power cord over counters, on hot surfaces, or in areas where damage to the integrity of the power cord may occur.
- Do not open the Raman Rxn4 unless you have been specifically training on service and maintenance of the unit.
- Do not look directly into the laser beam.
- Do not allow emitted laser light to reflect off of mirrored or shiny surfaces in an uncontrolled way.
- Minimize the presence of shiny surfaces in the working area and always use a laser beam block to prevent uncontrolled transmission of the laser light.
- Do not leave unused probes uncapped or unblocked, while they are still attached to the analyzer.
- Probe shutter on the Rxn-10 probe should always be in the **OFF** position when probe is not in use.

## 2.8 Health and safety considerations

It is the user's responsibility to understand and comply with all applicable safety regulations, which will vary depending on the installation location of the analyzer. Endress+Hauser takes no responsibility for determining a complete list of safe operating practices at any given installation site, and leaves that responsibility to the local user or owner of the equipment.

However, the following actions and laser safety precautions must always be observed while using the Raman Rxn4:

- The Raman Rxn4 is a [Center for Devices and Radiological Health](#) (CDRH) Class 3B device. The user should wear appropriate eye protection in areas where exposure to the laser light is possible.
- The Raman Rxn4 should only be used in a location with a suitable and stable power supply.
- If an interlock is required to meet local safety regulations, all entryways to the room or area housing the Raman Rxn4 analyzer must be fitted with clearly visible warning signs on doors and entryways into the Class 3B laser area.

## 2.9 Safety and handling notice

Raman Rxn4 analyzers incorporate a 532 nm, 785 nm, or 993 nm laser excitation source. Take the following precautions when handling the analyzer and probes when the laser is **ON**:

- Before making fiber connections and probe inspections, use the key on the front of the Raman Rxn4 to turn **OFF** the laser power.
- If using an Rxn-10 probe, turn laser output shutter to the **OFF** position before the removal or attachment of optics (see Figure 1).
- Do not look directly into the fiber probe output (when the optic is disconnected) or the output (window) of any probes. If an Rxn-10 probe is found with no optic or probe attached – turn laser output shutter on the Rxn-10 probe to OFF or use the key on the front of the Raman Rxn4 to turn the laser power to **OFF**.

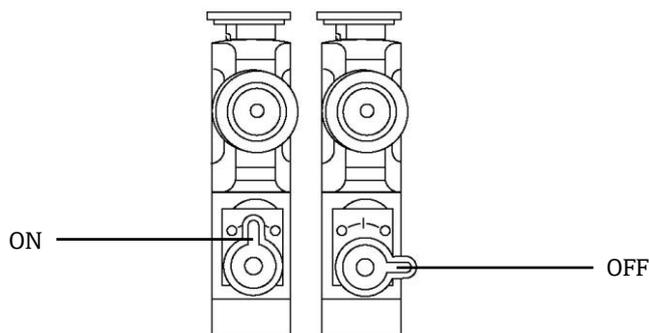


Figure 1. Rxn-10 probe showing the ON and OFF shutter positions

### NOTICE

- ▶ Handle probes and cables with care. Fiber cables should NOT be kinked and should be routed to maintain minimum bend radii (~6 inches). Permanent damage to the cables may result if they are bent beyond the minimum radius.

## 2.10 Laser safety

Laser light presents special safety hazards not associated with other light sources. All laser users, and others present, need to be aware of the special properties and dangers involved in laser radiation. Familiarity with the Raman Rxn4 and the properties of intense laser radiation will aid in the safe operation of the Raman Rxn4. The Raman Rxn4 may contain a 532 nm, 785 nm, or 993 nm laser. Refer to your system specification information to determine which laser you have. The combination of intense monochromatic light concentrated in a small area means that, under certain conditions, exposure to laser light is potentially hazardous. In workplace environments, a laser safety program provides environmental, training, and safety controls which may reduce the risk of laser-related injuries and/or workplace damage. For more assistance with taking appropriate precautions and setting the proper controls when dealing with lasers and their hazards, refer to the most current version of ANSI for Safe Use of Lasers Z136.1. The Raman Rxn4 analyzer has hardware safety controls to reduce the risk of laser-based injuries including an interlock and a spring-loaded protective cap covering the laser output of the fiber-optic cables.

The beam is routed from the rear panel of the instrument via a fiber optic patch-cord. In the unlikely event that the fiber optic probe cable is removed, the interlock is overridden, and the spring-loaded protective cap is overridden, there will be a laser beam exiting the analyzer unit. This beam has a beam diameter of 103  $\mu\text{m}$  and a Numerical Aperture (NA) of 0.29.

Table 4 provides the fiber core size and mode and the nominal ocular hazard distance equation for the case of laser exiting directly from the analyzer unit.

Base Unit Used	Fiber Core Size and Mode	Nominal Ocular Hazard Distance (NOHD) Equation
		
Raman Rxn4 Standard	103 μm multi-mode (NA =0.29)	$r_{NOHD} = 1.7/NA (\Phi/\pi MPE)^{1/2}$ multimode equation
MPE at 532 nm continuous viewing – $1 \times 10^{-3} \text{ W}\cdot\text{cm}^{-2}$ MPE at 785 nm continuous viewing – $1.479 \times 10^{-3} \text{ W}\cdot\text{cm}^{-2}$ MPE at 993 nm continuous viewing – $3.854 \times 10^{-3} \text{ W}\cdot\text{cm}^{-2}$		
$\Phi$ = Maximum Power in Watts (W)		

Table 4. Laser safety

Another nominal hazard zone calculation needs to be performed to account for the scenario when the analyzer is equipped with a probe. Depending upon the probe utilized, the beam diameter, numerical aperture of the fiber optical cable to the probehead and focusing characteristics of the probehead, the nominal hazard zone calculation will change depending upon if the potential exposure point is at the tip of the probe or at a broken optical fiber. Refer to the specifications section in the pertinent Endress+Hauser Raman probe operating instructions for the appropriate information to complete the nominal hazard zone calculations pertaining to other exposure points.

**CAUTION**

- ▶ Laser beams can cause ignition of certain substances such as volatile chemicals. The two possible mechanisms for ignition are direct heating of the sample to a point causing ignition and the heating of a contaminant (such as dust) to a critical point leading to ignition of the sample.

**WARNING**

- ▶ The Raman Rxn4 uses a Class 3B laser as defined in ANSI Z136.1. Direct eye contact with the output beam from the laser will cause severe damage and possible blindness.
- ▶ Use of controls or adjustments or performance of procedures other than those specified in this manual may result in hazardous radiation exposure.

For more assistance on appropriate precautions and setting the proper controls when dealing with lasers and their hazards, refer to the most current version of ANSI for Safe Use of Lasers Z136.1.

### 2.10.1 Optical safety

The Raman Rxn4 is outfitted with a Class 3B laser. Lasers at 785 nm and 993 nm present further safety concerns because the radiation is nearly invisible. Always be aware of the initial direction and possible scattering paths of the laser. The use of OD3 safety glasses is highly recommended for 532 nm and 785 nm excitation wavelengths and OD4 for a 993 nm excitation wavelength.

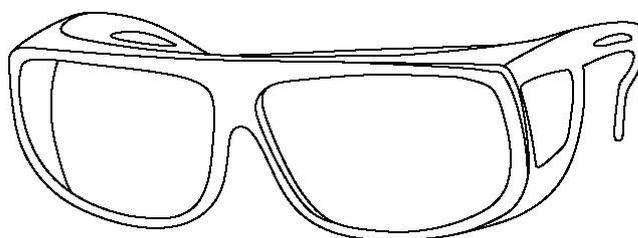


Figure 2. Laser safety glasses

### 2.10.2 Electrical safety

The Raman Rxn4 utilizes AC and DC voltages inside the enclosure. Do not disassemble the laser enclosure as there are no serviceable parts inside the laser assembly. Only qualified personnel familiar with high voltage electronics should open the system enclosure to perform necessary maintenance or service.

### 2.10.3 CDRH compliance

The Raman Rxn4 is designed and built to meet the laser performance requirements of 21 [Code of Federal Regulations](#) (CFR), Chapter I, Subchapter (J) and is registered with the CDRH.

The product report for the Raman Rxn4 can be found under accession number 1110121-000.

#### 2.10.3.1 Protective housing

The Raman Rxn4 is enclosed in a protective housing to prevent human access in excess of the limits of Class I radiation as specified in U.S. 21 CFR Section 1040.10 (f) (1) except for the output, which is Class 3B.

#### 2.10.3.2 Remote interlock connector

The Raman Rxn4 is supplied with a remote interlock connector for each channel. This connector allows the operator to utilize an external interlock circuit in conjunction with Raman Rxn4 operations. Design and function of an external interlock circuit should meet the capability and intent of the most current revision of the ANSI Z136.1 Standard. No laser radiation for a particular channel is emitted unless both the fiber and remote interlock connectors are connected.

#### 2.10.3.3 Key control

The Raman Rxn4 utilizes a key control system. The laser radiation will not be accessible until the system key switch is in the **ON** position. The key cannot be removed when the switch is in the **ON** position.

#### 2.10.3.4 Compliance labels

The Raman Rxn4 analyzer is certified to comply with the U.S. Federal Regulation 21 CFR, Chapter I, Subchapter (J), as administered by the CDRH.

### 2.10.4 WEEE directive compliance

The Raman Rxn4 complies with the [Waste Electrical and Electronic Equipment](#) (WEEE) Directive 2012/19/EU. The WEEE Symbol shown below is placed on all WEEE-compliant assemblies.



Figure 3. WEEE symbol

If no other means of disposal are available, Endress+Hauser offers a “Take Back” disposal program at no cost. To participate in the “Take Back” disposal program, please contact Endress+Hauser at [support.kosi@endress.com](mailto:support.kosi@endress.com) for further assistance.

### 2.10.5 Specific conditions of use

1. The fiber optic cable shall be installed so that the minimum bend radius specified by the cable manufacturer is maintained.
2. Sometimes it is necessary to monitor the level of a liquid process sample to ensure that the optical beam is not inadvertently exposed to a potentially explosive atmosphere. In these situations, the devices used to monitor the level shall be intrinsically safe or classed as simple apparatus, or be installed so as to provide a fault tolerance of 2 for Equipment Protection Level (EPL) Ga equipment or a fault tolerance of 1 for EPL Gb equipment. The functional safety of this arrangement has not been assessed as part of the certification for the Raman Rxn4 analyzer and it is the responsibility of the installer to ensure that an appropriate mechanism is in place. See *Hazardous Area Certification* for more information.
3. Where Intrinsically Safe (IS) galvanic isolators are added to the main enclosure in order to produce IS signals to external apparatus not covered by this certification, the IS galvanic isolators shall have an ambient working temperature upper limit of at least 55°C. The IS parameters pertaining to these isolators shall be conveyed to the user in an appropriate manner. The IS nature of any such circuits has not been assessed as part of the certification for the Raman Rxn4 analyzer and this certificate is not to be taken as indication that these IS circuits comply with relevant requirements.

## 3 Product description

### 3.1 The Raman Rxn4 analyzer

Raman spectroscopy provides the chemical specificity of mid-IR spectroscopy and the sampling simplicity of near-IR spectroscopy. By operating in the visible or near-infrared spectral region, Raman spectroscopy allows vibrational spectra to be easily collected *in situ*, using fiber-optic coupled probes, without sample chamber purging, and without the use of sample conditioning systems. There are three possible configurations of the Raman Rxn4 analyzer: single channel, four channel, and Hybrid. The unique characteristics of each are described in sections 3.1.1 to 3.1.2.

Features common to all Raman Rxn4 analyzer configurations include:

- Custom Raman RunTime analyzer control software operating on an embedded controller is located inside the analyzer housing.
- The ability to perform a two-point internal self-calibration process whenever necessary.
- Self-diagnostic tools and spectral correction methods are used to maintain high performance, when internal system calibration is unnecessary.
- A unique self-monitoring system to ensure the validity of each analysis.
- The ability to directly transfer methods and chemometric models between instruments, owing to the high precision and reproducibility of the analyzer.
- Installation flexibility with remote probe sampling points connected by a single fiber optic cable.
- Compatible with the entire Endress+Hauser line of Raman fiber optic probes and optical accessories.

#### 3.1.1 The Raman Rxn4 single channel and four channel analyzer

The Raman Rxn4 single channel analyzer offers one fiber-optic probe connection for the accurate measurement of a single point in a continuous or batch process. The Raman Rxn4 four channel analyzer is similar, except up to four channels can be configured to sequentially measure up to four different *in situ* sample points in continuous or batch processes in the life sciences, chemical, oil & gas, and food & beverage industries. With the Raman RunTime software running on the embedded controller, the Raman Rxn4 single channel and four channel analyzers meet the needs of both Good Laboratory Practice (GLP) and Good Manufacturing Practice (GMP) governed areas within the pharmaceutical industry for Process Analytical Technology (PAT) and Quality by Design (QbD) applications.

Raman Rxn4 single channel or four channel analyzers can be configured with a 532 nm, 785 nm, or 993 nm excitation wavelength laser.

#### 3.1.2 The Raman Rxn4 Hybrid analyzer

The Raman Rxn4 Hybrid analyzer is configured with two fiber-optic sampling probe connectors; one Rxn-20 probe channel and one Alternate (ALT) non-Rxn-20 probe channel. The Raman Rxn4 Hybrid analyzer is a unique Raman analyzer because it features the Rxn-20-based large volumetric Raman probe in addition to a backscattered Raman probe. These two probe types enable a variety of applications for solids, liquids, and turbid media. A backscattered immersion probe is the preferred approach for measuring liquids because of its short focus, optical window, and bubble-shedding design. The Rxn-20 probe is optimized for large volumetric measurements, enabling focus-free, non-contact representative measurements of solids or turbid media. Since the Raman Rxn4 Hybrid is equipped with these two probes, this analyzer provides maximal sampling flexibility for *in situ* analysis of continuous or batch processes. With Raman RunTime analyzer control software running on the embedded controller inside the analyzer, the Raman Rxn4 Hybrid analyzer meets the needs of both Good Laboratory Practice (GLP) and Good Manufacturing Practice (GMP) governed areas within the pharmaceutical industry for Process Analytical Technology (PAT) and Quality by Design (QbD) applications.

The Raman Rxn4 Hybrid analyzer is only available with a 785 nm excitation wavelength laser.

## 3.2 Raman RunTime software overview

Raman RunTime embedded software is the control platform for the suite of Raman Rxn analyzers. Raman RunTime software is intended for easy integration with standard multivariate analysis and automation platforms to enable a real-time, *in situ* process monitoring and control solution. Raman RunTime presents an OPC and Modbus interface, which provides clients with analyzer data as well as analyzer control functions. Raman RunTime is fully embedded into Raman Rxn analyzers.

The main view of Raman RunTime displays four quadrants for four channel analyzers, one for each probe and a status bar (bottom) for a quick view of warnings and acquisition status. Single channel analyzers display only one main channel/probe window, while Hybrid analyzers display two channel/probe windows, one for the Rxn-20 probe channel and one for the non-Rxn-20 probe channel ALT. Batch details are accessed and edited from each corresponding quadrant/probe window. To switch back and forth between the main view and batch detail views, click the **Title Bar** for each probe/quadrant. Views of current spectrum vs. process values (model results) can also be easily swapped by clicking on the **Quadrant/Probe** window display. Additional features, such as system settings, calibration and diagnostics, are found under the Options section on the lower left corner of the screen.



Figure 4. Raman RunTime's main view in a Raman Rxn four channel analyzer

### ⚠ WARNING

- ▶ Whenever the Raman Rxn4 analyzer main power switch and laser key are in their **ON** position, probes should be shuttered or covered, or remain immersed in the sample to be measured.

### NOTICE

- ▶ See *Operation* for more information about working with the Raman RunTime software.

## 3.3 Product design

### 3.3.1 Front panel

On the front panel of the instrument are the standard user interfaces. These include the main **ON/OFF** power switch, the laser **ON/OFF** key switch, Light Emitting Diode (LED) indicators, and one Universal Serial Bus (USB) 3.0 port.

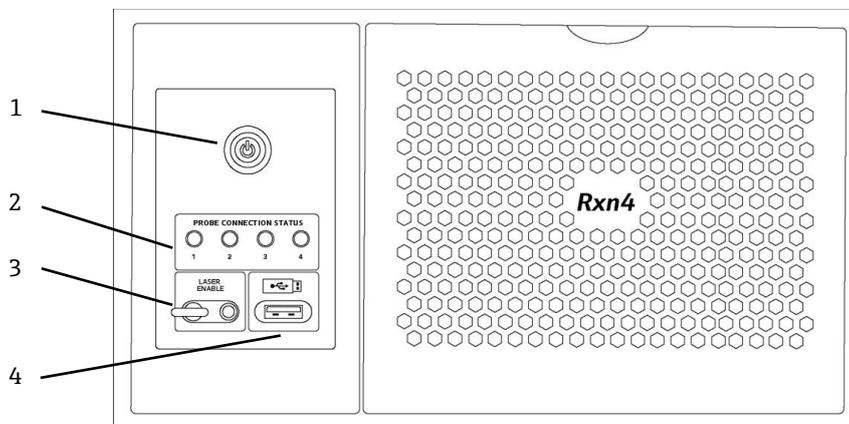


Figure 5. Front panel of a Raman Rxn4 four channel analyzer

#	Name	Description
1	Main Power Switch	The main power switch turns the instrument on and off, which includes the laser regardless of the position of the laser key switch. The <b>Power</b> push button incorporates a <b>Blue</b> LED in the shape of a power symbol, which indicates the system power status (all components are powered when lit). The <b>Power</b> push button will communicate error conditions using blink codes when embedded software is not able to communicate them. To turn the instrument on, press and release the <b>Power</b> button once. To turn a responsive instrument off, shut down using Raman RunTime. If the instrument is unresponsive, it may be powered down using a long 10 second press and hold of the <b>Power</b> button.
2	Probe Connection Status Indicators	The bank of <b>Yellow</b> LED indicators above the laser key and USB 3.0 port indicates the physical connection status of each probe. The LED is lit when the corresponding probe is properly connected. While the Raman Rxn4 four channel analyzer front panel has four LED indicators, the front panel of the Raman Rxn4 Hybrid analyzer has only two LED indicators, and the front panel of the Raman Rxn4 single channel analyzer has only one LED indicator.
3	Laser Key Switch	The laser key switch turns the laser on and off. The <b>Red</b> LED indicator adjacent to the laser key switch indicates the laser power status. To activate the laser, turn the laser key switch to the <b>ON</b> position. The Red LED indicator should remain lit whenever the laser is ON.
4	USB 3.0 Port	The USB 3.0 port is intended to obtain diagnostic exports from the instrument using a USB flash drive.

Table 5. Front panel of Raman Rxn4

### 3.3.2 Rear panel

On the rear panel of the instrument are the standard ports. These include touchscreen, USB, ethernet, serial, and video ports.

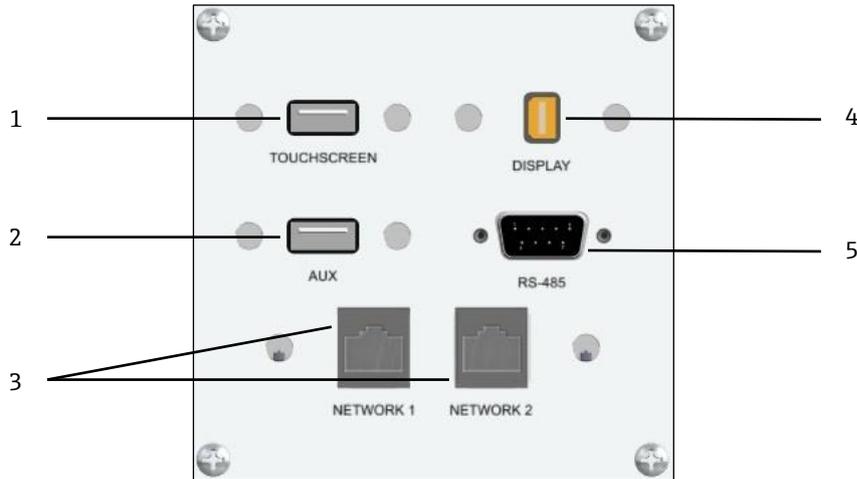


Figure 6. Rear external circuit input/output panel of a Raman Rxn embedded analyzer

#	Label	Interface Format	Description
1	TOUCHSCREEN	USB 2.0 Port	Input from touchscreen.
2	AUX	USB 2.0 Port	Reserved for future use.
3	NETWORK 1 and NETWORK 2	Two 1GB TCP/IP Ethernet Ports	Ethernet connection for OPC and Modbus communication and automation.
4	DISPLAY	Mini DisplayPort	Video connection for optional touchscreen.
5	RS-485	DB9 connector for 2-wire, half-duplex Modbus RTU interface. Pin 2 is Data+, Pin 3 is Data -, and Pin 5 is ground.	Modbus RTU interface connection.

Table 6. Raman Rxn4 ports

### 3.3.3 Rear panel – Rxn4 single channel and Rxn4 four channel analyzers

All normal system Input/Output (I/O) is located at the rear of the base unit. This includes:

- EO fiber connector/electrical connections for up to four remotely installed probes for the four channel Raman Rxn4 analyzer (single channel analyzers have only one probe connection). The electrical connection contained within the fiber optic cable assembly is an intrinsically safe wire loop that acts as an interlock cutting power to the laser upon breakage.
- Four remote interlock connections for the four channel Raman Rxn4 analyzer (only one for the single channel configuration), each intrinsically safe and in series with the fiber breakage detection loops described in previous bullet.
- Two TCP/IP Ethernet ports for OPC and Modbus automation as well as remote control.
- One serial RS-485 port for Modbus automation.
- One Mini Display Port for local display (optional).
- Two USB 2.0 Type A ports, one for local touchscreen (optional) and one reserved for future use.
- AC power inlet, C13 plug required.

#### **⚠ CAUTION**

- ▶ Care must be taken to make the bend radii of fiber optic cable breakouts as large as possible (minimum of 6 inches) with NO kinks and minimal strain on the jacketing and connectors.

### 3.3.4 Rear panel – Rxn4 Hybrid analyzers

All normal system I/O is located at the rear of Raman Rxn Hybrid analyzers. This includes:

- Fiber optic connectors/electrical connection for one remotely installed Rxn-20 probe. The electrical connection contained within the fiber optic is an intrinsically safe interlock loop which will turn off the laser for the Rxn-20 probe in case of fiber breakage. All connections are protected by a cover secured to the rear panel with two socket head cap screws.
- EO fiber connector/electrical connection for one remotely installed ALT probe. The electrical connection contained within the fiber optic is an intrinsically safe interlock loop which will turn off the laser for the alternate probe in case of fiber breakage.
- Two remote interlock connections for the Rxn-20 and ALT probes, each intrinsically safe and in series with the fiber breakage detection loops described in previous bullets.
- Two TCP/IP Ethernet ports for OPC and Modbus automation as well as remote control.
- One serial RS-485 port for Modbus automation.
- One Mini Display Port for local display (if needed).
- Two USB 2.0 Type A ports, one for local touchscreen (if needed) and one reserved for future use.
- AC power inlet, C13 plug required. See *Technical Data* for power requirements.

#### **⚠ CAUTION**

- ▶ Care must be taken to make the bend radii of fiber optic cable breakouts as large as possible with NO kinks.

## 3.4 Probe connectors

The probes are connected to the base unit at the connection panel located on the rear of the base unit.

For single channel or four channel Raman Rxn4 configurations, as well as the Alternate (ALT) probe channel of the Raman Rxn4 Hybrid configuration, each channel employs a single robust Electro-Optical (EO) connector which contains excitation and collection fiber-optics as well as an electrical laser interlock loop. The interlock contained within the probe fiber-optic is a low voltage and current loop designed to detect fiber cable breakage and will turn laser emission off for that channel in the event of a break. Ensure latch is engaged after inserting EO fiber connector.

For the Rxn-20 channel of the Raman Rxn4 Hybrid instrument, the main fiber optic bundle is furcated into three FC fiber optic connectors and one electrical interlock loop connector. The FC fiber optic connections are used for laser excitation, Raman scatter collection, and auto-calibration. The interlock loop contained within the probe fiber-optic is a low voltage and current loop designed to detect fiber cable breakage and will turn laser emission off for the Rxn-20 probe in the event of breakage.

## 4 Incoming product acceptance and identification

### 4.1 Incoming acceptance

1. Verify that the packaging is undamaged. Notify the courier of any damage to the packaging. Keep the damaged packaging until the issue has been resolved.
2. Verify that the contents are undamaged. Notify the supplier of any damage to the delivery contents. Keep the damaged goods until the issue has been resolved.
3. Check that the delivery is complete and nothing is missing. Compare the shipping documents with your order.
4. Pack the product for storage and transportation in such a way that it is protected against impact and moisture. The original packaging offers the best protection. Make sure to comply with the permitted ambient conditions.

If you have any questions, please contact Endress+Hauser at [support.kosi@endress.com](mailto:support.kosi@endress.com) for further assistance.

#### NOTICE

#### **Incorrect transportation can damage the analyzer**

- ▶ Always use a lifting truck or a fork-lift to transport the analyzer.

#### 4.1.1 Nameplate

The nameplate located on the rear of the Analyzer provides the following information about your device:

- Manufacturer Contact Information
- Laser Radiation Notice
- Electric Shock Notice
- Model Number
- Serial Number
- Wavelength
- Maximum Power
- Build Month
- Build Year
- Patent Information
- Certification Information

Compare the information on the nameplate with the order.

#### 4.1.2 Identifying the product

The order code and serial number of your product can be found in the following locations:

- On the nameplate.
- In the delivery papers.

#### 4.1.3 Manufacturer address

Endress+Hauser, 371 Parkland Plaza, Ann Arbor, MI 48103 USA

## 4.2 Scope of delivery

The scope of delivery comprises:

- Raman Rxn4 analyzer in the configuration ordered
- Raman Rxn4 Operating Instructions
- Raman Rxn4 Certificate of Product Performance
- Local declarations of conformity, if applicable
- Certificates for hazardous zone use, if applicable
- Raman Rxn4 optional accessories, if applicable

If you have any questions regarding the items delivered, or if anything appears to be missing, please contact Endress+Hauser at [support.kosi@endress.com](mailto:support.kosi@endress.com) for further assistance.

## 4.3 Certificates and approvals

The Raman Rxn family of base analyzer units are CE-marked as being compliant with the low-voltage safety directive, as well as applicable laser eye/skin safety standards 21 CFR 1040 LVS [low voltage safety] directive 2014/35/EU, EMC [electromagnetic compatibility] directive 2014/30/EU and IEC 60825-1 laser safety standard.

The Raman Rxn4 base unit has been certified for installation in a non-hazardous area with output into explosive atmospheres under the ATEX Directive, IECEx, and the applicable North American standards. See *Hazardous Area Certification* for more information.

## 5 Installation

### 5.1 Raman Rxn4 Analyzer with enclosure

#### NOTICE

- ▶ It is required that a trained representative of either Endress+Hauser or one of its authorized representatives be present for both initial inspection and installation of your Raman spectrometer system.

#### 5.1.1 Site requirements

It is required that the customer provide a space of not less than 8 inches (205 mm) in the front top, bottom, and sides of the analyzer enclosure.

The specific dimensions of the analyzer are listed in the *Specifications*. If the unit is to be mounted in a user-provided enclosure, the enclosure must allow for adequate airflow and temperature transfer. See *Ventilation* and *Temperature* for more information.

#### 5.1.2 Electrical power

The supply voltage is recommended to be regulated and free of voltage spikes. It is recommended, but not required, that an Uninterruptible Power Supply (UPS) be used with the instrument.

For a Raman Rxn4 with Enclosure, the enclosure should be wired with power adhering to local electrical codes and standards. Refer to specifications table for acceptable voltage and frequency ranges.

#### 5.1.3 Location

It is recommended that the Raman Rxn4 with enclosure be located on its cart, in a fixed position, on a level surface, or mounted securely on a wall or rack following local standards. The location selected should be isolated from excess vibrations.

#### 5.1.4 Ventilation

The location selected should allow for adequate ventilation to both the front and rear of the enclosure. A space of not less than 8 inches (205 mm) must be provided on the left side of analyzer enclosure (as viewed from the front of the analyzer) for proper inlet and outlet air movement for the air conditioning unit.

#### 5.1.5 Temperature

The Raman Rxn4 with Enclosure is designed to operate within a temperature range of 5 to 50°C within the enclosure. The unit uses an air-conditioner unit to maintain temperature for the analyzer below its maximum operating temperature.

#### 5.1.6 Relative humidity

The Raman Rxn4 with enclosure allows the system to operate to a maximum relative humidity range of up to 80% for temperatures up to 31°C and decreasing linearly to 20% at 50°C outside the enclosure.

#### 5.1.7 Sunlight and lighting

The Raman Rxn4 with enclosure and its associated probehead should be installed in a location protected from direct sunlight. A three-sided shelter or an appropriate sunshade should be used if needed to avoid direct sunlight on the Rxn4 enclosure. In addition, if the probehead is not installed in a supplied sample compartment, the optic attached to the probehead should be installed in a location protected from direct fluorescent, LED, and incandescent lights.

## 5.2 Raman Rxn4 Analyzer mounted in a computer or server rack

### NOTICE

- ▶ It is required that a trained representative of either Endress+Hauser or one of its authorized representatives be present for both initial inspection and installation of your Raman spectrometer system.

### 5.2.1 Site requirements

It is required that the customer provide a space of not less than 8 inches (205 mm) in the front top, bottom, and sides of the computer or server rack.

The specific dimensions of the analyzer are listed in the *Specifications*. See also *Ventilation* and *Temperature* for more information.

### 5.2.2 Electrical power

The supply voltage is recommended to be regulated and free of voltage spikes. It is recommended, but not required, that an Uninterruptible Power Supply (UPS) be used with the instrument.

For a Raman Rxn4, the computer or service rack should be wired with 100-240 VAC power adhering to local electrical code and standards. In a hazardous area, appropriate seals should be poured at the bulkhead adapters. Internal power to components is already complete.

### 5.2.3 Location

It is recommended that the Raman Rxn4 computer or server rack be located on in a fixed position, on a level surface following local standards. The location selected should be isolated from excess vibrations.

### 5.2.4 Ventilation

The location for the computer or server rack should allow for adequate ventilation to both the front and rear of the rack. A space of not less than 8 inches (205 mm) must be provided on the left side of analyzer (as viewed from the front of the analyzer) for proper inlet and outlet air movement.

### 5.2.5 Temperature

The Raman Rxn4 is designed to operate within a temperature range of +5 °C to +35 °C inside the computer or server rack.

### 5.2.6 Relative humidity

The Raman Rxn4 is designed to operate within an ambient relative humidity range of 20 to 80%, non-condensing.

### 5.2.7 Sunlight and lighting

The Raman Rxn4 with computer or server rack and its associated probehead should be installed inside a climate-controlled general purpose area, without any direct sunlight through windows, etc. In addition, if the probehead is not installed in a supplied sample compartment, the optic attached to the probehead should be installed in a location protected from direct fluorescent, LED, and incandescent lights.

## 5.3 Raman Rxn4 Analyzer on a benchtop

### NOTICE

- ▶ It is required that a trained representative of either Endress+Hauser or one of its authorized representatives be present for both initial inspection and installation of your Raman spectrometer system.

### 5.3.1 Site requirements

It is required that the customer provide a space of not less than 8 inches (205 mm) in the front, top, back, and sides of the Rxn4 analyzer outer casing.

The specific dimensions of the analyzer are listed in the *Specifications*. If the unit is to be mounted in a user-provided enclosure, the enclosure must allow for adequate airflow and temperature transfer. See *Ventilation* and *Temperature* for more information.

### 5.3.2 Electrical power

The supply voltage is recommended to be regulated and free of voltage spikes. It is recommended, but not required, that an Uninterruptible Power Supply (UPS) be used with the instrument.

Up to three (3) 15 to 20-Amp receptacles are needed (double gang box) to plug in the main analyzer unit, the optional touchscreen for the local HMI, and potentially a calibration accessory. For a Raman Rxn4 the receptacles should supply 100-240 VAC power adhering to local electrical code and standards.

### 5.3.3 Location

It is recommended that the Raman Rxn4 be located in a fixed position on a level surface. The location selected should be isolated from excess vibrations, and be able to accommodate the ambient conditions as specified below.

### 5.3.4 Ventilation

The location selected should allow for adequate ventilation to both the front and rear of the base analyzer.

### 5.3.5 Temperature

The Raman Rxn4 is designed to operate within a temperature range of +5 to +35 °C while sitting on a benchtop.

### 5.3.6 Relative humidity

The Raman Rxn4 is designed to operate within an ambient relative humidity range of 20 to 80%, non-condensing.

### 5.3.7 Sunlight and lighting

The Raman Rxn4 its associated probehead should be installed in a location protected from direct sunlight through windows or skylights. In addition, if the probehead is not installed in a vendor-supplied sample compartment, the optic attached to the probehead should be installed in a location protected from direct fluorescent, LED, and incandescent lights.

## 5.4 Initial analyzer setup

### 5.4.1 Installation of Raman Rxn4 analyzer

Endress+Hauser requires in some cases, that installation and initial analyzer setup be performed only by trained service professionals from Endress+Hauser or its affiliated representatives. This section provides only a basic overview of the analyzer setup process, and does not facilitate a full onsite installation or IQ/OQ. For IQ/OQ, it is required that a trained representative from Endress+Hauser or one of its authorized representatives be present for both initial inspection and installation of the Raman Rxn4 analyzer. Prior to the installation, prepare the site per the requirements in Section 5.1.

### 5.4.2 Connecting the touchscreen monitor

1. Connect a touchscreen monitor to the **Display** and **Touchscreen USB** ports on the back of the instrument.

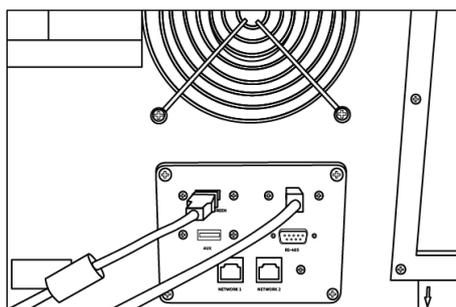


Figure 7. Touchscreen display connections

#### 5.4.2.1 For single channel, four channel, and Hybrid analyzers

Raman Rxn4 single channel, four channel, and Hybrid (ALT channel only) analyzers utilize a unique fiber-optic connector with integrated electrical laser interlock loop. The EO fiber connector on the Raman Rxn4 analyzer is referred to as the 'device-side' connector. The EO fiber connector on the probe fiber cable is referred to as the 'cable-side' connector. The instrument device-side connector uses an integrated spring-loaded cap that will protect the internal fibers from contamination.

To ensure optimal performance, it is recommended that you follow the steps below to properly clean and install a fiber optic cable assembly.

1. Remove cover from probe fiber cable-side connector.

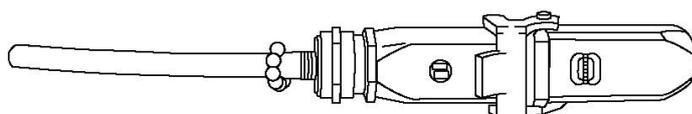


Figure 8. Electro-optical fiber connection cover

2. Clean fiber tips of cable-side connector prior to installation if cleanliness of fiber tips is unknown.
  - First use a lens wipe very lightly saturated with a solvent, such as reagent grade acetone or 100% Isopropyl Alcohol (IPA) followed by a final clean with a 1.25 mm fiber cleaning tool. Do not use the same wipe for both fiber tips.
  - Swipe the fiber tip once with the damp portion of the wipe, then swipe once more with a dry portion of the same wipe. Repeat for both fiber tips.

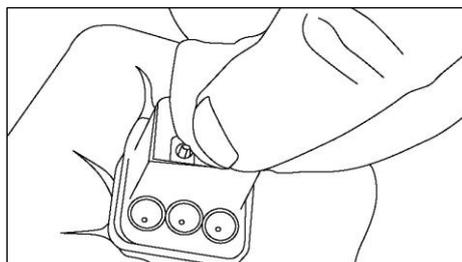


Figure 9. Cleaning electro-optical fiber connection

3. Next, use an IBC 1.25 mm ferrule cleaner with the bulkhead adapter attached to do a final clean of the center of the ferrule where the fiber resides. Press together until a click is heard and repeat once.

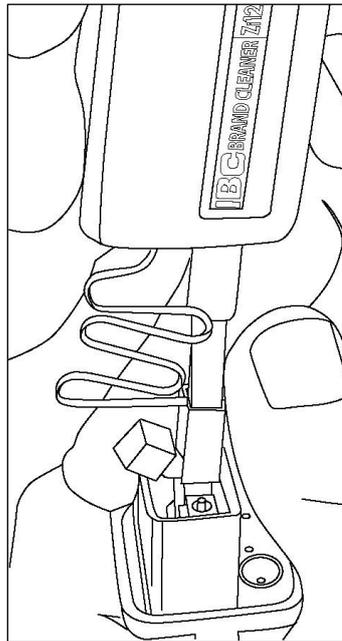


Figure 10. Final clean of electro-optical fiber connector fiber tips

4. Release latch and open spring-loaded cap on the Raman Rxn4 analyzer device-side connector. Insert cable-side connector into instrument device-side connector fully and engage latch to secure. The connectors are polarized and can only be inserted one way. The slotted head screws on the face of both connectors should be facing out.

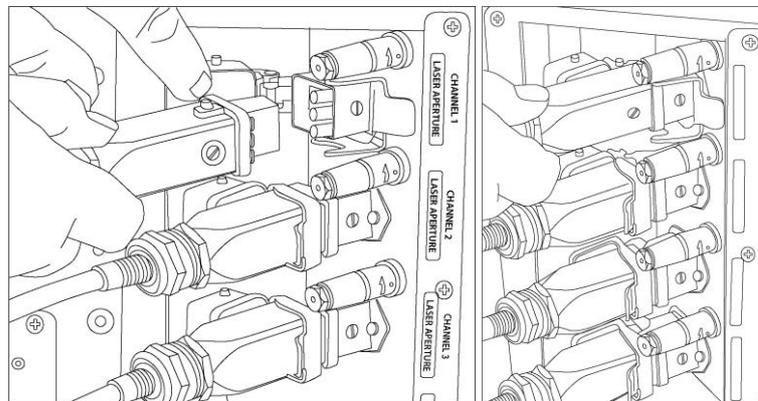


Figure 11. Connecting an electro-optical fiber cable to a Raman Rxn4 four channel analyzer

5. Repeat for each probe.

**CAUTION**

- ▶ Unused probes that are attached to the Raman Rxn4 analyzer should ALWAYS be capped to prevent stray ambient light from entering the probe. Stray ambient light, whether from an uncapped probe or through incomplete light shielding of the sample, may produce undesirable spectral interferences and result in calibration failure or inaccuracy.

**WARNING**

- ▶ Probes attached to the Raman Rxn4 analyzer should always be capped and/or pointed away from people toward a diffuse target if not installed in a sample chamber.

6. For each EO fiber cable, restrain the probe EO fiber optic cable using the strain relief located at the rear of the instrument.

**CAUTION**

- ▶ When installing the probe *in situ*, the user must provide strain relief to the EO fiber optic cable at the probe installation location.

**5.4.2.2 For Hybrid analyzers (Rxn-20 channel)**

The ALT channel utilizes an EO cable with an integrated electrical laser interlock loop, and the process of connecting the ALT channel is described in the previous section. The Rxn-20 channel of the Raman Rxn4 Hybrid Analyzer has four connections points: fiber electrical interlock, excitation, collection, and calibration. The excitation and calibration connections utilize FC style fiber connectors, while the collection connection utilizes a Mechanical Transfer (MT) style fiber connector. A remote interlock connector is also provided for the Rxn-20 channel and is located adjacent to the fiber electrical interlock connection. The Rxn-20 excitation, collection, and calibration fibers are fragile, and care must be taken to properly route and restrain the fibers using the following procedures.

To connect a probe to the Rxn-20 channel:

1. Remove the Rxn-20 plastic cover by unscrewing the two socket head cap screws using the 7/64" ball driver included with the instrument. This will reveal the individual connectors for the Rxn-20 channel.

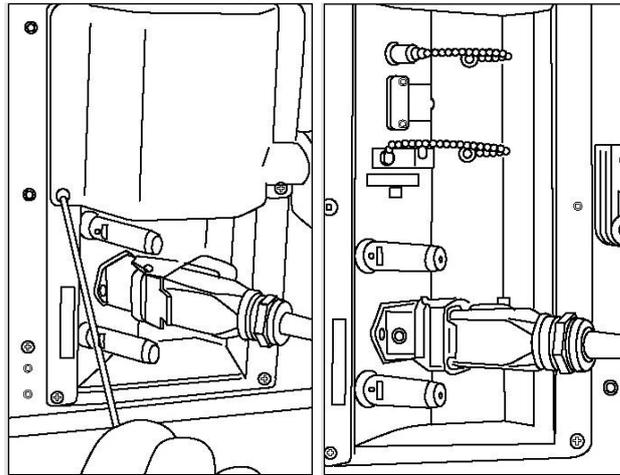


Figure 12. Rxn-20 channel cover on rear of Raman Rxn4 Hybrid analyzer and connectors for Rxn-20 channel

2. On the cable-side connectors, clean ONLY the excitation and calibration fiber tips prior to installation if cleanliness of these fiber tips is unknown.
  - o First use a lens wipe very lightly saturated with a solvent, such as reagent grade acetone or 100% IPA followed by a final clean with a 2.5 mm fiber cleaning tool. Do not use the same wipe for both fiber tips.
  - o Swipe the fiber tip once with the damp portion of the wipe, then swipe once more with a dry portion of the same wipe. Repeat for both fiber tips.
3. Employ the two strain reliefs on the rear of Raman Rxn4 Hybrid analyzer (using the 7/64" ball driver) to secure the fiber cable assembly.

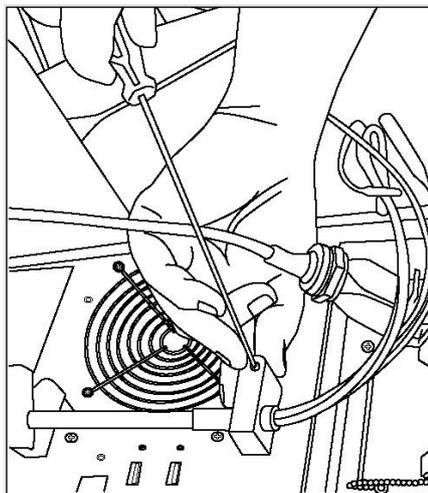


Figure 13. Employing strain reliefs to secure the fiber assembly for the Rxn-20 channel

4. Remove the threaded cap from the Calibration (CAL) port.

5. Connect the clean calibration fiber to the CAL port, aligning the key on the fiber connector with the notch on the CAL port connector. The fiber should be routed in a helical pattern as shown below to avoid kinks.

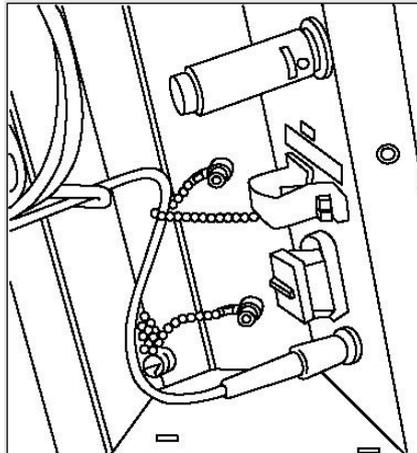


Figure 14. Proper connection and routing of the calibration fiber

6. Remove the rubber cap from the MT style collection fiber connector. Lift and hold the cover of the Collection (COLL) port as the fiber is connected. Align the white dot on the MT style fiber connector with the white mark on the COLL port and insert the fiber connector until it clicks into place. The fiber should be routed in a helical pattern as shown below to avoid kinks.

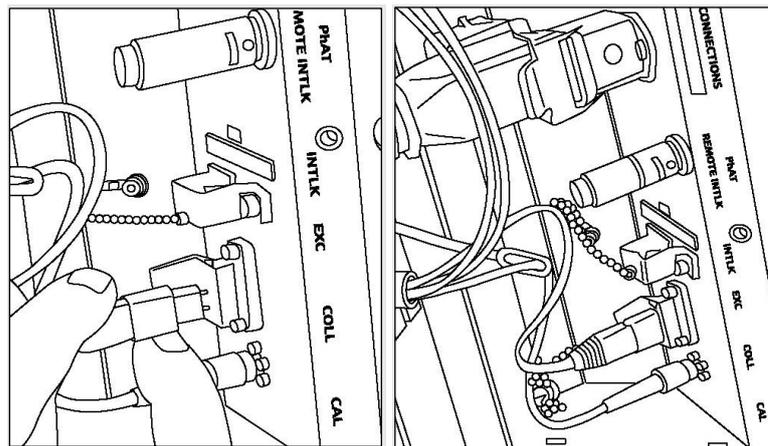


Figure 15. Proper connection and routing of the collection fiber

7. Remove the excitation fiber clamp by loosening the clamp screw with a 3/32" ball driver (provided with analyzer) and sliding it out of the way.
8. Remove the threaded cap from the Excitation (EXC) port.

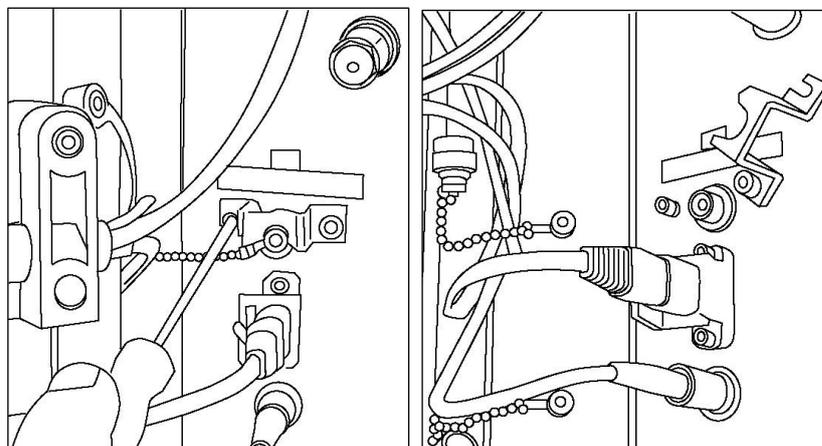


Figure 16. Proper removal of the excitation fiber clamp and threaded cap from the excitation port

9. Connect the clean excitation fiber to the EXC port on the connection panel, aligning the key on the fiber connector with the notch on the EXC port connector. The fiber should be routed in a helical pattern to avoid kinks.

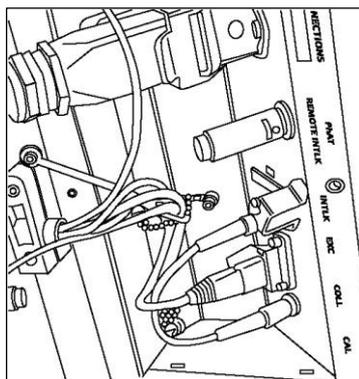


Figure 17. Proper connection and routing of the excitation fiber

10. Re-install the excitation fiber safety clamp using a 3/32" ball driver.
11. Connect the fiber electrical interlock connector to the Interlock (INTLK) port. Route cable behind fiber connections.

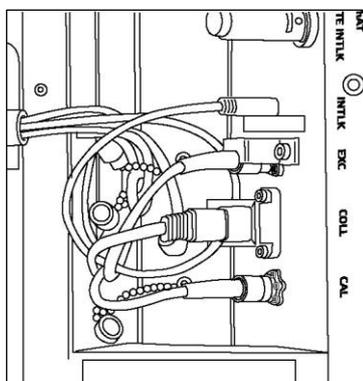


Figure 18. Proper connection of interlock connector and fiber routing

12. Replace the Rxn-20 plastic cover, ensuring that no fibers are caught between the cover and connection panel flange. Replace and tighten the two socket head cap screws to hold cover in place using a 7/64" ball driver.

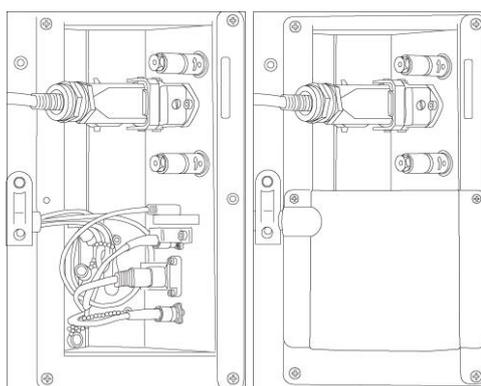


Figure 19. Before and after reattaching Rxn-20 probe

**CAUTION**

- ▶ Unused probes that are attached to the Raman Rxn4 analyzer should ALWAYS be capped to prevent stray ambient light from entering the probe. Stray ambient light, whether from an uncapped probe or through incomplete light shielding of the sample, may produce undesirable spectral interferences and result in calibration failure or inaccuracy.

**WARNING**

- ▶ The beam emerging from the Rxn-20 probe is hazardous to the eye. Always secure the probe so that it is pointing safely away from any personnel. Never handle the probe freely when it is operational.

## 5.5 Powering up the Raman Rxn4

Press and release the **Power** button and turn the laser key switch to the **ON** position. The **Power** button will blink once per second until Raman RunTime launches. The Laser Enable LED will illuminate **Red** and the power switch will illuminate a solid **Blue**.

**NOTICE**

- ▶ See *Front panel* for more information about the the **Power** button.

## 5.6 Powering down the Raman Rxn4 system

There are two ways to properly power down the Raman Rxn4 analyzer. One of these two methods should always be used to power down the instrument unless it is unresponsive.

1. In Raman RunTime embedded software, navigate to **Options > System > General**. Click **Shut Down**. The analyzer will power down after about 5 seconds.

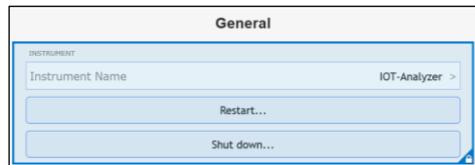


Figure 20. Steps to shut down the device via RunTime

OR

2. Press and hold the push button power switch until it starts to blink (2 seconds). Release the push button. A power down message is sent to Raman RunTime, and it will begin power down activities. The instrument will power down after about 5 seconds.

To perform a **hard shutdown**, there are two methods that can be used. These methods should **only** be used if Raman RunTime is unresponsive.

1. Press and hold the push button power switch for at least 12 seconds until the instrument powers down. Then release the button.

**NOTICE**

- ▶ After 2 seconds, the power switch will begin to blink; ignore and continue to hold down power button until instrument powers down.
- 2. Unplug the instrument.

**NOTICE**

- ▶ See the *Raman RunTime Software Manual (p/n 4004889)* for more information.

## 5.7 Initial Raman RunTime set up

### 5.7.1 Raman RunTime network configuration

The table below summarizes the ports relevant to specific features. Ports for OPC Classic are assigned dynamically in the indicated range; fixed-port behavior is only available for OPC UA. It is only necessary to open firewall ports for the features intended to use. Ports in bold should be regarded as mandatory for the associated protocol; other ports are recommended for full functionality (e.g., discovery services).

Protocol	Ports
OPC UA	TCP 4840, 4843, 52601, and <b>62886</b>
OPC Classic	TCP <b>135</b> and <b>49152-65535</b>
Modbus	TCP <b>502</b>
File Sharing	TCP <b>139</b> and <b>445</b>
Remote Access	TCP <b>943</b> , <b>3593</b> , <b>4525</b> , and <b>5674</b> ; User Datagram Protocol (UDP) 3702

Table 7. Raman RunTime network configuration

## 5.7.2 Initial setup of Raman RunTime

1. Customize the analyzer name in **Options > System > General**. For example, Raman Rxn4-785 sn0012345. Click **Apply**. This step is important because the analyzer name is how the system is identified via diagnostic exports.
2. Calibrate the touch screen (if needed):
  - Select **Options > System > General > Calibrate Touch Screen**.
  - Follow on screen prompts. A tip for achieving a better calibration is to use the edge of your fingernail when following on screen prompts and touching the requested touch points.
3. Connect to a network using one of the available ethernet ports. View and customize network settings, at **Options > System > Network**.
4. Set the date and time either manually or via network connection by specifying the time server address at **Options > System > Date & Time**. If setting the date and time manually, first ensure the time zone is set up correctly before proceeding to other adjustments. This step is also important because spectral acquisition and resulting files and OPC tags are managed by the system's date/time.
5. Specify names for each probe/quadrant (such as Probe 1) at **Probe Detail view > Settings Tab > Name > Apply**.

### ⚠ CAUTION

- ▶ You should allow the system to stabilize for a minimum of two hours before proceeding to the calibration steps.

## 5.7.3 Calibration and verification

Follow these instructions to calibrate and verify your Raman Rxn4 analyzer for the first time. All calibrations are required prior to spectral acquisition. Raman RunTime will not allow spectra to be collected without passing internal and probe calibrations. Passing the verification step is not required but highly recommended.

Navigate to **Options > Calibration**. The next page shows different calibration window previews for the different Raman Rxn4 analyzer configurations.



Figure 21. Calibration window with quick view buttons for a Raman Rxn4 – four channel analyzer

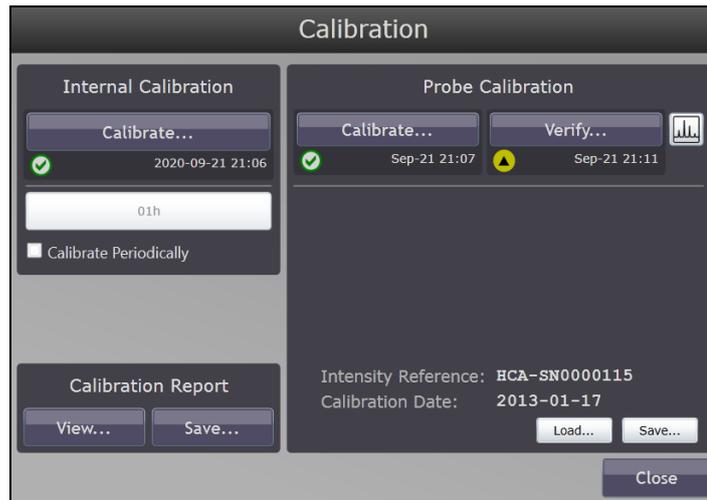


Figure 22. Calibration window with quick view buttons for a Raman Rxn single channel analyzer



Figure 23. Calibration window with quick view buttons for a Raman Rxn Hybrid analyzer

## 6 Electrical connection

### 6.1 Port connections

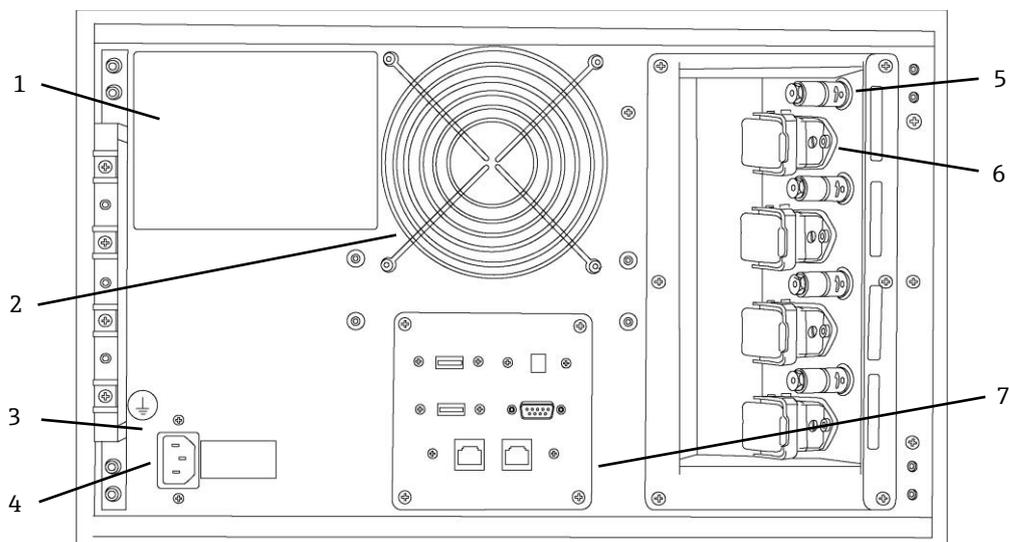


Figure 24. Rear panel of Raman Rxn4

#	Name	Description
1	CDRH Product Label	Product information about the Raman Rxn4 analyzer.
2	Air Exhaust	Air exhaust fan and outlet.
3	Strain Relief	EO fiber cable strain relief mounting location.
4	AC Inlet 100-240 VAC 50/60 Hz	Power socket outlet that AC power to the base unit. Ground pin on this connector serves as the Protective Conductor Terminal.
5	Remote Interlock Connectors	Safety feature. To interrupt the laser, remove the black plug.
6	EO Fiber Connector	Provides fiber optic laser radiation output, fiber optic Raman collection and electrical laser interlock loop for each instrument channel. The electrical laser interlock loop is intrinsically safe and is governed by Endress+Hauser drawing 4002396. Match 3 prongs on probe to 3 plugs on EO. Pull latch down to secure probe in place. Laser radiation may NOT exit a channel whose EO fiber connector is removed because removing the EO connector also interrupts the laser interlock loop for that channel.
7	Analyzer Ports	Touchscreen USB Port, USB Port, Ethernet Ports, RS-485 Serial Port, and Touchscreen Video Port.

Table 8. Port connection

## 7 Commissioning

### 7.1 Automation connection

Raman RunTime provides network-connected clients with analyzer data as well as analyzer control functions. OPC UA is the recommended protocol because it allows transfer of large data (full spectral data and diagnostics in this case) and is a more reliable connection than OPC Classic. However, legacy support for OPC Classic (DCOM, also called OPC DA) clients is also built-in.

#### NOTICE

- ▶ The Raman Rxn4 system must be connected to a network for OPC functionality. Network settings can be viewed and configured in **Options > System > Network**.

#### 7.1.1 OPC connectivity

To access the OPC server, all clients must authenticate with the name and password of an authorized user.

- **Automation.** The built-in user with the name 'kaiser-opc' is always authorized for OPC access. The password for 'kaiser-opc' is 'opc' by default; this password can be changed under **Options > System > Automation**.
- **Security.** Additionally, the OPC server can be accessed with user credentials created and managed under **Options > System > Security**.
- **OPC UA (recommended).** OPC UA clients access the OPC server using UA's binary protocol to connect to `opc.tcp://<computer-name>`, providing the name and password of an authorized user. The "computer name" can be viewed or changed under **Options > System > Network**.

The Basic128Rsa15, Basic256, and Basic256Sha256 algorithm suites are supported for signing and optionally encrypting OPC communications.

- **UA Certificates.** The first time that a given UA client connects to a Raman RunTime system, it is necessary for that client to accept or "trust" the certificate that the OPC server provides to identify itself. The mechanisms for accepting the server's certificate vary by client.

The OPC server provides a "self-signed" certificate; accordingly, it is common for the client to display a warning that the server's identity cannot be verified. Such a warning is normal, and the server's certificate must be accepted to enable the client to connect.

The OPC server's certificate is tied to the computer name of the Raman RunTime system. Any time the computer name is changed, a new certificate will be generated automatically, and UA clients will need to accept the new certificate before they can connect again.

- **OPC Classic (deprecated).** Full OPC functionality is available to OPC Classic clients. However, OPC Classic entails additional set-up requirements, and many opportunities exist for client-side configuration to interfere with successful communication, often in ways that are challenging to diagnose. Also, the underlying technology of OPC Classic can limit installation flexibility. For these reasons, it is recommended to use OPC UA instead of OPC Classic whenever possible.
- The OPC Classic client program must be executed using credentials that exactly match (name and password) an authorized user on the Raman RunTime system.
- This implies that a Windows user account must be created on the client workstation with a name matching that of a Raman RunTime user, and that their passwords must be kept in sync.

### 7.1.1.1 Asynchronous updates

In addition to responding to polling requests from clients, the OPC server is capable of providing asynchronous updates in which the server notifies clients of changes in the values of subscribed tags without the need for clients to continually poll the server.

#### NOTICE

- ▶ Many clients will fail to connect unless asynchronous updates are enabled.

To enable asynchronous updates, the 'kaiser-opc' user must exist on the client workstation with a password that matches the Raman RunTime system, regardless of whether the client program accesses the server using the 'kaiser-opc' user credentials.

#### NOTICE

- ▶ If the 'kaiser-opc' password is changed under **Options > System > Automation**, the Raman RunTime system must be restarted under **Options > System > General** for the new password to take effect.
- ▶ Client workstations must reside in the same TCP/IP subnet as the analyzer, with no intervening Network Address Translation (NAT).

### 7.1.2 Modbus connectivity

The Raman Rxn4 provides automation data via Modbus TCP (Ethernet) or Modbus RTU (RS-485 serial). If models are running on the instrument, the prediction values available over Modbus may be configured at **Options > System > Automation > Modbus**. In addition to prediction values, other instrument diagnostic values are available over Modbus.

#### NOTICE

- ▶ See *Raman RunTime Automation Modbus (p/n 4005029)* to view the current Modbus Map for Raman RunTime.

## 7.2 External circuit I/O panel

At the center of the rear panel, is an I/O panel that provides several extra low voltage, non-intrinsically safe external circuits:

- **Touchscreen.** Type A USB 2.0 for connection to a local touchscreen display. This is not required for the instrument to operate as all operation parameters may be set through the instrument's automation interfaces. A touchscreen kit, which includes the interface cable for this connection, is available for purchase from Endress+Hauser under *p/n 2018086*.
- **Display.** Mini Display Port for video connection to a local touchscreen display. This is not required for the instrument to operate as all operation parameters may be set through the instrument's automation interfaces. This port does NOT support DP++; therefore, an active adapter is needed if connecting to a display without native DisplayPort. A touchscreen kit, which includes the interface cable for this connection, is available for purchase from Endress+Hauser under *p/n 2018086*.
- **Aux.** Type A USB 2.0 reserved for future use.
- **RS-485.** DB9 which provides a half-duplex serial RS-485, two-wire plus ground, Modbus RTU automation interface. Pin 2 is Data +, Pin 3 is Data -, Pin 5 is Ground. All other pins are inactive.

Recommended wiring is commercially available shielded, 2 twisted pair, 22 American Wire Gauge (AWG), terminated with a DB9 receptacle and back shell kit. Endress+Hauser recommends Carol C1352A cable, TE Connectivity 5-747905-2 receptacle and 1991253-9 back shell kit. Cable and connector/back shell of equivalent specifications may be substituted. One pair is used for Data+ and Data- and one of the wires from the second pair is used for ground. It is not recommended to use the shield as a signal ground. No provision for connecting the shield drain is provided at the Raman Rxn4. The shield may be connected to earth at the device on the opposite end of the cable attached to the Raman Rxn4.

- **Network 1.** 10/100/1000 RJ45 Ethernet interface. Provides remote control option and automation data via OPC UA, OPC Classic and Modbus TCP. Use standard Ethernet cabling.
- **Network 2.** Same as Network 1. Both interfaces may be used at the same time.

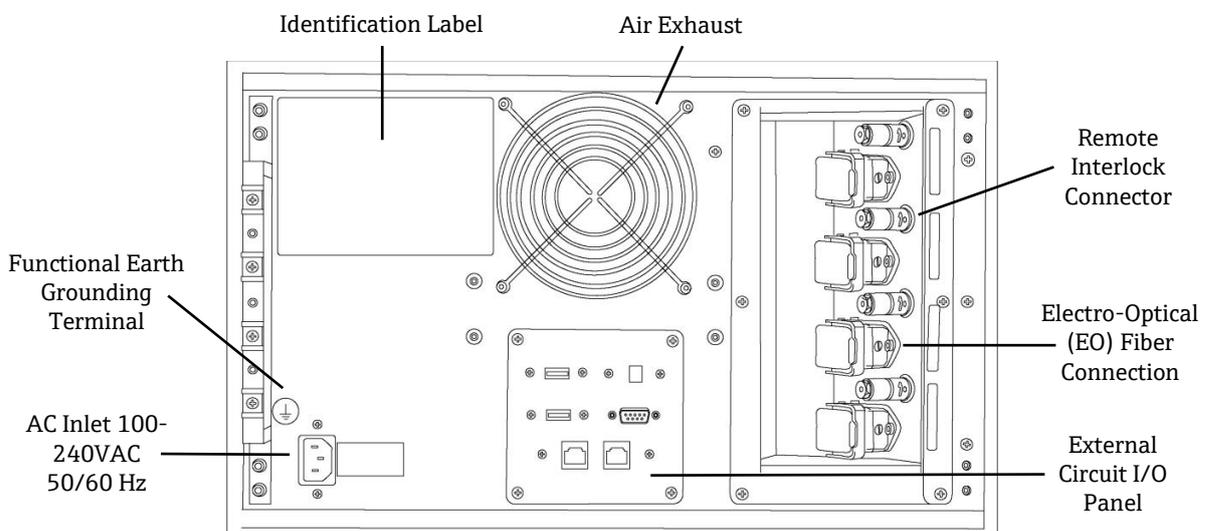


Figure 25. Rear panel on a Raman Rxn4 four channel analyzer

### 7.2.1 Power and grounding

The Raman Rxn4 has a standard IEC-320 C-14 inlet for power at the rear of the instrument. Any power cord with an IEC-320 C-13 plug will connect to the base unit. The Raman Rxn4 accepts AC power from 100 – 240V and 50/60 Hz. For U.S. applications, a power cord is supplied. For non-U.S. applications, the user must supply a power cable that meets local/national standards.

Also included on the rear of the instrument is a functional earth terminal for additional grounding if required. Primary grounding occurs through the IEC power inlet plug ground terminal which should be connected to the building grounding system.

Do not position the Raman Rxn4 in a way that makes it difficult to remove the mains cord. Only use adequately rated power cables with the Raman Rxn4 system.

### 7.2.2 Electrical interconnect block diagram – single channel Raman Rxn4

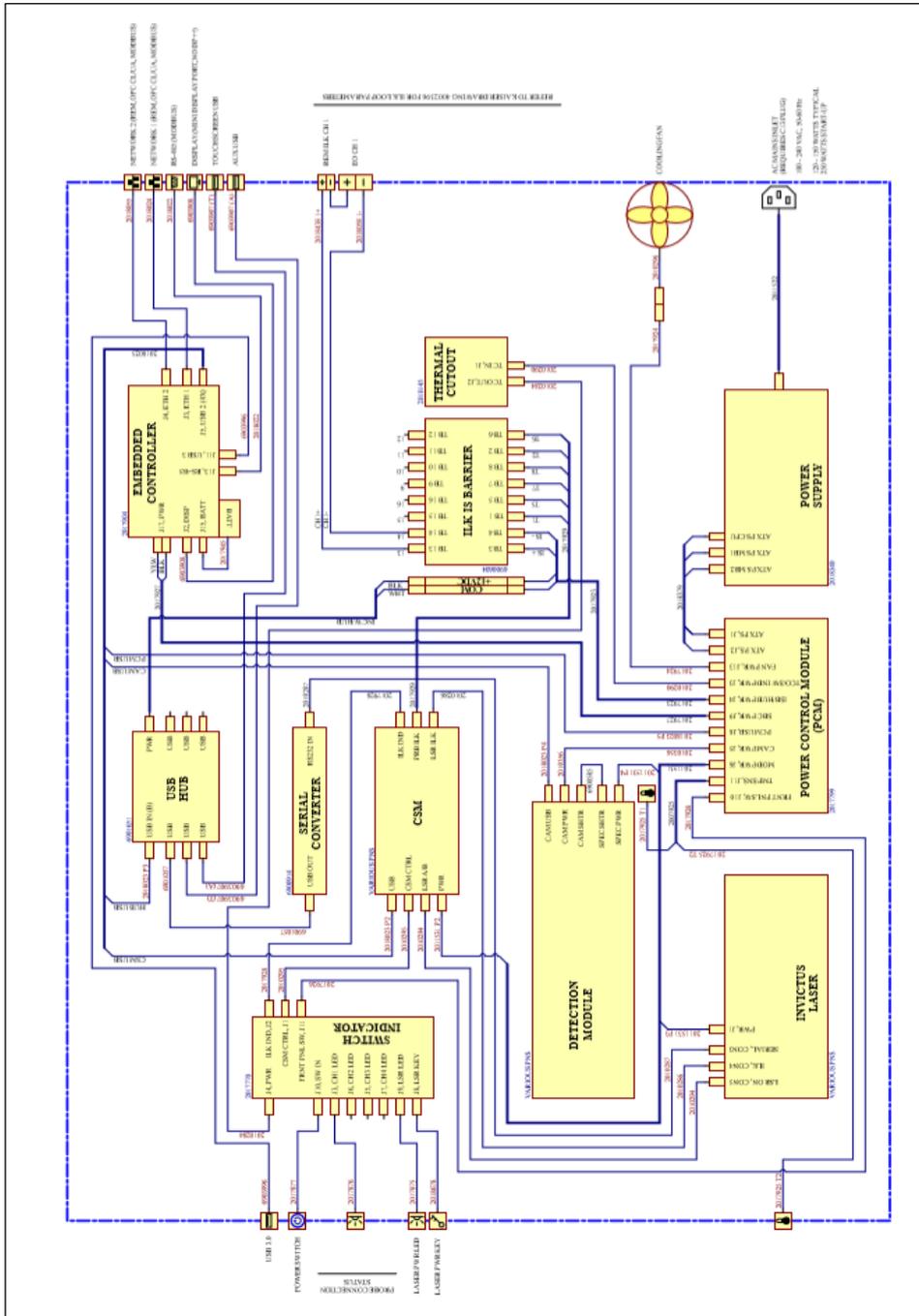


Figure 26. Single channel Raman Rxn4

### 7.2.3 Electrical interconnect block diagram – four channel Raman Rxn4

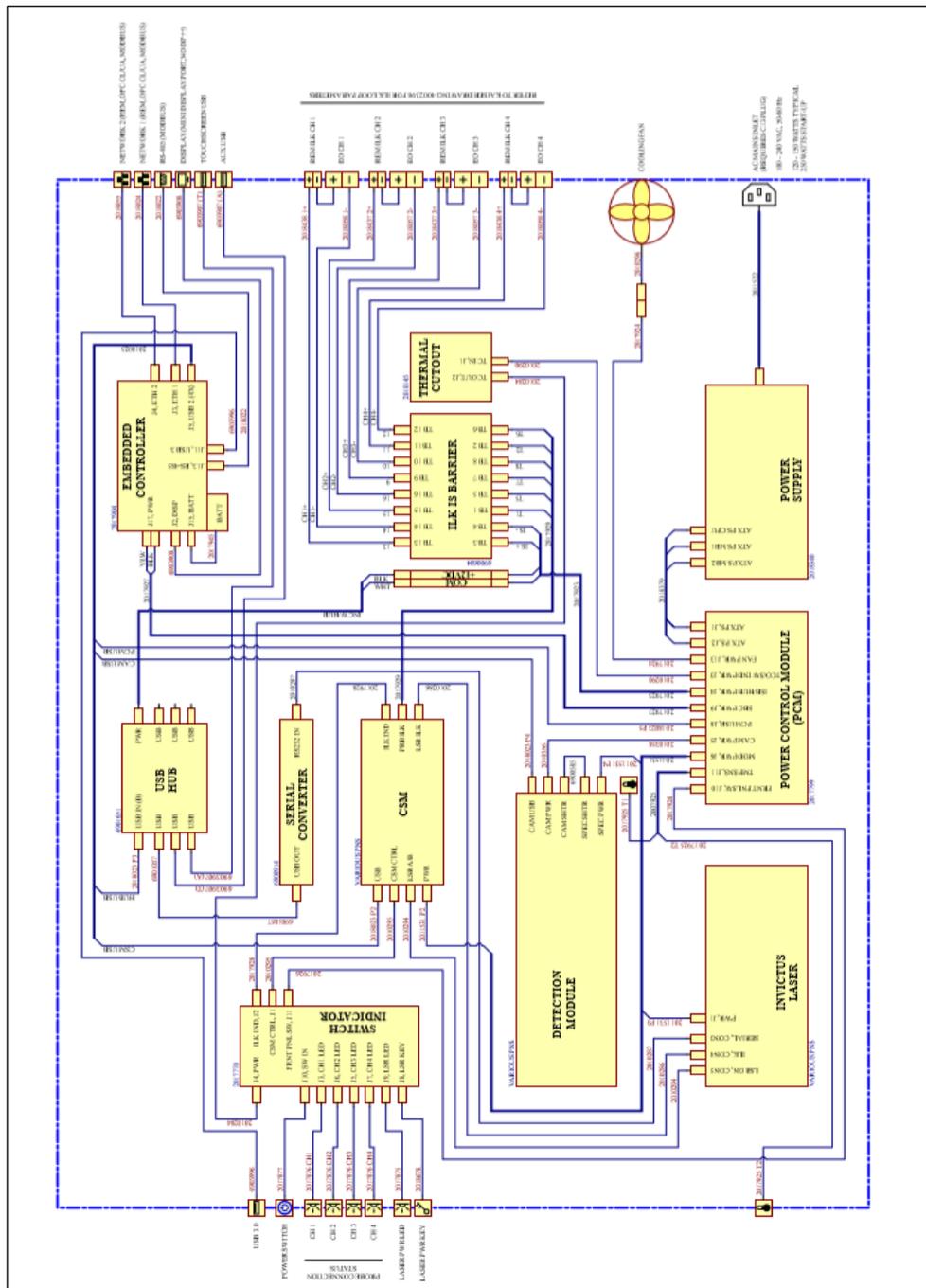


Figure 27. Four channel Raman Rxn4

### 7.2.4 Electrical interconnect block diagram – Hybrid Raman Rxn4

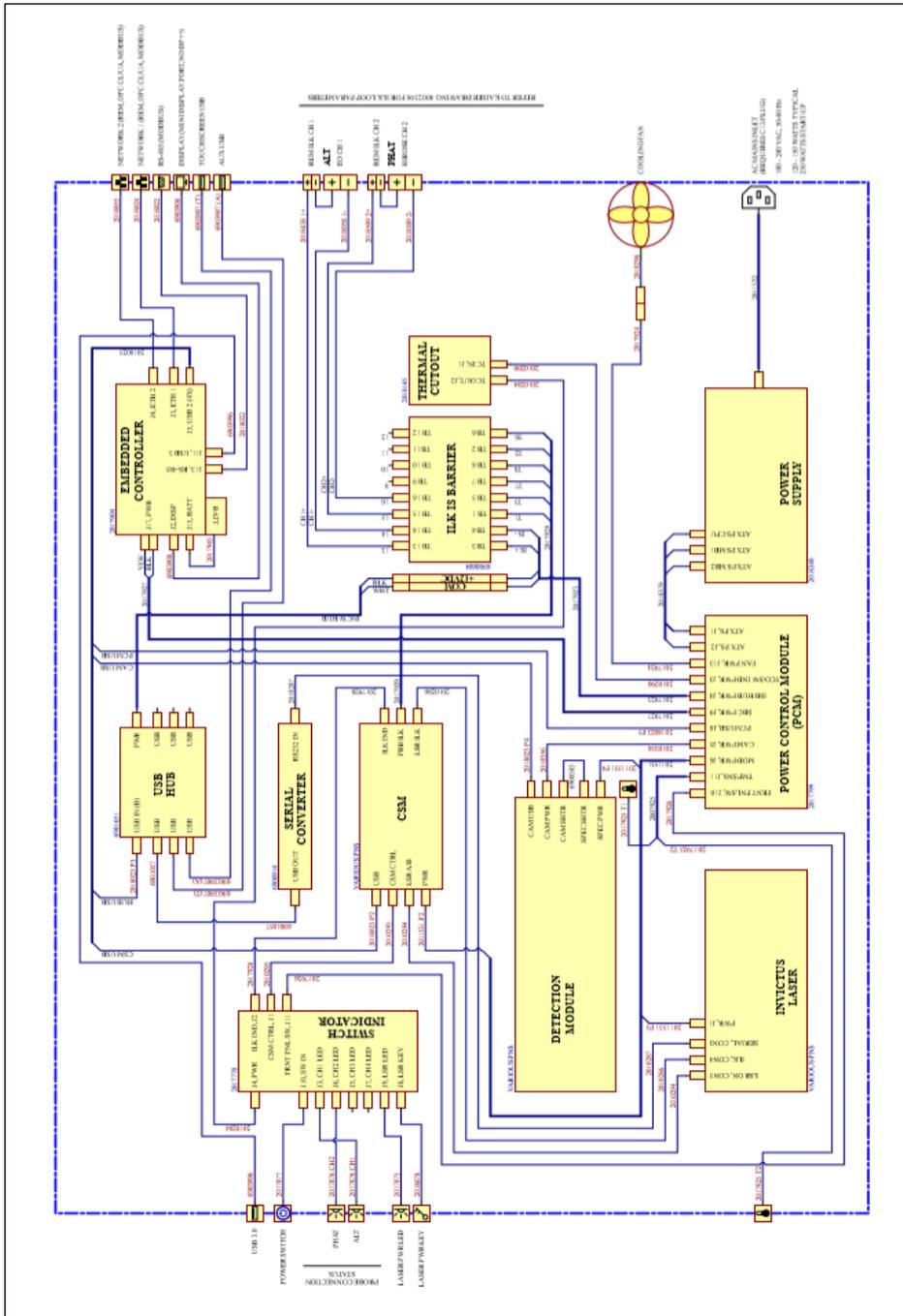


Figure 28. Hybrid Raman Rxn4



### 7.2.7 Interior of the Raman Rxn4

The interior of the Raman Rxn4 with the cover removed is shown below. The internal components are common among all configurations.

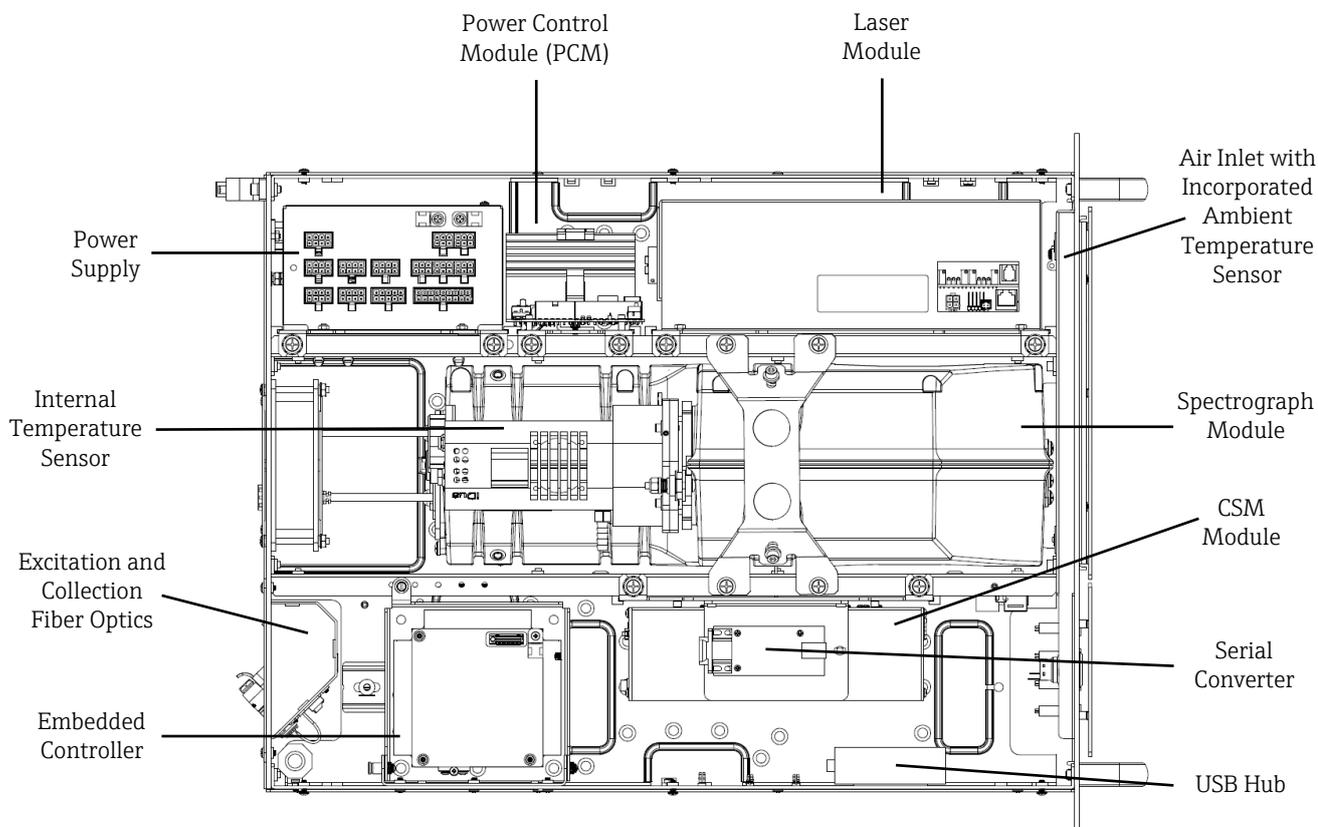


Figure 30. The interior of the Raman Rxn4 analyzer

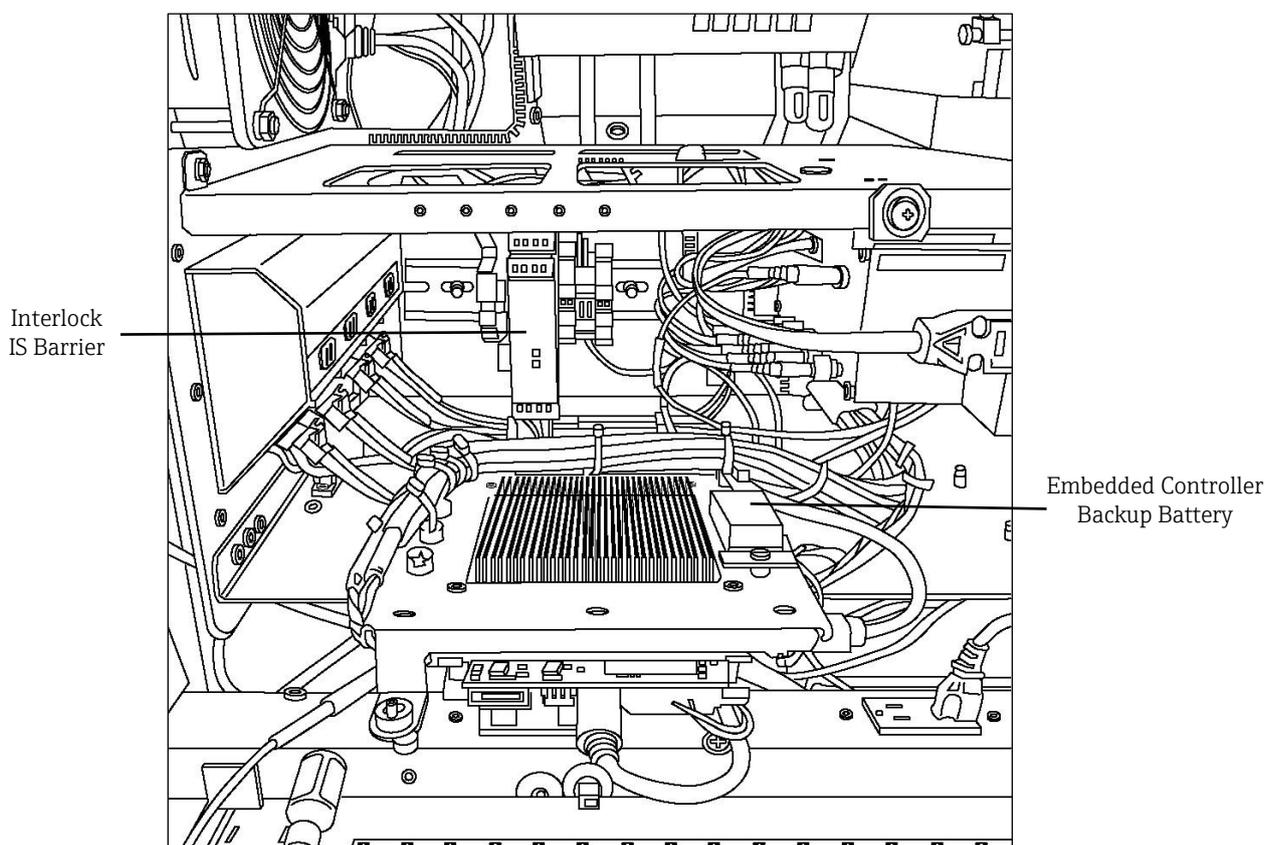


Figure 31. Embedded controller locked in service position

## 7.3 Raman Rxn4 hardware components

### 7.3.1 Laser

The laser used in the Raman Rxn4 is a special version of Endress+Hauser's Class 3B laser. It has a lockable injector that requires no routine adjustment.

The laser can be turned on and off using the LASER ENABLE switch on the front of the base unit at any time while the Raman Rxn4 is operating.

#### 7.3.1.1 Laser apertures

Apertures for laser emission are found in the following places on and within the Raman Rxn4:

- Probehead
- Connection Panel
- Calibration Module
- Laser

#### 7.3.1.2 Laser interlock circuit

If a fiber breaks the interlock, the laser output for that channel is disabled. Other channels with intact fiber interlocks will continue to have the laser available to them.

For laser output to occur on a channel, a probe and remote interlock shorting plug, Endress+Hauser p/n 2018429, must be installed to their respective connectors.

Auxiliary interlock laser emission indicators are on the probes. See the specific probe operating instructions for more information.

### 7.3.2 Spectrograph

The spectrograph includes the optical elements used to filter out the Rayleigh scatter and focus the Raman scatter onto the detector. The spectrograph assembly (which includes the detector) in the Raman Rxn4 is contained in a sealed assembly and has no user-serviceable parts.

### 7.3.3 Calibration switching module

The Calibration Switching Module (CSM) is a key component of the Raman Rxn4. Using high-reliability switches, it routes the several channels and performs automatic wavelength calibration with a neon source and laser wavelength calibration with an internal Raman shift standard. It also contains a software-controllable shutter for the laser.

The fluorescent lamp provides a broad spectrum of lines for wavelength calibration across the Raman spectrum. The neon lamp also is not susceptible to spectral shift with changes in temperature or pressure as are calibration protocols that rely on Raman bands.

The calibration can be performed on the internal neon lamp without reconfiguring the analyzer to accommodate an external calibration unit. The internal Raman shift standard allows the laser wavelength to be tracked.

Because the calibration light source is internal to the Raman Rxn4, it is susceptible to interference from stray light entering the connected probes. Prevent stray light from entering any probe connected to the base unit by covering the ends of the attached probes.

#### NOTICE

- ▶ See *Calibrations* for more information on calibrating the Raman Rxn4. Intensity calibration requires Endress+Hauser's *Raman Calibration Accessory* (p/n 2004909-501).

### 7.3.4 Fuses

There are no fuses to replace on the Raman Rxn4. The Raman Rxn4 is powered by a special adapted Advanced Technology eXtended (ATX) power supply, which has no external fuses. If a short circuit were to occur inside the Raman Rxn4 it would be on the DC output side of the power supply. In this event, the power supply would turn itself off and would require a manual power reset (i.e., removing the plug for five (5) minutes) after the source of the short circuit was resolved.

### 7.3.5 Raman Rxn4 storage options

The Raman Rxn4 analyzer is available in four different configurations: as a stand-alone single unit, in a rack holding up to two analyzers, a single unit in an enclosure on a trolley, and a single unit in an enclosure on a stand. All configurations contain the analyzer, a touchscreen monitor, keyboard, and integrated touchpad.

For connecting main power to the analyzer, an integrated internationally-approved pigtailed power cord is provided. The pigtail incorporates a standard IEC-320 C-14 inlet to which any standard and locally approved power cord with an IEC-320 C-13 plug may be attached to provide mains power to the accessory. The accessory accepts AC power from 100 – 240V and 50/60 Hz.

For the Raman Rxn4 sold within the continental United States, a power cord is provided with the attachment to mains power. For analyzers sold outside the continental United States, a power cord is **NOT** included. It is the responsibility of the end user and/or local Endress+Hauser Representative to provide the locally approved power cord for attachment to mains power.

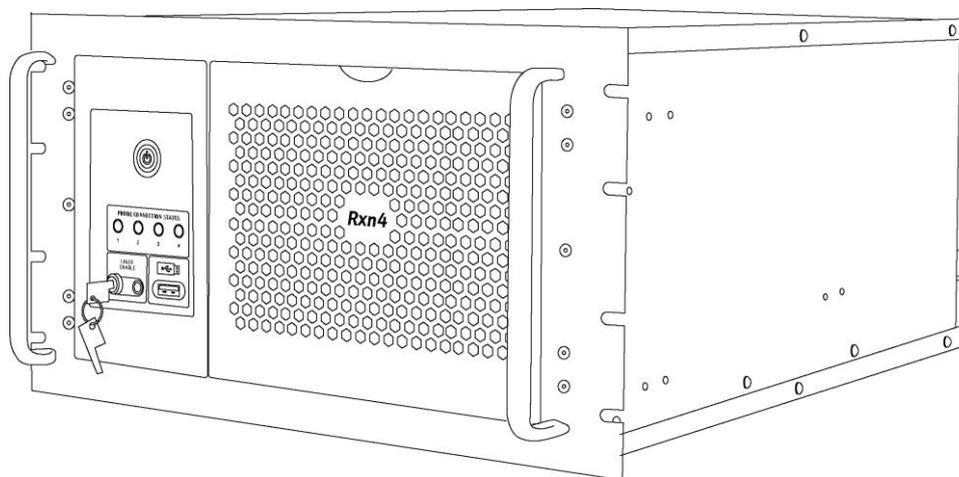


Figure 32. Raman Rxn4 unit

### 7.3.5.1 Rack

The rack can hold up to two units on lockable slides with cable carrier arms. It has a single touchscreen monitor with a switch to shift the unit display between analyzers. There are lockable doors on the front and rear of the rack. The power distribution unit within the rack contains 8 power receptacles. Rack installation drawing is 3000097.

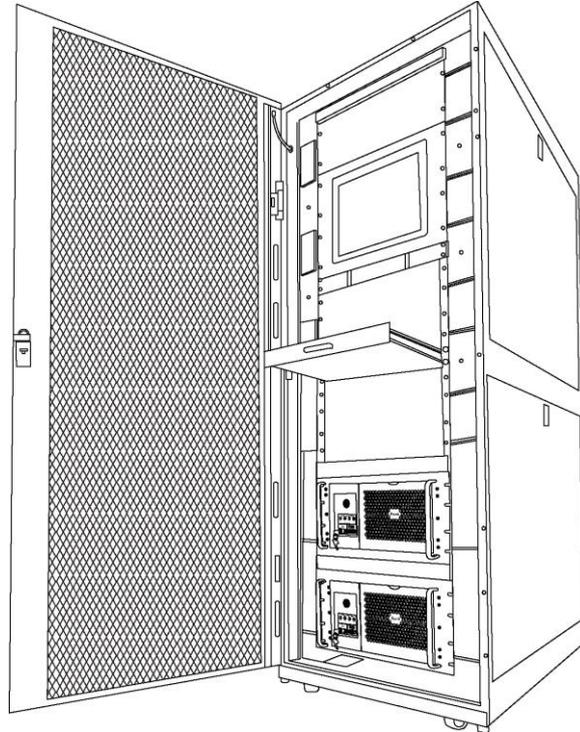


Figure 33. Two Raman Rxn4s in a rack

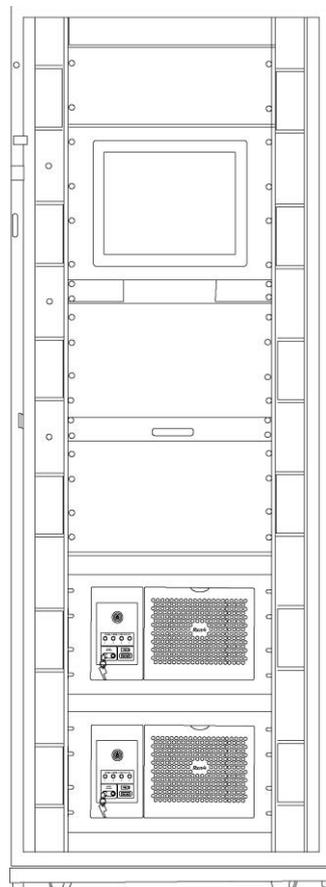


Figure 34. Two Raman Rxn4s in a rack

### 7.3.5.2 Enclosure

The enclosure is constructed of a welded 304 stainless steel cabinet with a door to access the touchscreen, and another door to access the Raman Rxn4 analyzer integrated within. The probes connect on the connection panel on the bottom of the unit. The external power cord protrudes from the enclosure on the right side. The USB port and air conditioner are on the the left side. There are four laser keys on the front of the device with laser indicator lights.

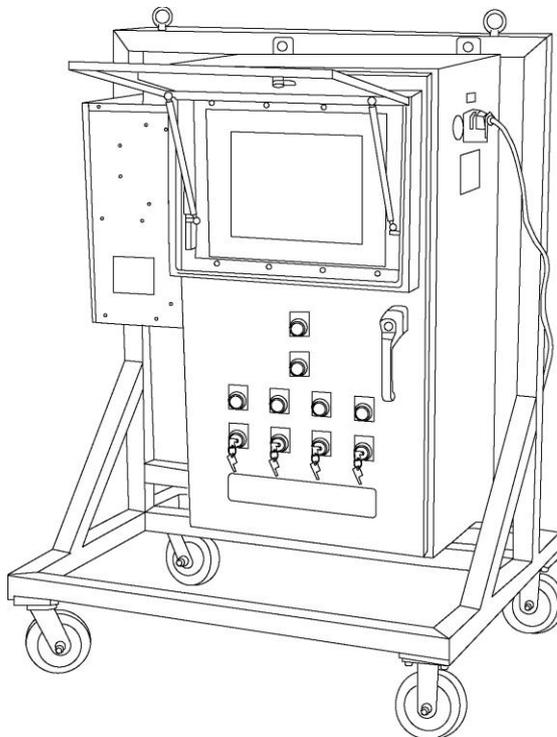


Figure 35. Raman Rxn4 enclosure and trolley option

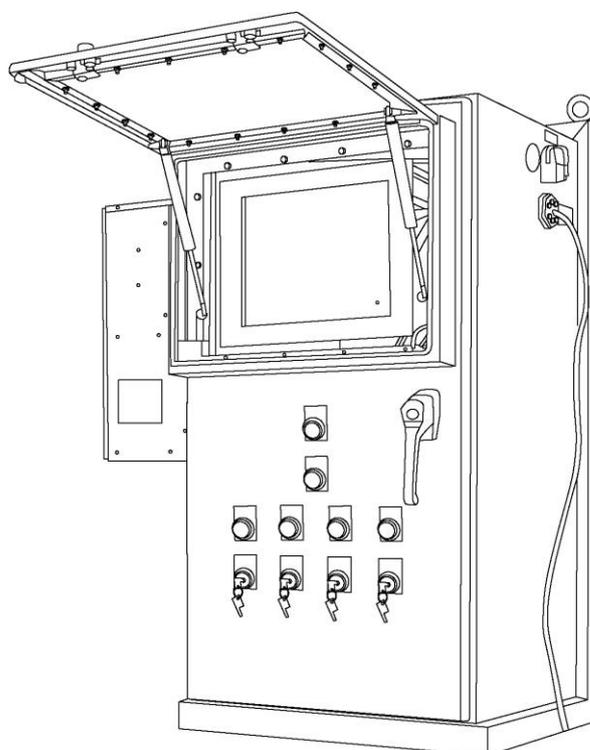


Figure 36. Raman Rxn4 enclosure and stand option

### 7.3.6 Air filter

The Raman Rxn4 incorporates a tacked polyester spun air filter element to reduce dust intake into the base unit. The air filter is accessed by a magnetically secured access panel on the front of the instrument. The air filter should be cleaned with compressed air once every month or if the embedded software is reporting an internal over-temperature error (if ambient temperature is within specification). In extremely dusty conditions, the air filter should be cleaned more often. The air filter has a blue tacky side which should be oriented toward the outside of the base unit.

If a replacement air filter is needed, please contact Endress+Hauser at [support.kosi@endress.com](mailto:support.kosi@endress.com) for further assistance.

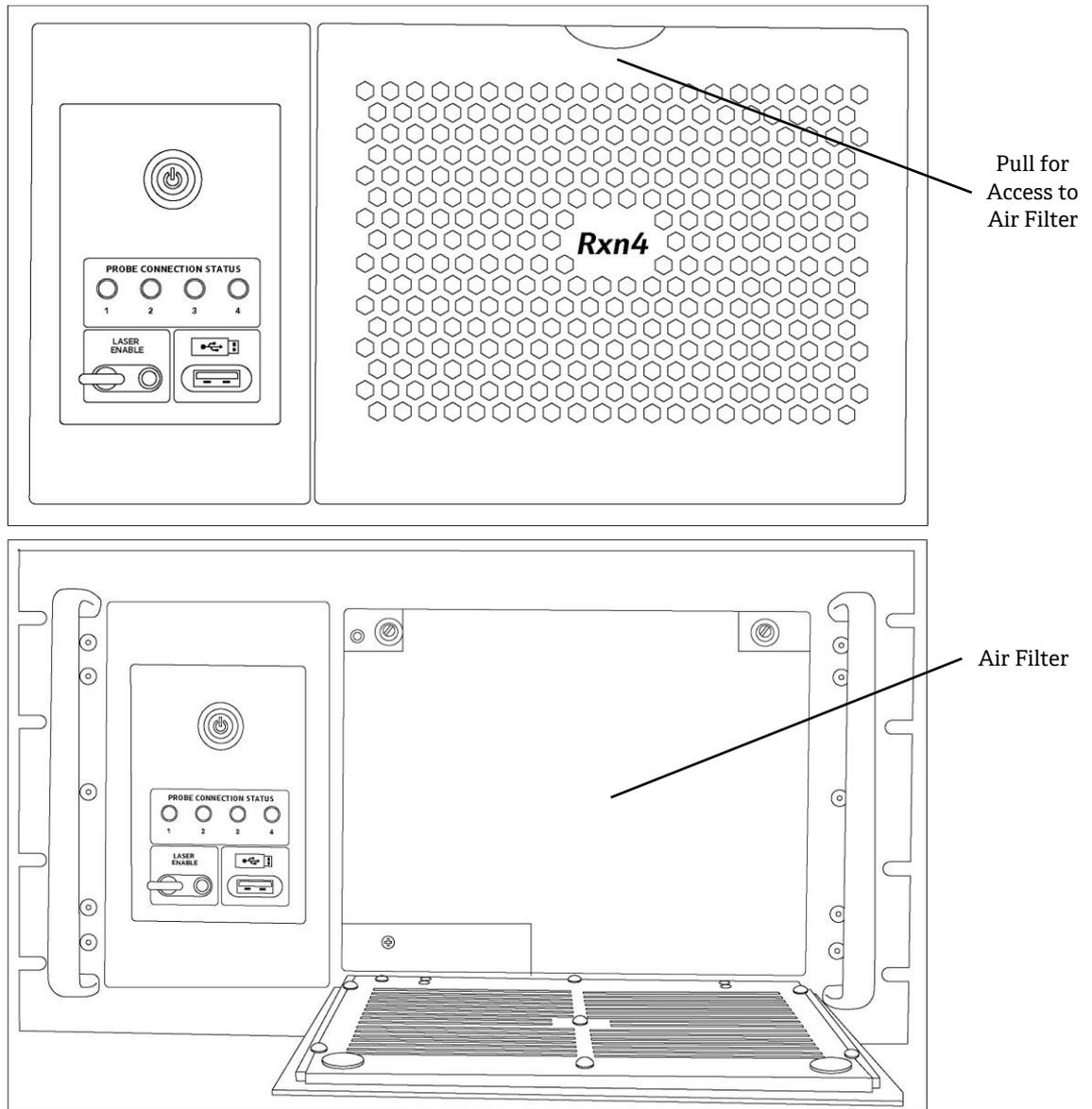


Figure 37. Filter access

## 8 Operation

### 8.1 Raman RunTime embedded software

Raman RunTime is the embedded control software installed on all the Raman Rxn4 analyzers. It is intended for easy integration with standard multivariate analysis and automation platforms to enable a real-time, *in situ* process monitoring and control solution. Raman RunTime presents an OPC and Modbus interface which provides clients with analyzer data as well as analyzer control functions.

Depending on the instrument configuration being used, the main view of Raman RunTime displays four “quadrants” or windows (one for each of the four probes for the four channel analyzer), two windows (one for each of the two probes of the Hybrid analyzer), or one window (for the single probe used in the single channel analyzer). The main view of Raman RunTime also displays a status bar (bottom) for a quick view of warnings and acquisition status. Details are accessed and edited from each corresponding quadrant.



Figure 38. Raman RunTime main screen for a Raman Rxn4 four channel analyzer

To switch back and forth between the main view and detail views, simply click the **Title Bar** for each probe/window as applicable. Views of current spectrum vs. process values (model results) can also be easily swapped with a click on the display windows. Additional features, such as system settings, calibration and diagnostics, are found under the Options section. Raman RunTime is also used as the interface between the Raman Rxn4 analyzer and third-party PAT software suites such as synTQ and SiPAT.

#### NOTICE

- ▶ This section provides details on configuring and using the Raman Rxn4 with Raman RunTime, but it is not intended to replace the full *Raman RunTime Software Manual (p/n 4004889)* or analyzer installation and training from Endress+Hauser representatives.

### 8.2 Calibrations

Raman Rxn4 analyzers have internal calibration standards for spectrograph and laser wavelength. This section assumes the instrument is being setup for the first time and utilizes the Recalibrate All option, which is only required at initial start-up or when the instrument is moved or serviced.

There are several internal calibration options to choose from:

- **Automatic.** If the instrument is already calibrated, this will compare the current analyzer response to calibration specifications and will recalibrate if the spectrograph wavelength and/or laser wavelength is out of spec. If the analyzer is uncalibrated, this will perform an alignment calibration, followed by a full wavelength calibration and full laser wavelength calibration.
- **Recalibrate X Axis.** Forces full wavelength and laser calibrations without first checking whether the analyzer is within spec.
- **Recalibrate All.** This will cause the alignment calibration to be repeated prior to performing full spectrograph wavelength and laser wavelength calibrations. Note that when "Recalibrate All" completes, the intensity calibrations and verifications of all probes will be invalidated.

Steps for Internal Calibration:

1. Ensure all probes are capped.
2. Click **Calibrate** under Internal Calibration.

For initial startup, click **Recalibrate All** from the Calibration Mode drop-down list and click **Calibrate**.

**NOTICE**

- ▶ The **Recalibrate All** option is only required at initial start-up or when the analyzer is moved or serviced.



Figure 39. Recalibrate all

For subsequent calibrations, select **Automatic**.

3. Select **Calibrate Periodically** and set the frequency.
  - Setting is configurable in one-hour increments.
  - At least once per day (1d 00h) is recommended.

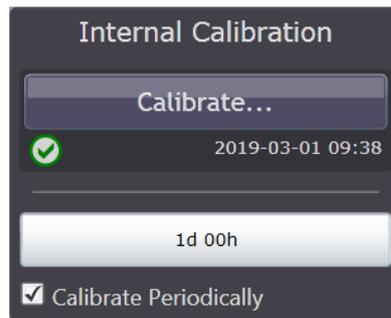


Figure 40. Periodic calibration setting

### 8.2.1 Probe calibration – single channel, four channel, or Hybrid analyzers

A Calibration Accessory (HCA) with an appropriate optic adapter is required for probe calibration of single channel, four channel, and Hybrid (ALT channel only) Raman Rxn4 analyzers. For the Raman optic system for single use, a single use calibration adapter is also needed. Ensure the HCA calibration has been calibrated within 1 year and has an accompanying Intensity Reference source spectral file (\*.spc).

Probe calibrations can be executed during active experiments, e.g. if a probe needs to be set up while another probe is active. When a probe calibration is triggered, any acquisitions currently in progress will be aborted automatically, and the calibration will proceed. Upon completion of the calibration, active probes will automatically resume normal operation.

Steps for probe calibration:

1. Connect the HCA to the first (or only) probe. Use the set screw to hold the probe in place.

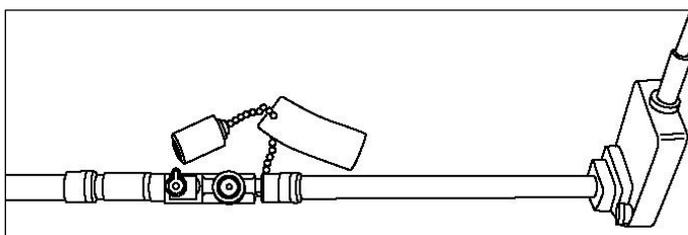


Figure 41. Example of the Rxn-10 probe with a bIO-Optic connected to the HCA

2. Turn on the HCA and set the switch to Intensity. The intensity indicator on the HCA will blink until the bulb warm up time is complete (15 minutes). Do not proceed until indicator stops blinking.
3. For Rxn-10 probes, be sure the laser shutter is set to **ON** (indicator parallel to probe body).
4. Loading the HCA Intensity Reference spectral file (\*.spc):
  - Attach the USB memory stick that came with the HCA kit to the USB Extension or USB port on the front the analyzer. This is only required for new device setup or when the HCA is serviced or changed.
  - For single channel or Hybrid (ALT channel) analyzers, click **Load** on the Probe Calibration section of the screen to browse to the correct Intensity Reference spectral file (\*.spc) located on the memory stick. Click **Select File**.
  - For a four channel analyzer, click **Calibrate** for the targeted probe, which will result in a pop-up window that lets the user load the Intensity Reference spectral file as above.

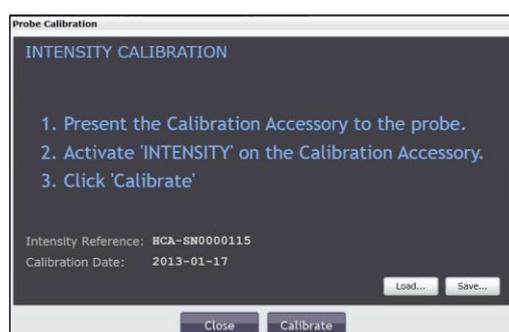


Figure 42. Intensity calibration window in Raman RunTime and memory stick provided with the HCA

5. Click **Calibrate** to start the calibration process on the selected probe:
  - **Four Channel Raman Rxn4 System.** Make sure the **Blue** indicator is active on the probe intended for calibration – cancel and recalibrate if needed. A countdown timer will start.



Figure 43. Four channel calibration

- **Single Channel Raman Rxn4 System.** There is no **Blue** indicator and instead only a countdown timer will start, indicating probe calibration has begun.

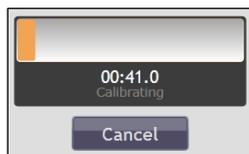


Figure 44. Single channel calibration

- **Hybrid Raman Rxn4 System.** Make sure the **Blue** indicator is on the ALT probe. Cancel and recalibrate if needed. A countdown timer will start.



Figure 45. Hybrid calibration

6. Repeat the probe calibration for each active probe (if applicable).

#### NOTICE

- ▶ For analyzers with any unused channels/probes, the warning indicator will turn **Yellow** indicating there are uncalibrated channels. To resolve this erroneous warning, turn off unused probes/channels.

### 8.2.2 Probe calibration – Hybrid (Rxn-20 channel) analyzers

For the Rxn-20 channel on a Raman Rxn4 Hybrid analyzer, follow the steps below:

1. Connect the appropriate optic (3mm, 6mm) to the Rxn-20 probe.
2. Connect the appropriate extension tube to the optic. The 3mm optic uses the 3.0” long extension tube, while the 6mm optic uses the 8.0” long extension tube.
3. Connect the HCA lamp head to the extension tube. Use the thumb screw to hold the HCA lamp head in place.

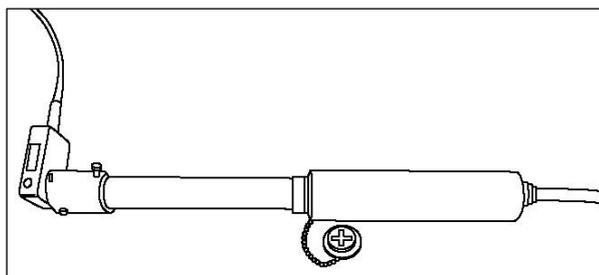


Figure 46. HCA lamp head and extension tube attached to Rxn-20 non-contact optic and probe

4. After powering on the HCA, set the switch to Intensity. Let the white light bulb warm up for approximately 15 minutes.

#### CAUTION

- ▶ For HCAs delivered after approximately 01-Nov-2017, the HCA intensity indicator light will blink until the halogen bulb warm-up period is complete. Wait to proceed with probe calibration until the light stops blinking.
5. Loading the HCA Intensity Reference spectral file (\*.spc):
    - Attach the USB memory stick that came with the HCA kit to the USB port on the front the analyzer. This is only required for new device setup or when the HCA is serviced or changed.
    - On the probe calibration section of the screen, click **Load** to browse to the correct Intensity Reference spectral file (\*.spc) located on the memory stick. Click **Select File**.



Figure 47. Calibration window for a Raman Rxn Hybrid analyzer

#### 6. Click **Calibrate**.

Make sure the **Blue** indicator is on the Rxn-20 probe. Cancel and recalibrate if needed. A countdown timer will start.

#### NOTICE

- ▶ For analyzers with any unused channels/probes, the warning indicator will turn **Yellow** indicating there are uncalibrated channels. To resolve this erroneous warning, turn off unused probes/channels.

### 8.2.3 Probe verification

For any Raman Rxn4 analyzers (single channel, four channel, or Hybrid), probe verification will verify the calibration results using a standard reference sample, such as 70% IPA or cyclohexane. This step is not required to collect a Raman spectrum, but it is highly recommended.

#### CAUTION

- ▶ Do not use cyclohexane for verification with any bIO-Optic, RXN-45 and single-use adapters. Bioprocessing probes such as bIO-Optic, RXN-45 and single-use adapters, should **ONLY** use 70% IPA. Only 70 percent by volume (%v/v) will work. Endress+Hauser recommends using CiDehol 70 by Decon Laboratories. All other probes can use cyclohexane.

For bioprocess probes, use a bIO Sample Chamber for verification:

1. Connect the bIO sample chamber at the white Teflon end to the first probe and fill it about half-way with 70% IPA.
2. While holding the attached sample chamber for support (to keep it upright), tilt the probe/optic to a 15-30° angle and tap the sample chamber to ensure any bubbles in the 70% IPA rise to the top.

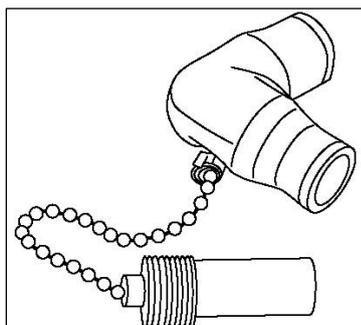


Figure 48. Sample chamber

3. Click **Verify** under the Probe Calibration section and select 70% IPA as the verification standard.
4. Repeat the probe verification for each active probe.

For all other (non-bioprocess) probes use a sample container appropriate for the probe connection:

1. Click **Verify** under the Probe Calibration section and select cyclohexane or 70% IPA as the verification standard.
2. Repeat the probe verification for each active probe.

How to interact with the probe verification results:

1. Access the **Spectrum Viewer** button to display the current verification spectra and allow for addition of previous spectra.
2. Click **Spectrum Viewer** to view the current verification spectrum.

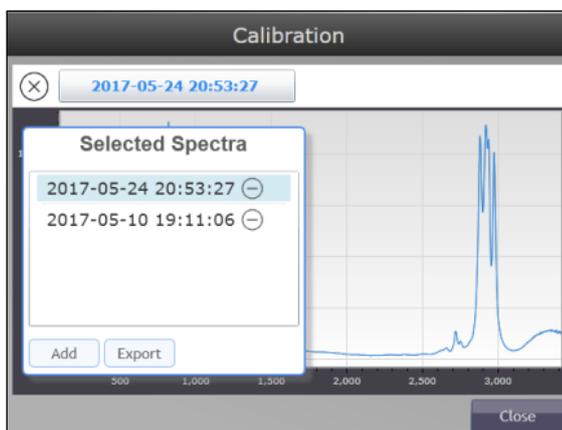


Figure 49. Probe verification spectrum viewer

3. Click the spectrum's name at the top of the window (click the **Date** and **Time** of the spectrum which appears in **Blue**). Click **Add** to include previous spectra on the plot.
4. Spectra can also be exported as \*.spc files (to a USB memory stick) from this view.
5. Additionally, the symbols under the **Calibrate** and **Verify** buttons can be clicked for details about the recent calibration/verification.

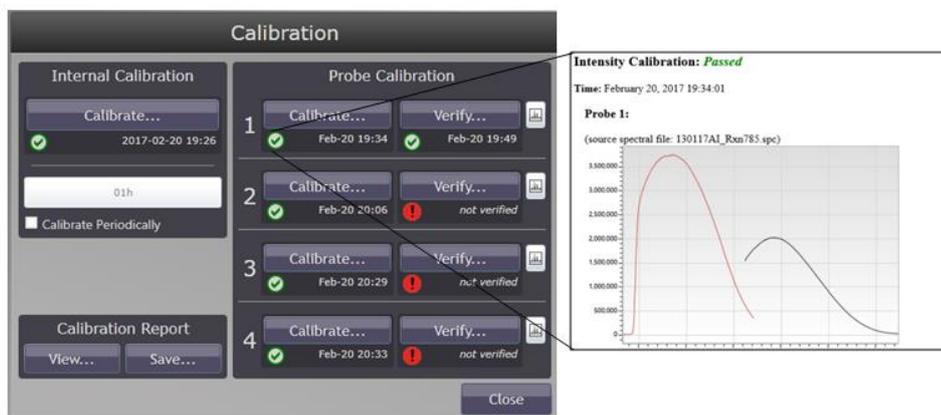
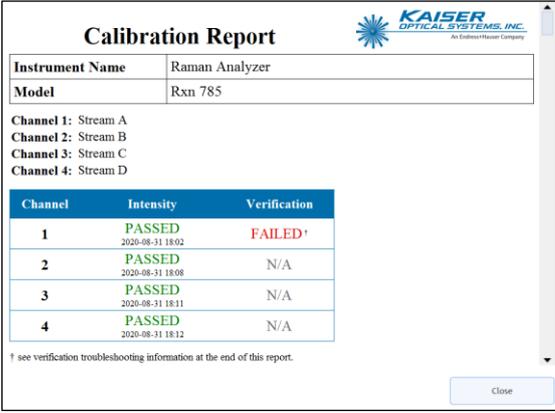


Figure 50. Probe calibration details

6. Click **Export** to save the verification spectrum to an external USB memory stick that can be inserted in auxiliary USB ports on the front and rear of the device. A network connected drive can also be used for \*.spc file export.

## 8.2.4 Calibration and verification reports

1. On the lower left of the screen under **Calibration Report**, click **View** to see the calibration and verification report. A summary of the internal calibration report appears at the top of the screen.



Calibration Report		
Instrument Name	Raman Analyzer	
Model	Rxn 785	
Channel 1:	Stream A	
Channel 2:	Stream B	
Channel 3:	Stream C	
Channel 4:	Stream D	
Channel	Intensity	Verification
1	PASSED 2020-08-31 18:02	FAILED*
2	PASSED 2020-08-31 18:08	N/A
3	PASSED 2020-08-31 18:11	N/A
4	PASSED 2020-08-31 18:12	N/A

\* see verification troubleshooting information at the end of this report.

Figure 51. Calibration and verification report

2. The full calibration and verification report can be viewed on screen by clicking the **Black Arrow** above the **Close** button to scroll down.
3. Click **Close** at the bottom of the report window to exit.
4. Click **Save** to save the full calibration and verification report locally as a \*.pdf file (to a USB memory stick). The calibration report can also be accessed remotely via network Raman RunTime connection or via OPC.

## 8.3 Data collection

There are several collection modalities available in Raman RunTime including Manual, Continuous, Periodic, Focus, and Snapshot.

Exposure Length and Count (sometimes referred to as accumulations) need to be specified for each collection option, except Focus. Focus may be used to determine exposure length.

- **Exposure Length.** How long the laser will be exposed to the sample.
- **Count.** The number of times the exposure will be repeated for a single spectrum.

The goal of determining an appropriate length and count combination is to maximize the signal-to-noise ratio within the time allotted for sampling without overexposing the detector.

- Ideal detector saturation is between 40% – 70%.
- Avoid detector saturation below 10% and above 80%.

### 8.3.1 Notes about data collection with Raman RunTime

- Batch settings for Collection Mode and Exposure Settings are remembered. This makes it very easy to start a new batch that is like the previous.
- It is not necessary to use the same collection mode for each probe. Collection mode differences and how they affect sampling sequence are further described in corresponding sections below.
- Active batches can be paused or stopped at any time using the corresponding buttons.
  - Pausing a batch can be used to not disturb the sample/spectrum while interrupting the experiment, such as exposing a reactor to room light or extracting a sample.
  - It is best to pause at the start of a new sample since the current spectrum/sample will terminate.
  - When collection is paused or stopped, Raman RunTime will automatically proceed to the next probe in sequence (or wait until the next periodic acquisition for another probe). Stopping acquisition of a Raman RunTime batch means the same experiment cannot be restarted – new spectra will need to be stored under a new “batch” name and collection of spectra. If there is a chance the user might need to return to the experiment, be sure to pause rather than stop the acquisition process.
- Exposure settings can also be changed during an active experiment. It is not necessary to pause to change exposure settings. New settings will take effect on the next sample acquisition.

### 8.3.2 Dark exposures

Dark exposures are used to reduce noise in spectra by accounting for the noise arising from the detector. For example, 532 nm and 785 nm detectors naturally have low noise, so dark exposure requirements for these systems are minimal and mostly automatic. However, 993 nm detectors have intrinsically high noise levels and require extra dark exposure attention.

Dark handling for Raman Rxn4 532 nm and 785 nm analyzers:

- There is only one user initiated dark setting for 532 nm and 785 nm systems, located by clicking **Advanced** under **Exposure Settings**.



Figure 52. Exposure settings

- Leave the **Force New Dark** check box deselected which should be the default setting for 532 nm and 785 nm systems.

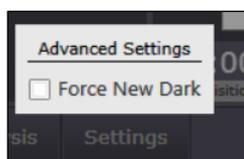


Figure 53. Force new dark

Selecting the **Force New Dark** check box will collect and apply a new dark every time a spectrum is collected. Therefore, this is not recommended for most applications since it will double the collection interval time.

- Dark exposures are automatically collected at the beginning of acquisition whenever an Exposure or Count setting has been changed.
  - There is an exception if a dark exposure has already been collected and stored for the same Length and Count setting, e.g. for another probe or during a previous experiment. Then the system will use the stored dark.
  - To expire an old dark and force a new one at any length and count interval, select the **Force New Dark** check box for at least one interval, then turn it off.
- If a dark exposure is needed when acquiring in continuous or periodic mode, one will be collected at the start of the first acquisition and used for all subsequent spectra.
  - This will cause the first spectral collection interval to take double the time of subsequent intervals.
  - The status indicator specifies when a dark exposure is active and how long is remaining.



Figure 54. Dark exposure

#### NOTICE

- It is best to collect a dark after the system has stabilized for about 2 hours after start up. To collect a dark to be stored and used repeatedly, such as for routine exposure settings, allow the analyzer and laser to remain on for 2 hours prior to dark collection if the laser has been turned off. If the analyzer has been relocated, then it should stabilize for at least one day with the laser on before collecting a new dark. Note that this is not applicable to moving short distances on a Raman Rxn4 cart.

Dark handling for Raman Rxn4-993 nm single channel and four channel analyzers:

- On 993 nm systems, dark exposures are collected automatically at the end of every acquisition.
- The number of dark exposures collected at the end of each acquisition is determined by the Dark Exposures setting under the **Advanced** button.

- Typically, dark subtraction is effective at mitigating the non-sample contributions in the measurement due to "dark current" when the Dark Exposures setting is approximately one half the count setting.
- In processing the final spectrum, the "trailing" dark exposures taken after the sample is measured are combined with "leading" dark exposures taken before the sample is measured.
- Typically, the trailing dark exposures from one acquisition are used as the leading dark exposures for the next acquisition. This significantly reduces the time needed to collect the requisite number of dark exposures for a given acquisition.
- Alternatively, new leading dark exposures are collected at the beginning of every acquisition if any of the following conditions are met:
  - The length setting has changed since the most recent dark collection.
  - The most recent dark collection completed more than 10 minutes prior.
  - The Force New Dark option is selected under the **Advanced** button.
- Due to the conditional nature of leading dark collection, there is the potential for inconsistent acquisition times, especially on the first acquisition after starting a new experiment or rebooting the instrument, or generally when using periodic or manual collection. Selecting the Force New Dark option can be used to achieve consistent acquisition times, when doing so is more beneficial than minimizing acquisition time.

### 8.3.3 Focus mode

Focus mode is used to position probes (typically non-contact optics) and/or determine appropriate collection settings for a given sample or process. No spectra are saved from Focus mode – focus spectra are for visual evaluation only.

#### NOTICE

- ▶ For the Rxn-20 probe with the Raman Rxn Hybrid analyzer, be sure to use the appropriate extension tube for the Rxn-20 optic to help in locating the sample to the focal plane.

1. Position probe to sample and click **Focus** under the probe details view.

A Suggested Exposure will be displayed. The example below shows 1.7s – 3.0s for a sample of 70% IPA.

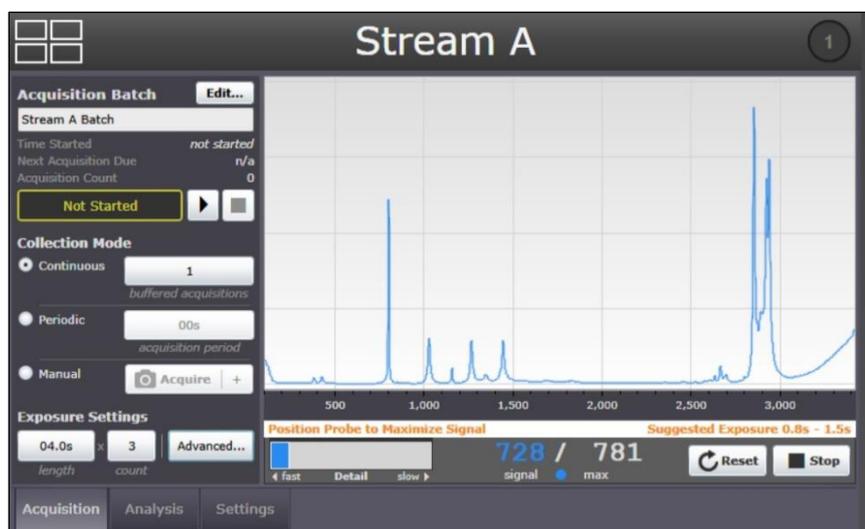


Figure 55. Focus mode example

2. Move the **Detail** bar to the "slow" position to increase the focus time as needed. Samples yielding weaker signal features may not be obvious with the "fast" focus setting.

The current signal vs. max signal is displayed so that the current probe/sample positioning can be compared to the max observed signal. The current signal will change with repositioning of the probe/sample.

3. Reposition the probe or sample to achieve the best focus/signal-to-noise.
4. Click **Reset** to reset the remembered max signal.
5. Click **Stop** to exit focus mode.

### 8.3.4 Snapshot mode

Snapshot mode is similar to Focus, in that no spectra are saved. Snapshot is intended for quick acquisitions to measure laser power, try out different length and count settings for a sample, or more commonly to quickly assess spectral quality either visually or by applying a model.

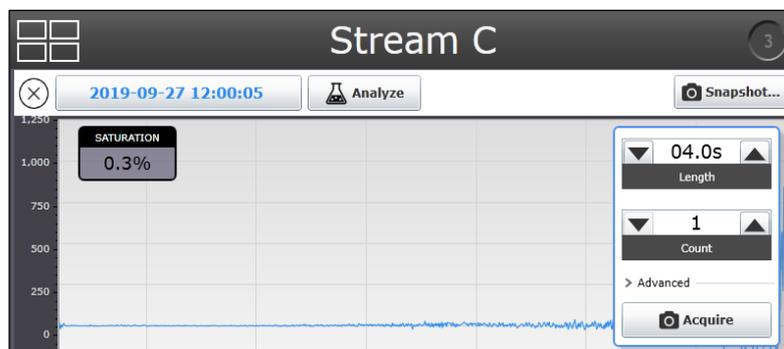


Figure 56. Snapshot mode and options

- To access Snapshot mode, click anywhere within the spectral plot from one of the probe detail views. The spectra overlay plot/Snapshot view will appear.
- Select an exposure length and count, then click **Acquire**:
  - The snapshot spectrum will be overlaid with the most recent spectrum if an experiment is already in progress, such as shown below.
  - It will not be stored with the current batch data; a snapshot spectrum is for onscreen tests only.
- Spectra from previous batches/experiments can be overlaid with the snapshot spectrum by clicking the spectrum name (the Blue date and time appearing in the top right header). Then click **Add** and browse to select the reference spectra:
  - Multiple spectra can be added to the overlay, but only a single spectrum is distinguished as the "principal" spectrum by displaying it in **Blue** and listing its name in the header.
  - When a new snapshot is collected, it automatically becomes principal, so is shown in blue. The spectrum is principal and can be changed by selecting/highlighting it in the spectrum list.
  - This list is viewable by clicking **Primary File Name** (located at the top, to the left of **Analyze** button) to display the Selected Spectra drop-down list.
- Additionally, a model can be applied by clicking **Analyze** and selecting a model. Ad hoc analysis only applies to the principal spectrum.

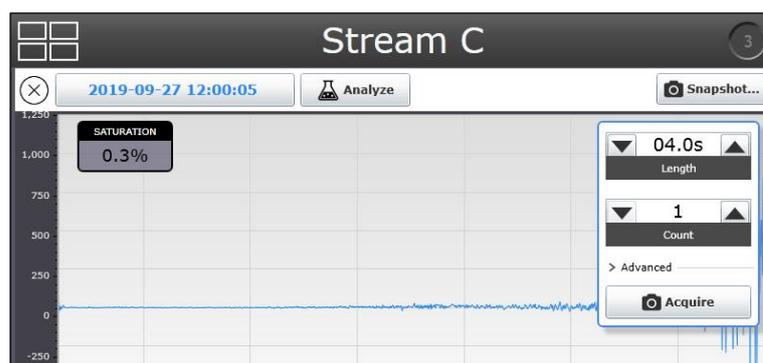


Figure 57. Analyze function in snapshot mode

It is recommended to use Snapshot mode for *in situ* verification of starting materials, especially for long experiments like bioprocesses. Using this method, verification spectra can be collected quickly without needing to adjust batch exposure settings. To exit the spectra overlay view, click anywhere on the quadrant name or click **Exit** in the upper left of the display window.



Figure 58. Exit button to exit the spectra overlay

### 8.3.5 Manual mode

Use the Manual collection mode to acquire spectra that are triggered manually by clicking **Acquire**. A batch/experiment name can be specified to group manual samples together for spectra storage and sample names can be specified for each spectrum.

1. First create a new name by clicking **Edit > New** from the Probe Detail view – the example screen shown at right shows the manual batch name as “Off-line Samples.”

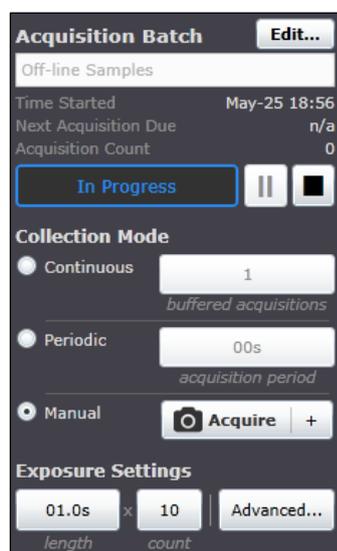


Figure 59. Manual collect mode options

2. Set the Collection mode to **Manual**.
3. Click **Play**. The Acquisition Batch will show “In Progress” but no spectra will be collected yet until triggered (by clicking **Acquire** in a later step below).
4. Use the **Up** or **Down** arrows to adjust Exposure Settings set the Exposure Settings, both length and manual collect mode options count.



Figure 60. Exposure settings as described with length and count boxes

5. If a custom sample name is desired, click the **+** option next to **Acquire** to enter a sample name, such as the Sample 1 example shown here:

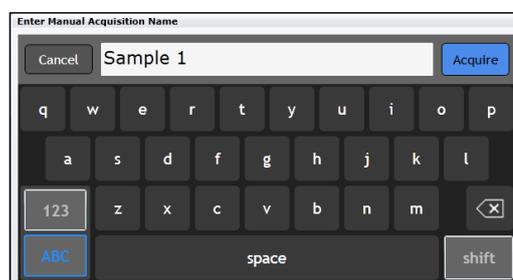


Figure 61. Keyboard that pops up to rename the sample

6. Click **Acquire** to collect a spectrum.
  - To collect another spectrum, specify a new sample name (if desired), change Exposure Settings as needed, then click **Acquire** again.
  - Or click the **Stop** symbol to end the sequence of manual samples stored together.

### 8.3.6 Continuous mode

- Continuous collection mode cycles through each active probe as quickly as possible. It is recommended for method development when collecting frequent reference samples, and for monitoring and control when models are active.
  - Continuous mode includes a buffered acquisition option.
  - Buffered acquisition provides a way to receive updated spectra and model values more frequently, without sacrificing accuracy or repeatability.
  - The buffered acquisitions setting specifies the number of consecutive acquisition cycles to combine in each reported spectrum by adding together the individual acquisition spectra.
  - The spectrum and model values are updated at the end of each acquisition cycle.
  - Only the combined spectrum is reported, the individual acquisition spectra are not.
  - Active models operate on the combined spectrum, not on the individual acquisitions.
  - Setting buffered acquisitions to a value of 1 (the default) effectively disables the feature, resulting in conventional acquisition in which each spectrum is independent of previous spectra.
  - To configure buffered acquisition that achieves the same total target collection time as non-buffered acquisition, reduce the count setting and increase the buffered acquisitions setting, keeping their product the same. For example:
    - If exposure settings of 10s x 60 with 1 buffered acquisition are used, spectra and process values will update only at the end of the full spectrum collection cycle, approximately every 10 minutes.
    - But if settings of 10s x 6 with 10 buffered acquisitions are used, then spectra and process values will update approximately every 1 minute.
    - Each reported spectrum will still include 10 minutes of total acquisition time, because each update adds together the ten most recent acquisitions of 10s x 6.
  - For applications requiring long collection intervals, buffered acquisition is not recommended when more than one probe is active.
    - As collection alternates among multiple probes, combining consecutive acquisitions on a given probe runs the risk of including outdated process spectra if other active probes have long intervals.
1. To set up a continuous batch, first create a batch under **Edit > New** and specify a new batch name.
  2. Set the collection mode to **Continuous**.
  3. Set the exposure and buffer settings desired.

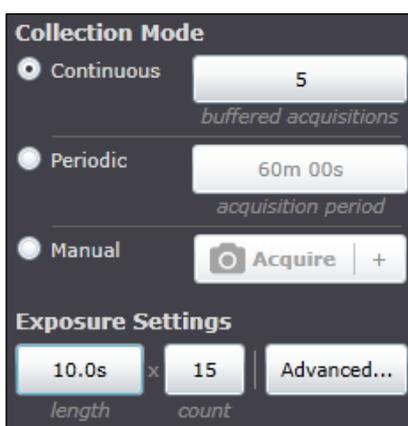


Figure 62. Collection mode details for continuous mode

4. Repeat for all active probes and click **Play** in the desired probe sequence.
  - Pausing, stopping, adding new batches, rebooting, etc. could affect the probe sampling sequence in continuous mode. If cycle order matters, periodic mode is recommended.

### 8.3.7 Periodic mode

Periodic collection mode acquires spectra at specified intervals and is typically used during method development to allow spectra to sync with samples being drawn from reactors or other timed process events. Buffered acquisitions are not an option in periodic mode.

- In the example shown here, periodic acquisition is scheduled for 60 min.
  - The batch details show when the next acquisition is due and how many counts (spectra) have been collected for the current batch.
  - If spectral acquisition is active in periodic mode, the Next Acquisition Due will read “now.”
1. To set up a periodic batch, first create a batch under **Edit > New** and specify a new name.
  2. Set the collection mode to **Periodic**.

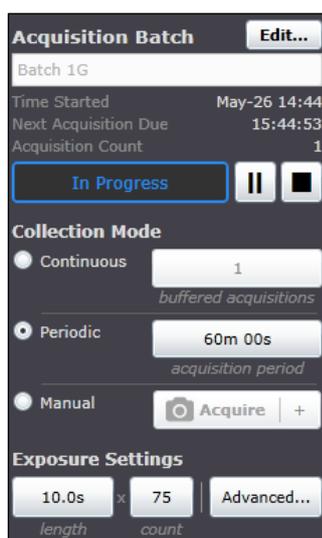


Figure 63. Periodic mode batch details

3. Set the exposure settings and acquisition period.
4. Repeat for all active probes and click **Play** in the desired probe cycle order (1, 2, 3, 4 or 1, 3, 2, 4, etc.).

## 8.4 Using models

Raman RunTime supports executing models generated in PLS Model GRAMS IQ™ ([Thermo Fisher Scientific](#)), PEAXACT ([S-Pact](#)), Unscrambler (Camo Analytics, An Aspen Technologies Company) and SIMCA® ([Sartorius](#)). These multivariate models are based on in-line Raman spectra correlated to off-line analytical measurements and can be used to turn raw spectra into meaningful process values in real time. Model results can be viewed on-screen as well as communicated via OPC and Modbus.

Raman RunTime supports the following model file versions:

- SIMCA version 13, 14, 15, and 16
- GRAMS IQ versions 9.3 and previous
- PEAXACT version 4 , 5, and 5.4
- Unscrambler v11
- PLS\_Toolbox
- Solo version 8.9

### 8.4.1 Recommendation for model and process value names in Raman RunTime

- Model titles and Y variable names (“Process Values” in Raman RunTime) should be changed in the final models to reflect the desired display names and OPC tags.
- It is wise to include units (g/L, mM, etc.) in the Process Variable name, since model outputs/Raman RunTime do not automatically display units.
- For OPC communication it is very important use a consistent naming scheme, because each time a Model Title or Assay name is changed, the OPC tags will change accordingly (and need to be reconfigured for OPC communication).
- The DATA LIBRARY can be used to ensure consistent Process Value naming. Contact Endress+Hauser at [support.kosi@endress.com](mailto:support.kosi@endress.com) for more information on DATA LIBRARY.
- Avoid using periods and commas in Model Titles and Assay names.
- Special characters (e.g. &, %) work with some OPC configurations, but should always be tested and removed from Model/Process Value names as needed.
- There can be multiple models per Process Value type. This allows for easy prediction comparisons during model development/validation phases, and the use of multiple Process Value models per batch, for example Gluc M1, Gluc M2 or VCD Day 1-6, VCD Day 7-14.

### 8.4.2 Loading models

1. Save the desired project files from the modeling package to a USB memory stick and connect it to the USB port on the front of the Raman Rxn4. Alternately, models can be loaded from a network connected folder.
2. Select **Options > System > Analysis > Add Model** and browse to the appropriate model file. Repeat for additional files.
3. The file name(s) will appear in the Analysis window. Select a file name to turn model components and properties on/off. Repeat for additional files.
4. Return to the main view and go to the details section for one probe.
5. Press the **Analysis** tab in the lower left and enable the model file(s) on or off. Repeat for additional probes.

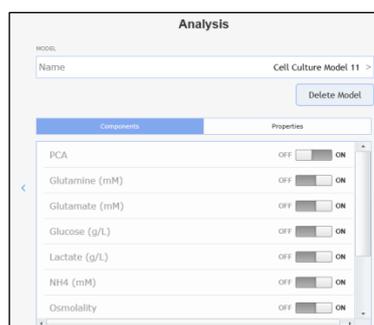


Figure 64. Analysis screen to select models

### 8.4.3 Viewing model results

- From the main view during active experiments, process values will automatically be displayed instead of the current spectra.



Figure 65. View of spectrum for probe 1

- To view the most recent spectrum instead of process values from the main view, click the quadrant display.
  - For Hybrid analyzers, the current spectrum and process values are both automatically displayed, there is no need to click the window to change views.
  - For single channel analyzers, there is no quadrant view. Process values will be displayed under the Analysis tab.
  - Model results will update each time a new spectrum is complete, or after each buffer cycle in continuous mode.
  - If models are not active for a probe/batch, then “No Analysis” will appear when the spectral plot is clicked.



Figure 66. Results for an Rxn4 four channel analyzer with models active for probe 1 and probe 4

To access additional model result information (which is the only way to view model results for single channel analyzers):

1. From a probe details view, click the **Analysis** tab.
2. Use the **Expand** and **Collapse** buttons to show more or less model details.

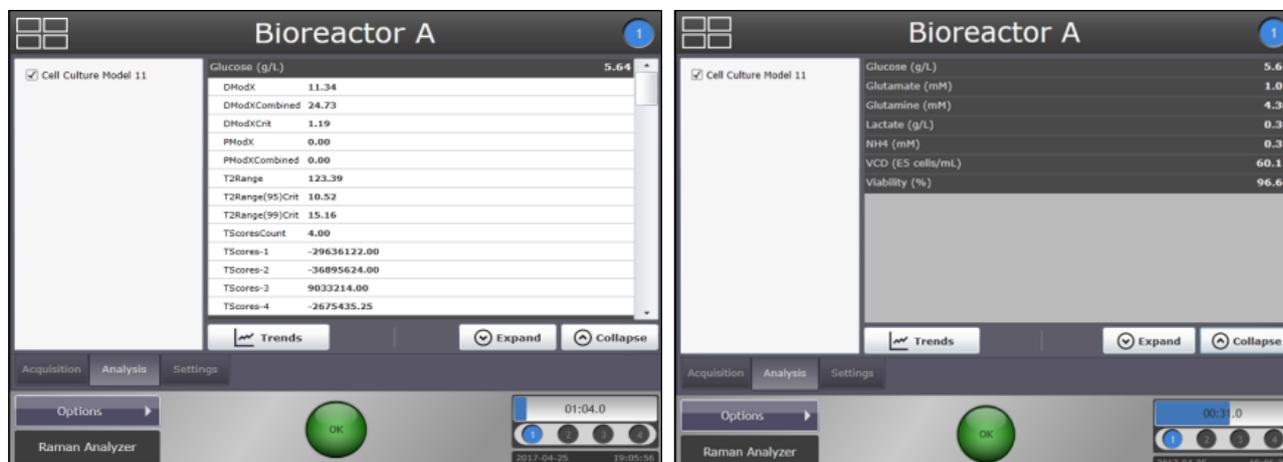


Figure 67. Probe details view of model process values and properties

3. Click **Trends** to enter the trend viewer.
4. Select a **Principal Trend** and, if desired, a **Comparison Trend**.

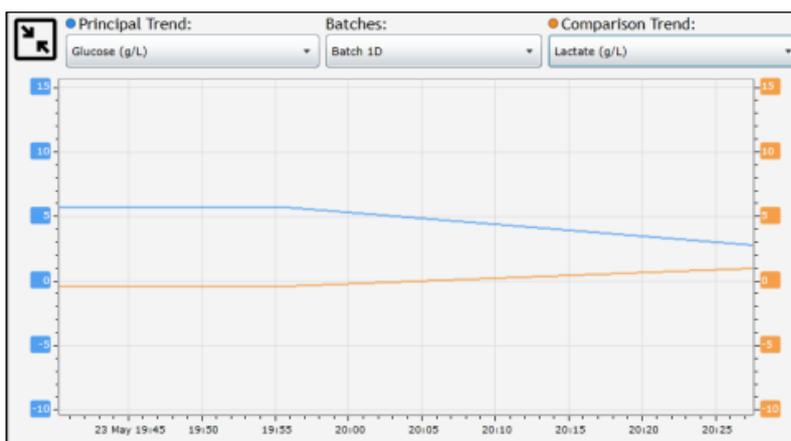


Figure 68. Model results in the trend view

#### 8.4.4 Saving model results

Stored model results are included in exported batch data and are also available via OPC if Client connections are established.

## 8.5 Data transfer

Raman RunTime offers two ways to transfer or export spectral batch data in \*.spc format. One method is manually and locally exporting on to a USB memory stick. The second is automatically (once configured) exporting \*.spc files over the local network.

### 8.5.1 Batch data export

Spectra (\*.spc format) and model results (\*.csv format) for collected batches can be exported locally from the Raman Rxn4 onto a USB Memory Stick.

1. Connect a USB memory stick to the USB port on the front of the Raman Rxn4.
2. From the probe detail view, click **Edit**, check the batches to export, then click **Copy**.
3. Browse to the USB memory stick and desired folder, and click **Select Folder**.

#### NOTICE

- ▶ Two \*.csv files (processvalues.csv and allproperties.csv) containing model results will also be included in the export, ONLY if models were active and predicting during collection.

#### 8.5.1.1 SPC file network export

If the Raman Rxn4 is connected to a network, Spectrum (SPC) files are automatically published in network-accessible folders. A common file share is available on the Raman Rxn4 at \\<computer-name>\DataLibraryBatchExport. This directory contains distinct subfolders corresponding to each acquisition batch:

1. Batch folder names are of the form *Probe <#>\_<batch>\_<YYYYmmdd-HHmms>*, where <#> is the instrument collection channel, <batch> is a user-specified batch name, and <YYYYmmdd-HHmms> encodes the date and time the batch was started.
2. Spectrum file names are of the form *<batch>\_<YYYYmmdd-HHmms>*, which encodes the time the individual acquisition completed.

### 8.5.2 Remote access

Remote Access permits the Raman RunTime user interface to be accessed using a desktop web browser from a remote workstation that meets the following requirements:

- A web browser running the Silverlight 5 plug-in. [Internet Explorer](#) 11 is recommended.
- Network connectivity between the instrument and the remote workstation.

To access the Raman RunTime user interface remotely:

Navigate to *http://<IPaddress>:3593/SolutionControl/BIO/RuntimeView.html* or *http://<computer-name>:3593//SolutionControl/BIO/RuntimeView.html* or in a qualifying web browser to use Remote Access. The IP Address and Computer Name can be viewed under **Options > System > Network**.

### 8.5.3 Status indicator

The circular **Status** button in the center of the main screen has three modes: **Green**, **Yellow**, and **Red**. When the status indicator is **Green** with an OK in the center, it means there are no detectable problems.



Figure 69. Green OK status indicator

When the status indicator turns **Yellow** with a flashing warning in the center, it means there is a caution. Click the **Yellow** status indicator for an explanation for the warning.

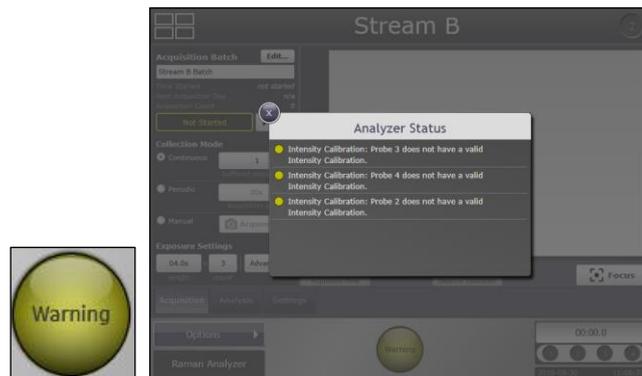


Figure 70. Explanation for why system has issued a yellow warning

**NOTICE**

- ▶ For analyzers with any unused channels/probes, the warning indicator will turn Yellow indicating there are uncalibrated channels. To resolve this erroneous warning, unused channels can be turned off.

When the status indicator turns **Red** with an Error in the center, it signifies a more serious problem that needs immediate attention. Click the **Red** status indicator for an explanation of the error. The error message will disappear automatically once the problem is resolved.

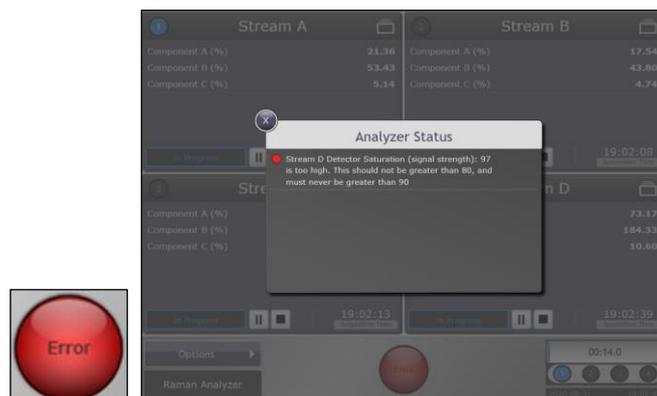


Figure 71. Explanation for why system has issued a red error

## 8.6 Automatic connection

Raman RunTime provides network-connected clients with analyzer data as well as analyzer control functions. OPC UA is the recommended protocol because it allows transfer of large data (full spectral data and diagnostics in this case) and is a more reliable connection than OPC Classic. However, legacy support for OPC Classic (DCOM, also called OPC DA) clients is also built-in.

### NOTICE

- ▶ The system must be connected to a network for OPC functionality. Network settings can be viewed and configured in **Options > System > Network**.

### 8.6.1 Basic connectivity

To access the OPC server, all clients must authenticate with the name and password of an authorized user.

The built-in user with the name 'kaiser-opc' is always authorized for OPC access. The password for 'kaiser-opc' is 'opc' by default; this password can be changed under **Options > System > Automation**.

The OPC server can be accessed with user credentials created and managed under **Options > System > Security**.

- **OPC UA (Recommended).** OPC UA clients access the OPC server using UA's binary protocol to connect to *opc.tcp://<computer-name>*, providing the name and password of an authorized user. The "computer name" can be viewed or changed under **Options > System > Network**.
- **UA Certificates.** The first time that a given UA client connects to a Raman Rxn4 system, it is necessary for that client to accept or "trust" the certificate that the OPC server provides to identify itself. The mechanisms for accepting the server's certificate vary by client.

The OPC server provides a "self-signed" certificate; accordingly, it is common for the client to display a warning that the server's identity cannot be verified. Such a warning is normal, and the server's certificate must be accepted to enable the client to connect.

The OPC server's certificate is tied to the computer name of the Raman RunTime system. Any time the computer name is changed, a new certificate will be generated automatically, and UA clients will need to accept the new certificate before they can connect again.

- **OPC Classic (Deprecated).** Full OPC functionality is available to OPC Classic clients. However, OPC Classic entails additional set-up requirements, and many opportunities exist for client-side configuration to interfere with successful communication, often in ways that are challenging to diagnose. Also, the underlying technology of OPC Classic can limit installation flexibility. For these reasons, it is recommended to use OPC UA instead of OPC Classic whenever possible.

The OPC Classic client program must be executed using credentials that exactly match (name and password) an authorized user on the Raman Rxn4 system. This implies that a Windows user account must be created on the client workstation with a name matching a Raman Rxn4 user, and that their passwords must be kept in sync.

### 8.6.2 Asynchronous updates

In addition to responding to polling requests from clients, the OPC server is capable of providing asynchronous updates in which the server notifies clients of changes in the values of subscribed tags without the need for clients to continually poll the server. Note that many clients will fail to connect unless asynchronous updates are enabled.

To enable asynchronous updates, the 'kaiser-opc' user must exist on the client workstation with a password that matches the Raman Rxn4 system, regardless of whether the client program uses the 'kaiser-opc' user credentials.

### NOTICE

- ▶ If the 'kaiser-opc' password is changed under **Options > System > Automation**, the Raman Rxn4 system must be restarted under **Options > System > General** for the new password to take effect.
- ▶ Client workstations must reside in the same TCP/IP subnet as the instrument, with no intervening NAT.

### 8.6.3 Modbus

The Raman Rxn4 provides automation data via Modbus TCP (Ethernet) or Modbus RTU (RS-485 serial). If models are running on the instrument, the prediction values may be configured at **Options > System > Automation > Modbus**. In addition to prediction values, other instrument diagnostic values are available over Modbus.

## 8.7 Software security

Security can be enabled to block non-authorized users from performing Raman RunTime functions. By default, security is set to **OFF**.

1. To turn security settings on browse to **Options > System > Security**.
2. Move the Security setting to **ON** and select **OK** for the Administrator password notice.
3. Enter a password for the Administrator user and then verify the password in the second password step. Be sure to record the Administrator password. It is required to turn on/off security and create new users.

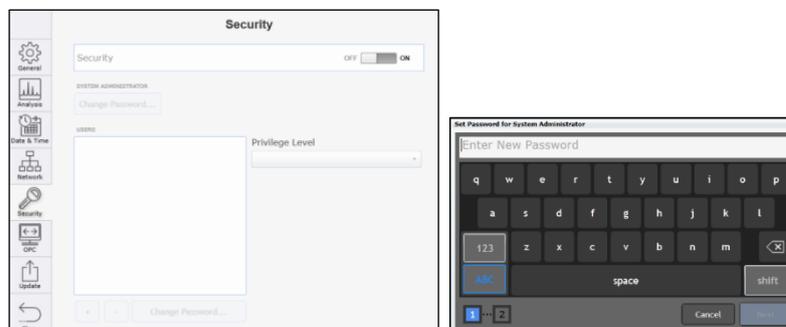


Figure 72. Setting up security

4. Once the Administrator password is verified, the system security will switch to **ON**.

### NOTICE

- ▶ The Administrator password can be provided to all users, or multiple users with different access levels can be added.
5. Click **New** to add a new user.
  6. Create and verify the new user's password.
  7. Specify the **Privilege Level** for the user by selecting **User**, **Operator**, or **Administrator** from the drop-down list. See below for privilege level definitions. Once security is **ON**, access to restricted functionality will require the name and password of an authorized user.
  8. To lock the system immediately after enabling security, click **Lock System Now**.
  9. Click **OK** when the Lock System? confirmation message appears, and then **OK** again when the System locked message appears.

Upon returning to the main Raman RunTime quadrant/probe window view, a **Blue** lock symbol will appear over restricted features. On this main Raman RunTime view, note that the system can also be locked by clicking **Lock** in the lower left corner next to the Raman Analyzer name.

### NOTICE

- ▶ When the security feature within Raman RunTime is enabled, the system will automatically lock itself after 15 minutes of inactivity.

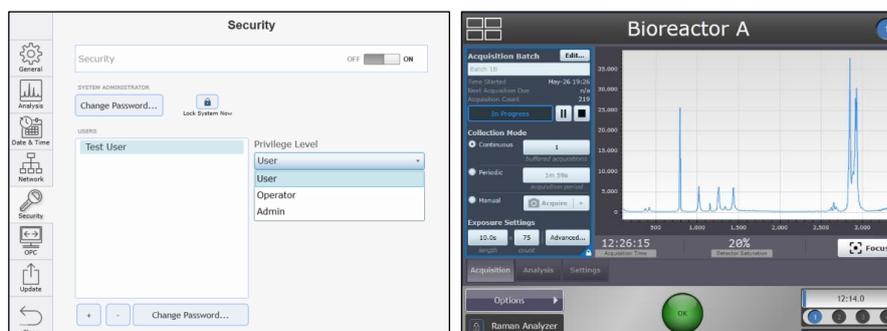


Figure 73. Security settings, adding users, and restricted access

### 8.7.1 User privilege levels

The Raman Rxn4 analyzer with Raman RunTime presents a customized embedded spectroscopic platform that is not compatible with installation of third-party software or customer reconfiguration beyond that which is available through the Raman RunTime user interface.

The customized embedded nature of the Raman Rxn4 presents a non-standard attack surface. Raman RunTime's for-purpose operational profile eliminates risky user behaviors and network accessibility is limited to instrument core services. The Raman Rxn4 employs password protection (detailed below) of instrument functionality and only authenticated updates digitally signed by Endress+Hauser can be applied. Furthermore, there is no facility for running non-Endress software, and any system modifications are automatically purged upon restart.

Security can be enabled to block non-authorized users from performing Raman RunTime functions. Security is set to **OFF** by default. There are three user privilege levels: **User**, **Operator**, and **Admin**. The User level is the most basic, followed by Operator with more privileges, and then Admin which can perform all actions. These privileges are detailed below:

User Level	Action
User	<ul style="list-style-type: none"> <li>▪ Change subject (channel) display name</li> <li>▪ View summary and detail of active batch acquisitions</li> <li>▪ View calibration of information</li> <li>▪ View diagnostics</li> <li>▪ Perform exports (Basic, Diagnostic, Full)</li> </ul>
Operator	User level actions plus: <ul style="list-style-type: none"> <li>▪ View active batch acquisitions</li> <li>▪ Perform calibration and view calibrations information</li> <li>▪ Perform verification and view verification results</li> <li>▪ Start/stop batch acquisitions</li> <li>▪ Focus</li> <li>▪ Snapshot</li> <li>▪ Ad hoc analysis</li> <li>▪ Change system display name</li> <li>▪ Configure date and time</li> <li>▪ Restart</li> </ul>
Admin	No Restrictions Operator level restrictions plus: <ul style="list-style-type: none"> <li>▪ Add/remove models</li> <li>▪ Configure models (display name, enable/disable components, and properties)</li> <li>▪ Configure network</li> <li>▪ Configure Open Platform Communications (OPC)</li> <li>▪ Change security settings and manage users</li> <li>▪ Apply embedded software updates</li> </ul>

Table 9. User privileges

### 8.7.2 Password management and issues

It is a common best practice to routinely change user passwords. In order to do so, an assigned user with varying privilege levels can click **Change Password** in the bottom left corner of the login keyboard screen. Raman RunTime system administrators can also change their passwords in the same way.

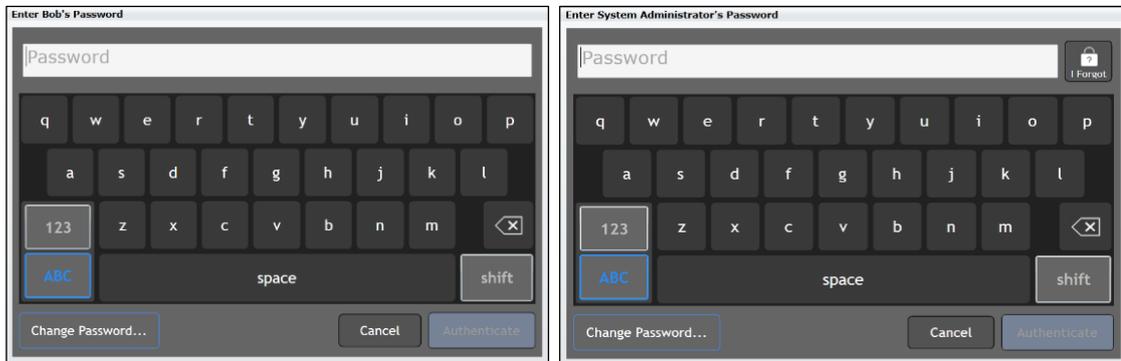


Figure 74. Enter user password screen and enter system administrator password screen

To recover a lost or forgotten password for an assigned user, a user will have to contact their Raman RunTime system administrator to help reset their password. The system administrator will be able to do so by navigating to **Options > System > Security**, then by logging into their system administrator account on this screen. From here, they can select one of the individual assigned users and select **Change Password** at the bottom of the screen. Note that from this screen's Change Password request, it will not ask for the user's old password, just a new password.

Furthermore, if the Raman RunTime system administrator forgets their own password, they can select the **I Forgot** icon in the top right corner of their system administrator password entry screen.

After doing so, they will be provided with a code and will be instructed to contact Endress+Hauser at [support.kosi@endress.com](mailto:support.kosi@endress.com) and share this code. In response, they will receive a reset code to enter at their prompted screen. They can then select **Authenticate** and proceed to set their new password on the screen that follows:



Figure 75. Password recovery screen for a Raman RunTime system administrator

### 8.7.3 Additional security features

In addition to creating users for password protection of system functionality, the Raman RunTime system has additional security features to protect against unauthorized usage, such as:

- Customized embedded system presents non-standard attack surface.
- For-purpose operational profile eliminates risky user behaviors.
- Network accessibility limited to analyzer core services.
- Only authenticated updates digitally signed by Endress+Hauser can be applied.
- No facility for running non-Endress software.

Unauthorized system modifications are automatically purged upon reboot.

### 8.7.4 Export

An Export file is necessary to restore the instrument, if necessary. A file can be saved to the instrument, networked remote computer or to a flash drive. Go to **Options > Diagnostics > Export**.



Figure 76. Steps to export a file

If the user chooses to create an export file by clicking **New**, they have a choice between **Basic**, **Diagnostic**, and **Full**. Click **Export** to create the file.

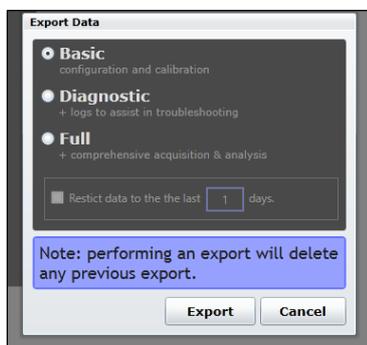


Figure 77. Menu received to export new file

The **Basic** button contains the configuration and calibration information, while the **Diagnostic** button provides logs to assist in troubleshooting with Endress+Hauser. The **Full** button contains all comprehensive acquisition and analysis information in addition to information available in Basic and Diagnostic sections.

If chosen, the **Save** option either lets you save the created export file to a USB flash drive or download it to the network computer accessing the embedded RunTime software.

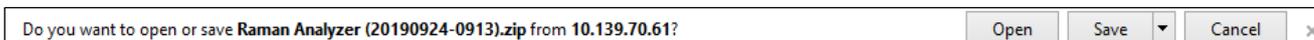
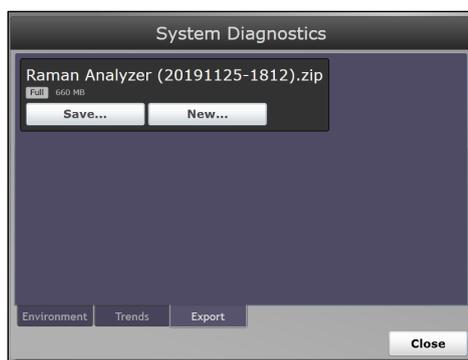


Figure 78. Steps to save export file

### 8.7.5 Client system software requirements

- Silverlight 5.0 or greater (for remote access)
- OPC UA client software (for OPC interface)
- OPC Classic client software (for OPC interface)
- Modbus client software (for Modbus interface)

## 9 Diagnostics and troubleshooting

### 9.1 Diagnostics

System diagnostics can be viewed from **Options > Diagnostics > Environment** tab. The purpose of the system's Diagnostics section is for the user to view system environment data, trend historical environment data, and to save an export file to perform a system restore, if necessary. Regular system exports should be done to ensure the system configurations and calibrations are backed up for future use.

#### NOTICE

- ▶ System exports are intended for Endress+Hauser Support to investigate problems or restore analyzers. The contents are subject to change with new RunTime versions and should not be treated as user accessible files.
- ▶ Full exports can be very large. A Full export is recommended for regular archival of system info and logs and is required for a system restore.

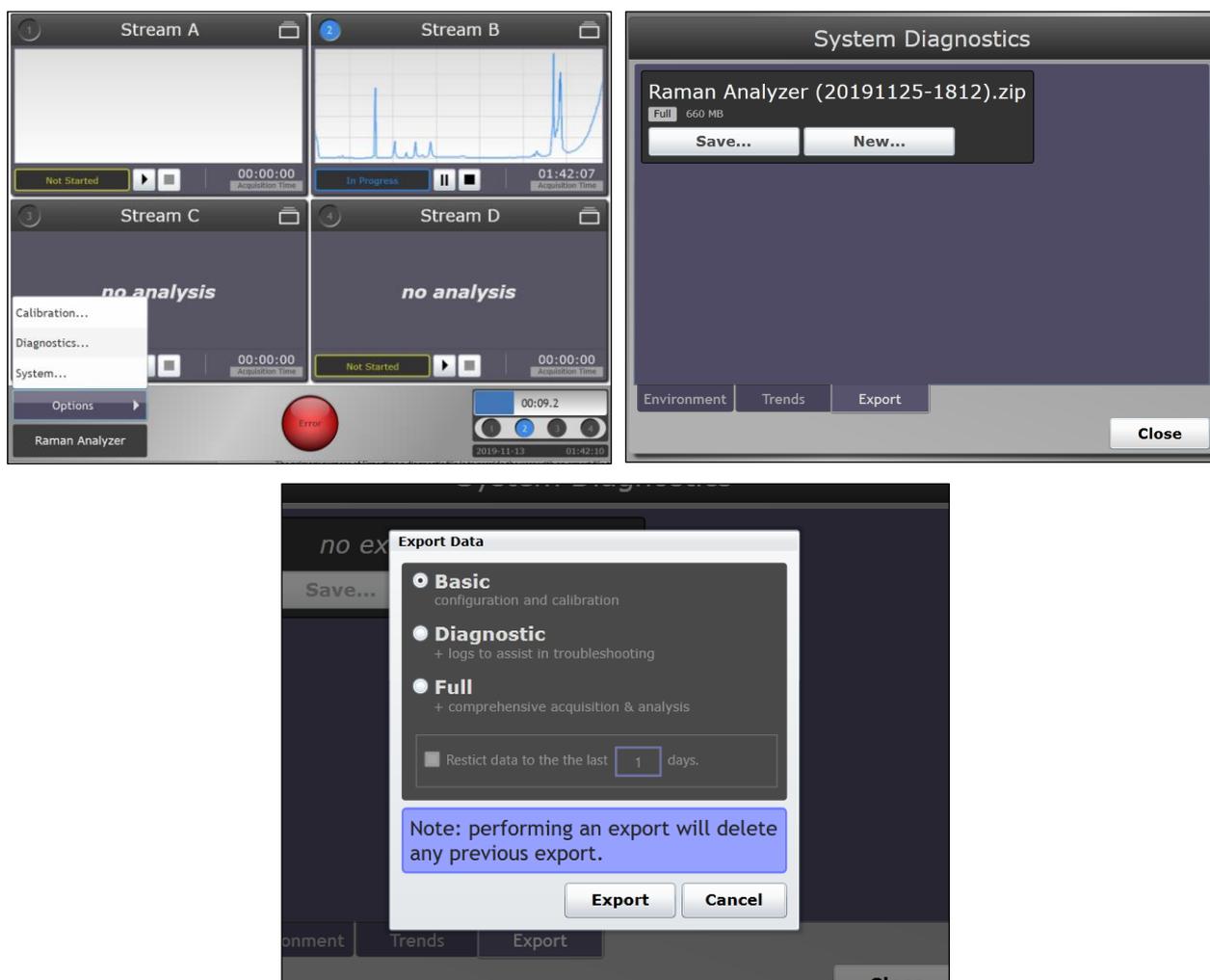


Figure 79. Steps to reach environment tab and export tab

### 9.1.1 Trends

1. To view system diagnostics, go to **Options > Diagnostics** from the main Raman RunTime menu. This will bring you to the Environment tab within the Systems Diagnostics dialog box where you can see system data.



Figure 80. Environment tab to view system data

2. To display Trends of diagnostic values, click the **Trends** tab. Within the Trends tab, users can access the Principal Trend, History, or Comparison Trend as shown below.

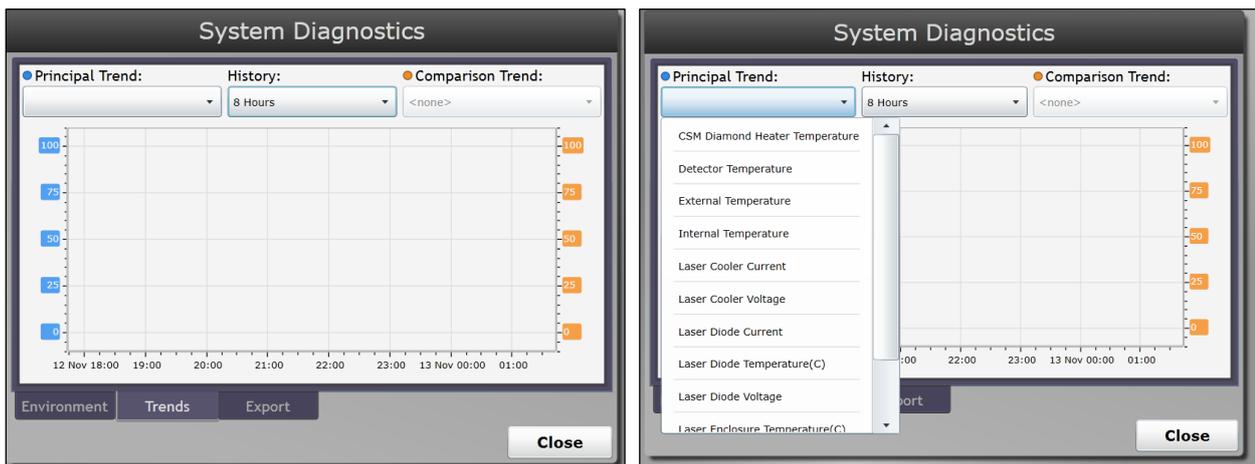


Figure 81. Choices with the trends tab

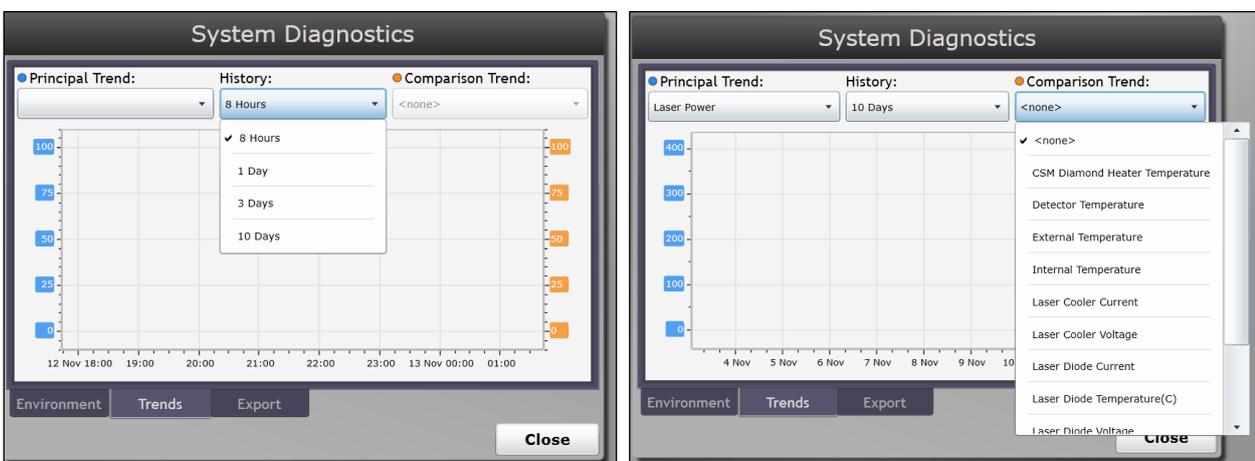


Figure 82. More choices with the trends tab

## 9.1.2 Diagnostic exports

It is an Endress+Hauser advised best practice to export user/spectral data, custom settings and configurations frequently. A full system Export is also recommended to be generated and saved onto external media periodically. This should be considered for inclusion in the local site Standard Operating Procedure (SOP).

### NOTICE

- ▶ A Full level Export file is required to fully restore the system (including settings, configuration, models and data) to an earlier state, if necessary.

On the system interface, go to **Options > Diagnostics > Export** tab. To create a new export file, click **New**. The user can opt between Basic, Diagnostic, and Full exports. Click **Export** to create the file.

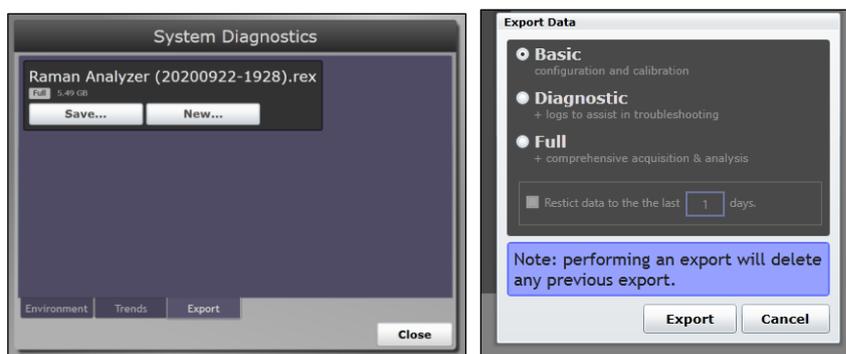


Figure 83. Steps to create a new export file

### NOTICE

- ▶ While the last generated export file is saved onto the onboard analyzer storage, it is only saved there until a newer export file is generated which overwrites the old one. As such, the generated export files should be periodically backed up onto a USB drive for backup and restore purposes.

The Basic option contains the configuration and calibration information, while the Diagnostic option provides logs to assist in troubleshooting with Endress+Hauser. The Full option contains all comprehensive acquisition and analysis information in addition to information available in the Basic and Diagnostic options.

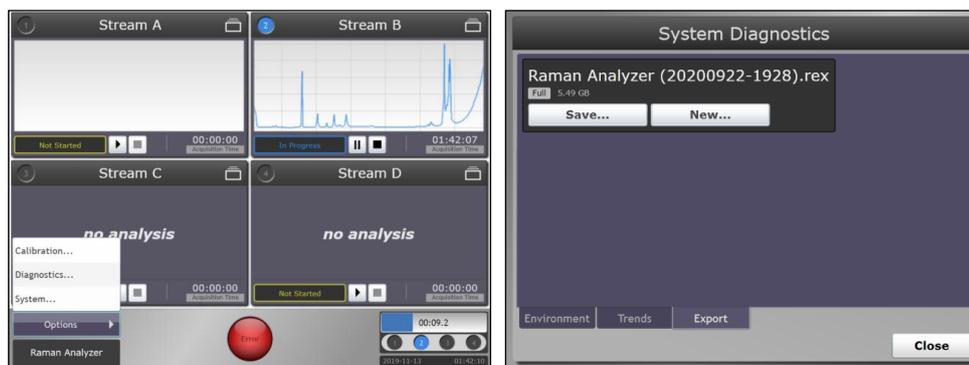


Figure 84. Steps to save an export file

After creating a new export, it will be saved and held on the onboard analyzer storage until overwritten by a newly created one. The Save option on the same screen allows you to either save the created export file to a USB drive or download it to the network computer accessing the remote interface of the Raman RunTime software.

To perform a diagnostic export:

1. Navigate to the **Options > Diagnostics > Export** tab. Click **New**.
2. Insert a USB flash drive into the USB port on the front of the Raman Rxn4 analyzer.
3. Select **Basic**, **Diagnostic**, or **Full** (descriptions are shown on screen).  
Full exports are usually very large in file size. A Full export is recommended for regular archival of system information and logs. A Full export may be requested when working with Endress+Hauser Support.
4. Once the export archive has been generated, click **Save** to save the created export file to a USB drive or download it to the network computer accessing the remote interface of the Raman RunTime software.

## 9.2 Warnings and errors

When the system is fully calibrated and operating as expected, the **Status** button in the middle of the main view status bar will read OK and appear **Green**.



Figure 85. Status bar

Symbol	Description
	<p>If a system warning is encountered, the display will change to <b>Yellow</b>. Warnings should be acknowledged but immediate action may not be necessary. Click the <b>Status</b> button to view details of the warning. The most common warning occurs when all the channels are not occupied. The button will pulse incessantly until the problem is resolved.</p> <p>Click the <b>Status</b> button to view details about the warning.</p>
	<p>If a system error is encountered, the display will change to <b>Red</b>. An error requires immediate action to restore system performance.</p> <p>Click the <b>Status</b> button to view details about the error.</p>

Table 10. Warning and errors

In some cases, users may choose not to utilize all available channels on a Raman Rxn4 analyzer. These unused/uncalibrated channels may result in warnings generated, thereby putting the whole system in a warning state (yellow indicator). To resolve these erroneous warnings about unused channels not being calibrated, the user can individually turn off unused probes/channels in the **Options > Calibration** screen and selecting the **ON/OFF** marker beneath each probe's number as shown below.

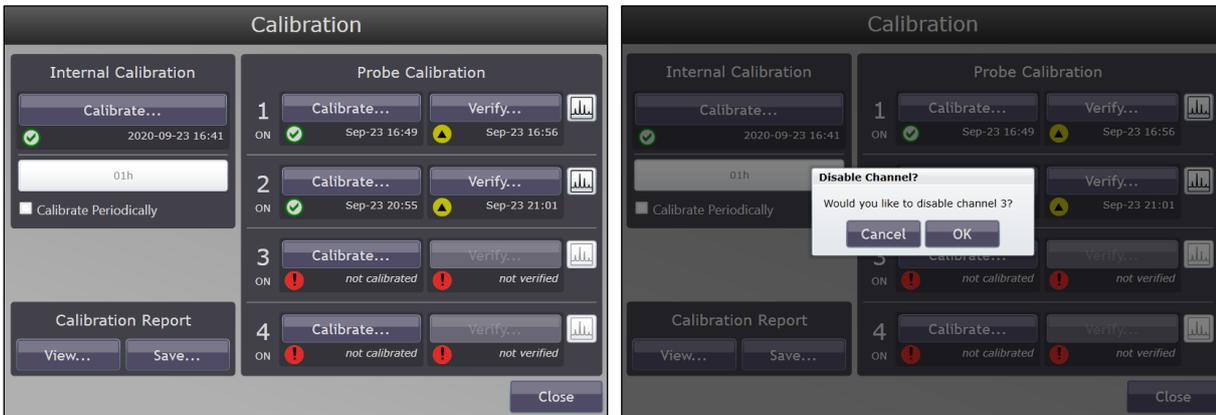


Figure 86. Channels 3 and 4 shown unused/uncalibrated and the disable channel 3 prompt

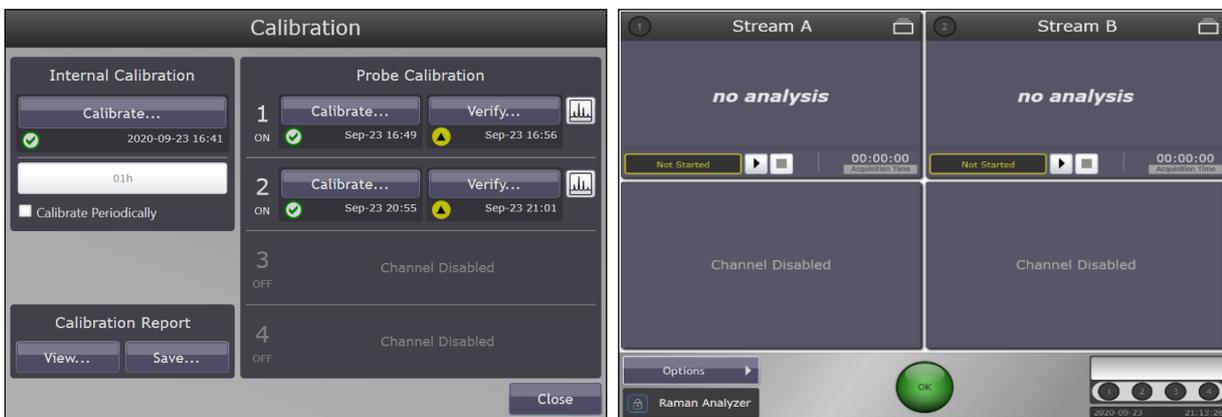


Figure 87. Channels 3 and 4 shown disabled and warning indicator resolved to green OK state

If a system error is encountered, the display will change to **Red**.

1. Click the **Red** status indicator to view details about the warning or error.

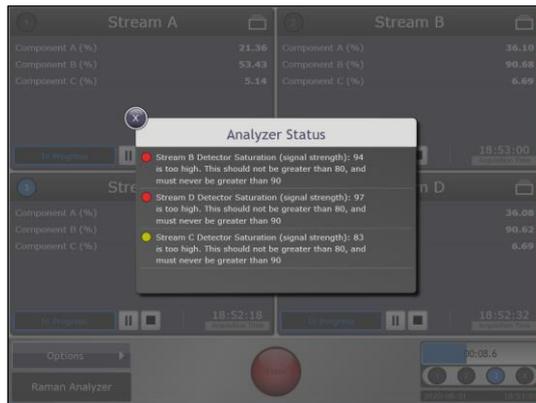


Figure 88. Analyzer status details

2. In the event analyzer stops communication with the interface, go to **Options**, select **System**, choose **Restart** and the analyzer will reboot. This will re-establish camera/interface communication.

### 9.2.1 Low laser power

To check laser environment data, go to the **Options > Diagnostics > Environment** tab.

If it is suspected that laser power is low due to lower signal in spectra, conduct a power check with the laser power meter. A laser should register between 380-400 mW of Laser Power. The Laser Diode Current should be between 0.7 – 2.0A and will creep up over time due to normal diode ageing.

The user will get a warning from RunTime once laser diode current exceeds 1.6A recommending service of laser module soon, to avoid downtime. Once the laser diode current reaches the 2.0A limit, the laser is considered to be in a failure state, and as a result laser power will gradually start decreasing until it gets to zero. The user should contact Endress+Hauser at [support.kosi@endress.com](mailto:support.kosi@endress.com) for further assistance.

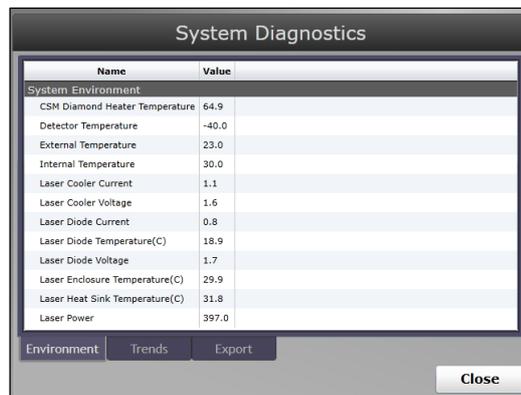


Figure 89. System diagnostics environment tab

### 9.2.2 ON/OFF button flashing

The **ON/OFF** button emits a flashing blink code to communicate a problem when the software is unavailable.

Sign	Problem	Solution
2 blinks in quick succession followed by a solid long pause.	Indicates problem with main power supply. Could indicate power has been interrupted. Flashing will cease when reserve power is depleted if it is not replenished.	Check security of power cord and its connection. If there is no facility power outage, problem could be with power unit and a replacement is necessary, call service.
6 blinks in quick succession	It is too hot inside the instrument. The device is rated for an environment up to 35°C. Instrument will shut down its power source when it is too hot.	Check ambient temperature in the environment around the instrument. If temperature does not exceed limit, call service.

Table 11. ON/OFF button warning signs

### 9.2.3 RunTime system warnings and errors

Diagnostic Title	Faults when...
Internal Calibration	Internal calibration missing on multi-channel instrument.
Wavelength Calibration	Wavelength calibration missing on single channel instrument.
Laser Calibration	Laser calibration missing on single channel instrument.
Intensity Calibration	Intensity calibration missing on channel.
Detector Temperature	Camera temperature out of tolerance.
Detector Locked	Camera temperature not stable.
Detector Saturation	Camera saturation < 2% or > 80%.
CSM Diamond Heater Temperature	Laser calibration standard temperature out of tolerance.
CSM Laser Interlock Alarm	Laser interlock interrupted, e.g., probe cable broken or improperly connected
Laser Interlock Status	Laser disabled, e.g., due to being turned off.
Laser Diode Current	Laser diode drive current approaches maximum.
Laser Cooler Open Circuit	Error received from laser.
Laser Diode Current Error	Error received from laser.
Laser Diode Temp Error	Error received from laser.
Laser Diode Temp Startup	Error received from laser.
Laser Diode Temp Warning	Error received from laser.
Laser Power Feedback	Error received from laser.
Laser Power Feedback Error	Error received from laser.
Laser Unit Temp Error	Error received from laser.
Laser Unit Temp Startup	Error received from laser.

Table 12. System warnings and errors

### 9.2.4 Quick reference troubleshooting

Diagnostic Title	Solution
Probe is not emitting laser	Check whether the probe is connected properly. Confirm that laser key is turned <b>ON</b> and indicator light is lit. Inspect whether the shutter switch is in the <b>ON</b> position. Examine whether the remote unlock connector is present on specific channel.
RunTime is frozen and not responding	Reboot device by holding the <b>ON/OFF</b> button on the front of the device for 12 seconds until it powers down. Release power button. Depress power button momentarily to power the device back up.
RunTime reports a detector temperature warning	Camera hasn't had time to cool down. The camera usually needs 20 to 25 minutes from when it powered up to cool down to the proper temperature.
The probe fiber is broken	The interlock connector will cut off power to the system if the cable is broken. Contact Endress+Hauser at <a href="mailto:support.kosi@endress.com">support.kosi@endress.com</a> for further assistance.
The laser has failed	Check <b>Options &gt; Diagnostics</b> for a reading on the laser's current and power. Contact Endress+Hauser at <a href="mailto:support.kosi@endress.com">support.kosi@endress.com</a> for further assistance.
RunTime won't initialize	Follow instructions in the Restore Console to restore an export file already saved that contains settings, calibrations, and verification data.

Table 13. Troubleshooting

### 9.3 OPC connection troubleshooting

Endress+Hauser cannot support connection to user specific OPC clients. Endress+Hauser uses a free OPC Client, UAExpert for testing server-to-client connections. A Service Engineer can provide instructions for the UA Expert Client to run Raman RunTime OPC Server tests. If problems persist, check the following items:

- Confirm whether the current version of Raman RunTime is operating.
- Verify the status of “Connected” under **Options > System > Network**.



Figure 90. Network screen showing connected

- Make sure the correct Ethernet port is used.
- Check whether the Ethernet port is active with link/activity lights.
- Make sure a valid IP Address is shown.
- Test the ping from a direct connected laptop and ensure both are configured properly.
- Validate the OPC UA communication by using a test client such as UA Expert.
- Check port configuration on client.

### 9.4 Restarting the system

In Raman RunTime, navigate to **Options > System > General** and click **Restart**. Only users with administrative privileges can restart the device.



Figure 91. Restart

### 9.5 Raman Rxn4 system and power loss

The instrument retains its last known power state in non-volatile memory. Should power be interrupted to the instrument at any time, the instrument will recall its last known power state and return to that power state once power is restored. For example, if the instrument was ON when power was interrupted, it will power on automatically once power is restored. If the laser was ON and the laser key is also in the ON position as well, then the laser will turn on. In the unlikely event of this occurring, this represents a possible laser exposure hazard. While power is interrupted, if the instrument was ON at the time of power loss, the power switch will flash a two-blink error code for 30 – 60 seconds, indicating that power has been lost.

### 9.6 Recovery console

The Recovery Console appears if Raman RunTime is unable to initiate. Raman RunTime will produce a prompt to enter recovery console after trying to initiate five times. There are several options for resolving the problem.



Figure 92. Recovery console menu

The Recovery Console consists of the following functions:

- **Restart.** This button will restart the system.

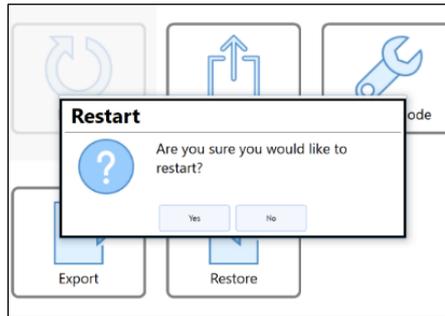


Figure 93. Restart warning

- **Update.** This button is used to update the Raman RunTime embedded software that is provided on a USB stick. Put the USB flash drive in the USB slot and follow menu prompts to find the file and initiate the update.

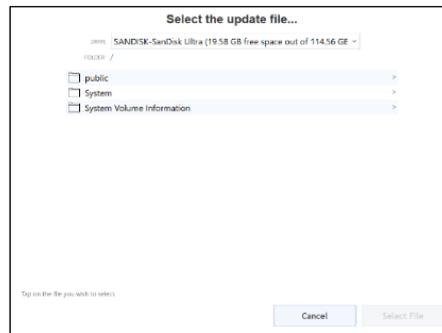


Figure 94. Update mode menu

- **Service Mode.** The Service Mode option is only available to qualified service personnel. Contact Endress+Hauser Support at [support.kosi@endress.com](mailto:support.kosi@endress.com) for further assistance.



Figure 95. Service mode menu

- **Export.** This button is used to download data, settings, or configurations of the analyzer, and only when it is in an error state. This export is intended for Endress+Hauser Support to investigate problems. In order to Restore the analyzer, a user can ONLY use a previously generated and saved (to a USB drive) Export file from within Raman RunTime. The last generated and saved export file will also reside on the system’s onboard memory.

**NOTICE**

- ▶ The recovery console generated export is ONLY intended for Endress+Hauser Support to investigate problems. This export file CANNOT be used to restore the analyzer.



Figure 96. Exporting a file

- **Restore.** This button can restore Raman RunTime to an earlier state of the analyzer that was saved at an earlier time from within Raman RunTime, and exists on the onboard storage or on a USB drive. This is the recommended solution to restoring Raman RunTime to an operational mode.

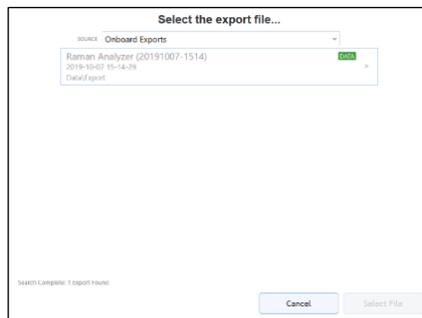


Figure 97. Restoring Raman RunTime to an earlier version using export stored on the analyzer storage

1. If the export file is on a USB drive, search through folder structure to find the needed file to restore settings and configuration. Please choose a Full level export file to restore the settings, configuration, models, and data. If an export is Full level and contains the aforementioned content for a full restore, this is indicated by the **Green DATA** tag next to the export file as shown below.

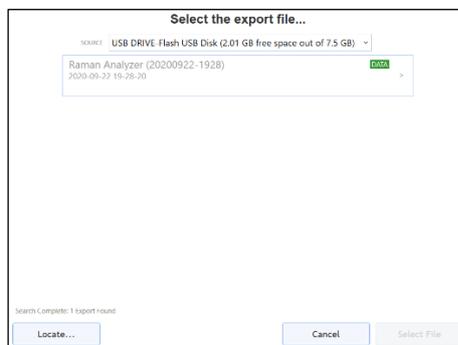


Figure 98. Restoring Raman RunTime to an earlier version using export stored on a USB drive

While the settings and configuration will always be restored, Raman RunTime will prompt and ask whether the user also wants to restore data as well if a Full export (with a **Green DATA** tag) is available and selected.

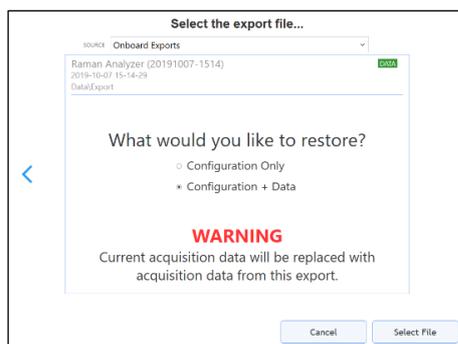


Figure 99. Warning menu to select level of restore for Raman RunTime

2. Select the file to restore the analyzer. Once the file is selected, a new menu will appear to confirm the action. Click **OK**.



Figure 100. Menu to confirm restore

3. The system will now Restart and Restore. This can take a while, so **DO NOT** shut down the analyzer. Once the Restore is finished, the instrument will Restart, and Raman RunTime will Launch.
  - **Reset.** By clicking the **Reset** button, and then **Continue**, the system will reboot and delete all of the calibrations, models, acquisitions, logs, and other data.

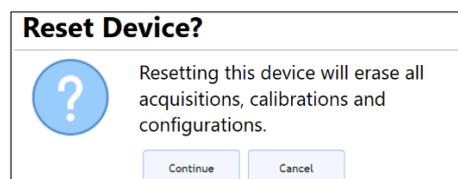


Figure 101. Menu to confirm resetting the device

## 10 Maintenance

### 10.1 Optimization

If you move the Raman Rxn4, it may be necessary to re-optimize its performance. First, re-verify its performance using Raman RunTime and compare the results for the current to the previous verification. If the signal intensity has dropped significantly, you may benefit from following the optimization guidelines below.

#### 10.1.1 Sample position

If the sample has been moved from the focal point of the probehead, less Raman scattering is recovered by the probehead lens and transmitted to the spectrograph. This is the easiest area to check first.

Perform the following procedure in a darkened room:

1. Click **Focus** on the Stream Detail View.
2. Watch the signal increases and decreases in response to the sample movement in front of the probehead lens.
3. Be aware of any potential laser light reflected off the sample container during this procedure.

#### 10.1.2 Cleaning the lens or window

If the lens or window on the probehead has come in contact with a sample, dust or fingerprints, etc., it may need to be cleaned. Use a lens cloth and a water-based lens-cleaning solution to gently wipe away any contaminant.

#### 10.1.3 Detector camera alignment

If the Raman Rxn4 spectrograph internal optics have shifted, the detector camera alignment may need to be changed.

##### **CAUTION**

- ▶ The CCD camera alignment is set at the factory and rarely needs to be altered in the field. Alignment should be performed only by experienced personnel.

Prior to performing a camera alignment operation, it is important to ensure that no stray light is entering any of the probes that are attached to the Raman Rxn4. Alignment is performed with an internal white light source, and stray light entering on any of the attached probes can interfere with the alignment light source.

To perform the camera alignment:

1. Navigate to **Options > Calibration**.
2. Click **Calibrate** under the Internal Calibration section then select **Recalibrate All** from the Calibration Mode drop-down list. Click **Calibrate**.

##### **NOTICE**

- ▶ All probe calibrations and verifications are invalidated after Recalibrate All and will need to be re-performed.

#### 10.1.4 Calibration and verification wizard

Reliable, transferable calibration is important for comparing data acquired at various times or with different analyzers. Different instruments analyzing the same sample can generate nearly identical spectra if they are properly calibrated. The Raman RunTime software package includes an automatic calibration wizard that guides you through a procedure to automatically calibrate the wavelength and intensity axes of the spectrograph, in addition to the wavelength of the laser.

##### **NOTICE**

- ▶ After the initial calibration during installation, the Calibrate Periodically function is usually sufficient to maintain the wavelength and laser calibration of the Raman Rxn4.

A summary of the recommended calibration and verification sequence is as follows:

1. Internal Calibration.
2. Probe Calibration (Raman Calibration Accessory).
3. Probe Verification (external 70% IPA or cyclohexane sample where applicable).

#### 10.1.4.1 Internal calibration

Internal calibration includes spectrograph alignment, spectrograph x-axis wavelength, and laser wavelength calibrations.

The wavelength calibration of the Raman Rxn4 can be automatically checked at a frequency of choice by navigating to **Options > Calibration > Internal Calibration** and selecting **Calibrate Periodically**. At least once per day is recommended. Once enabled, the Raman Rxn4 will automatically compare the current analyzer response (spectrograph and laser wavelength calibrations) to calibration specifications and will recalibrate if the spectrograph wavelength and/or laser wavelength is out of spec.

#### 10.1.4.2 Probe calibration

The sensitivity of the Raman Rxn4 varies with wavelength due to variations in the throughput of the optics and the quantum efficiency of the CCD. The Probe Calibration function in your embedded software application can be used to remove the effects of this variation from measured spectra.

Attach the lamp head to the probe on channel 1 using the appropriate optic adapter. Each channel must be probe-calibrated separately. Follow the instructions in the automatic calibration wizard.

#### 10.1.4.3 Probe verification

##### CAUTION

- ▶ Bio probes such as bIO-Optic, RXN-45, and single-use adapters, should ONLY use 70% IPA. Only 70 percent by volume (%v/v) will work. Endress+Hauser recommends using CiDehol 70 by Decon Laboratories. Other probes can use cyclohexane.

The Probe Verification wizard may be used to verify that the Raman Rxn4 is performing within specifications. Probe verification will acquire a Raman spectrum of a standard Raman sample, usually 70% IPA or cyclohexane, and analyze the resultant spectrum for peak positions, peak area ratios and Raman signal strength. The peak position verification will verify that the spectrograph and laser wavelength calibrations are within specification. The peak area ratio verification will verify that the probe intensity calibrations are within specification. The signal strength verification will verify that the instrument's signal-to-noise ratio is within specification. A report will be generated showing the results of the verification steps along with a Pass/Fail indication.

## 10.2 Servicing the Raman Rxn4 analyzer

This section is divided into two parts: 1) Embedded software-related symptoms, and 2) Hardware-related symptoms. The distinction is not clear-cut in many cases, so both sections should be checked for a possible solution.

Some of the service procedures require removal of the protective cover. Special precautions are therefore necessary to deal with the added optical and electrical hazards that are present during service operations.

### WARNING

- ▶ General users should not open the Raman Rxn4 enclosure due to potential exposure to hazardous laser radiation or high voltages. Only qualified personnel familiar with high voltage electronics should open the system enclosure to perform necessary maintenance or service.

### 10.2.1 Embedded software related symptoms

#### **Raman spectra contain non-random noise**

Possible Solutions:

1. The intensity calibration file is no longer valid.  
The intensity calibration file is a map of the total instrument response of the system (CCD quantum efficiency, grating and lens efficiencies, etc.). If the spectrograph focal plane shifts with respect to the CCD detector, then the intensity calibration map is no longer correct. An incorrect intensity calibration file will not remove pixel-to-pixel sensitivity variation, which is as high as 3% for some CCD chips. Shifting of the spectrograph focal plane on the CCD detector can result from adjusting the Raman Rxn4 spectrograph alignment, mechanical shock applied to the Raman Rxn4 or substantial ambient temperature shifts. Recalibrate the intensity axis.
2. The intensity per pixel per accumulation exceeded the half-well potential of CCD pixels during the creation of the intensity calibration file.  
Non-linearity reduces the effectiveness of the intensity calibration file at correcting the CCD pixel-to-pixel sensitivity variation. Recalibrate the intensity axis.

#### **Intensities in Raman spectra show non-linear behavior or Raman peak shapes are distorted**

Possible Solutions:

1. Repeat the data acquisition using a shorter data acquisition time and perhaps more accumulations (which adds intensities in the embedded software rather than on the CCD chip).  
The signal from the CCD can become slightly non-linear as the photo-generated charge approaches the full-well potential. This can cause non-linear behavior and peak distortion in Raman spectra.
2. The intensity calibration file is invalid.  
If the intensity calibration was made using a light source that did not evenly illuminate the entire collection lens of the spectrograph, then any experiment that does not reproduce the exact uneven illumination at the time of the intensity calibration will not have the same instrument response and therefore will not be properly corrected. Recalibrate the intensity axis.

#### **Raman RunTime reports a detector temperature warning**

Possible Solutions:

1. The camera has not had time to cool down.  
The camera usually requires 15 to 20 minutes from the time it is powered up until it has cooled down to the proper temperature.

## 10.2.2 Hardware related symptoms

### **Symptom: Several sharp artifact peaks appear in all Raman spectra**

Possible Solutions:

1. The room lights are introducing an emission line spectrum into the spectrograph.  
Turn off any fluorescent lights during future experiments. Cover reactor with aluminum or other light-blocking material to prevent light entering.

### **Symptom: The number of intensity counts from verification is significantly less than specification**

Possible Solutions:

1. The sample is not in the focal plane of the fiber optic probehead.  
Adjust the position of the sample with respect to the probe focus.
2. The fiber optic cable is not attached correctly to the Raman Rxn4 base unit.  
Check fibers for proper engagement and that they are latched.
3. The laser power reaching the sample is too low.  
Measure the laser power at the sample and compare it to the normal power for your configuration. Contact Endress+Hauser at [support.kosi@endress.com](mailto:support.kosi@endress.com) or an authorized distributor for further assistance.

### **Symptom: Spectrum sits on top of a broad intensity pedestal**

Possible Solutions:

1. Probe tip may be fouled.  
Pull probe from process and clean the probe per the appropriate service manual instructions. Contact Endress+Hauser at [support.kosi@endress.com](mailto:support.kosi@endress.com) or an authorized distributor for further assistance.

### **Symptom: No laser light reaches the sample**

Possible Solutions:

1. The laser is not on.  
Check to see if the laser key is in place and the indicator is lit.
2. The laser is not lasing.  
Contact Endress+Hauser at [support.kosi@endress.com](mailto:support.kosi@endress.com) or an authorized distributor for further assistance.
3. The internal power plug has disconnected from the laser.  
Open the Raman Rxn4 base unit enclosure. The computer-style power cord should be firmly plugged into its socket on the laser.
4. The fiber optic cable is not attached correctly to the Raman Rxn4 base unit.  
Check Hybrid fibers for proper engagement and that they are latched.
5. The laser injector is misaligned.  
Contact Endress+Hauser at [support.kosi@endress.com](mailto:support.kosi@endress.com) or an authorized distributor for further assistance.
6. The remote interlock connector shorting plug is unplugged.  
Make sure the remote interlock connector shorting plugs for all channels are installed. Make sure the corresponding front panel interlock indicators are illuminated.
7. The probe fiber is broken.  
The interlock cuts power to the system if the cable is broken. If this happens, contact Endress+Hauser at [support.kosi@endress.com](mailto:support.kosi@endress.com) or an authorized distributor for further assistance.
8. The Calibration Switching Module has failed.  
Contact Endress+Hauser at [support.kosi@endress.com](mailto:support.kosi@endress.com) or an authorized distributor for further assistance.
9. The laser has failed.  
Check **Options > Diagnostics** for laser diode current and power.

**Symptom: Embedded software indicates an excessive number of tracks found during recalibrate all**

Possible Solutions:

1. Stray light from connected probes are entering spectrograph during camera alignment.  
Cover all connected probe optics to prevent any stray light from entering the spectrograph.

**Symptom: Embedded software indicates a failure during wavelength calibration**

Possible Solutions:

1. Stray light from connected probes is entering spectrograph during calibration.  
Cover all unused but connected probe optics to prevent any stray light from entering the spectrograph. Also, ensure that probes being used for sampling are protected from stray light. Wavelength calibration is performed with a light source internal to the Raman Rxn4 base unit. If stray light from connected probes can enter the spectrograph, it may interfere with the internal calibration lamp.

**Symptom: Embedded software indicates internal temperature error**

1. Possible Solutions:The filter needs attention.  
Clean or replace the filter.
2. The ambient temperature is above 35°C.  
Lower ambient temperature to a temperature within specified ambient temperature range.

## 10.3 Support

Diagnostic exports and the current Raman RunTime version number will be needed for Endress+Hauser Support. The version can be viewed from **Options > System > Update**.

Click **Information** to display additional details about the versions and updates applied.

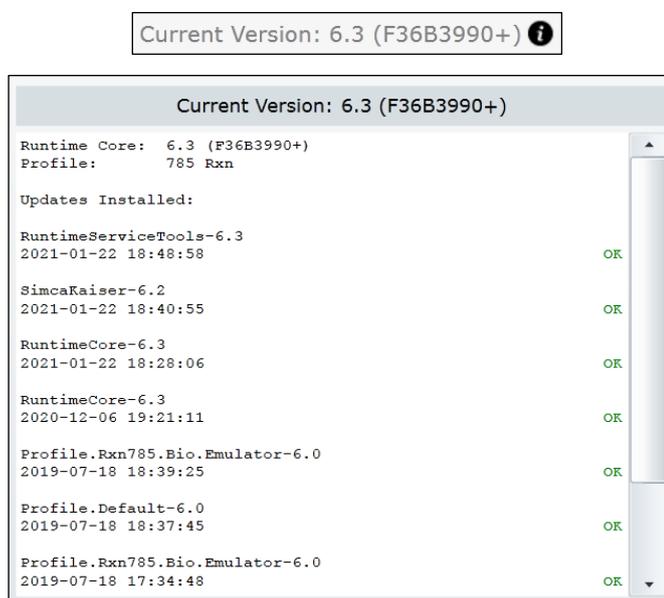


Figure 102. Current version

### 10.3.1 Contact information

Endress+Hauser will provide telephone consultation for this product during normal U.S. East Coast business hours 8:00 AM to 5:00 PM. Under no circumstances does telephone consultation affect the terms of any warranty agreement:

**Email** [support.kosi@endress.com](mailto:support.kosi@endress.com)  
**Phone** +1 (734) 665-8083, press 0, ask to speak with Support  
**Address** Endress+Hauser, 371 Parkland Plaza, Ann Arbor, MI 48103 USA

# 11 Repair

## 11.1 Servicing and spare parts

The two main user-serviceable or replaceable parts are the disposable air filter and the laser. Part numbers for these items are listed in the table below. The laser assembly has been designed for easy replacement and this is typically accomplished by the customer. Optionally, an Endress+Hauser service engineer can install the laser during a contracted service visit.

### NOTICE

- ▶ The performance of procedures (including service), the use of controls, or the adjusting of the instrument other than as specified in the manual will void the warranty.

The following table provides a list of common parts that may be ordered and installed.

Model Number	Description
RXN4 Air Filter	One packet of replacement Air Filters for a Raman Rxn4 Analyzer (Quantity 5 filters)
ULA-EM-785-2/4	<p>Embedded Invictus NIR 785 nm Diode Laser for Raman Rxn4 features:</p> <ul style="list-style-type: none"> <li>▪ Laser Wavelength – 785 nm</li> <li>▪ &gt;125 mW of 785 nm laser power delivered to the Probehead*</li> <li>▪ Integrated Holographic Laser Bandpass Filter</li> <li>▪ Universal Laser Injector Assembly</li> <li>▪ One Year Unlimited Hours Warranty</li> </ul> <p>*Using standard multi-mode optical fiber</p>
L-INV-EM2/4-785-R	<p>Refurbished Embedded Invictus NIR 785 nm Diode Laser for Raman Rxn4 analyzer features:</p> <ul style="list-style-type: none"> <li>▪ Return of Existing Invictus NIR 785 nm Diode Laser and Injector Assembly</li> <li>▪ Clean and Refurbish Laser and Injector as necessary</li> </ul> <p>Refurbished Specifications:</p> <ul style="list-style-type: none"> <li>▪ &gt;150 mW of 785 nm laser power delivered to the Probehead*</li> <li>▪ One Year Unlimited Hours Laser Warranty</li> </ul> <p>*Using standard multi-mode optical fiber</p> <p>Requires Trade-in of Existing Customer-owned Embedded Invictus NIR 785 nm Diode Laser (serial number to be provided)</p>
ULA-EM-532-2/4	<p>Embedded Invictus 532 nm Frequency Doubled Diode-Pumped Nd:YAG Laser for Raman Rxn4 analyzer features:</p> <ul style="list-style-type: none"> <li>▪ Laser Wavelength – 532 nm</li> <li>▪ Diode-Pumped Nd:YAG Laser</li> <li>▪ 150 mW Laser Head Output</li> <li>▪ One Year / 5000 Hours Warranty</li> <li>▪ &gt;80 mW of 532 nm laser power delivered to the probehead*</li> </ul> <p>*Using standard multi-mode optical fiber</p>
L-INV-EM2/4-532/R	<p>Refurbished Embedded Invictus VIS 532 nm Diode Laser for Raman Rxn4 features:</p> <ul style="list-style-type: none"> <li>▪ Return of Existing Invictus VIS 532 nm Diode-Pumped Nd:YAG Laser and Injector Assembly</li> <li>▪ Clean and Refurbish Laser and Injector as necessary</li> </ul> <p>Refurbished Specifications:</p> <ul style="list-style-type: none"> <li>▪ &gt;80 mW of 532 nm laser power delivered to the probehead*</li> <li>▪ One Year or 5000 Hours Laser Warranty</li> </ul> <p>*Using standard multi-mode optical fiber</p> <p>Requires Trade-in of Existing Customer-owned Embedded Invictus VIS 532 nm Diode-Pumped Nd:YAG Laser (serial number to be provided)</p>

Model Number	Description
ULA-EM-1000-2/4	Embedded Invictus NIR 993 nm Diode Laser for Raman Rxn4 analyzer features: <ul style="list-style-type: none"> <li>▪ Laser Wavelength – 993 nm</li> <li>▪ &gt;150 mW of 993 nm laser power delivered to the Probehead*</li> <li>▪ Integrated Holographic Laser Bandpass Filter</li> <li>▪ Universal Laser Injector Assembly</li> <li>▪ One Year Unlimited Hours Warranty</li> </ul> *Using standard multi-mode optical fiber
L-INV-EM2/4-1000/R	Refurbished Embedded Invictus NIR 993 nm Diode Laser for Raman Rxn4 analyzer features: <ul style="list-style-type: none"> <li>▪ Return of Existing Invictus NIR 993 nm Diode Laser and Injector Assembly</li> <li>▪ Clean and Refurbish Laser and Injector as necessary</li> </ul> Refurbished Specifications: <ul style="list-style-type: none"> <li>▪ &gt;150 mW of 993 nm laser power delivered to the Probehead*</li> <li>▪ One Year Unlimited Hours Laser Warranty</li> </ul> *Using standard multi-mode optical fiber  Requires Trade-in of Existing Customer-owned Embedded Invictus 993 nm Laser (serial number to be provided)

Table 14. Spare parts

For all other service needs, please contact an approved Endress+Hauser representative.

## 12 Technical data

### 12.1 Specifications

Raman Rxn4 analyzers may be configured to operate with one of several different laser wavelengths. Currently, Raman Rxn4 analyzers may be equipped with a 532 nm, 785 nm, or 993 nm laser as standard.

#### 12.1.1 Base unit

Item	Description
Operating temperature (532 nm, 785 nm)	+5 to +35 °C
Operating temperature (993 nm)	+5 to +30 °C
Storage temperature	-15 to +50 °C
Relative humidity	20–80%, non-condensing
Warm-up time	120 minutes
Operating voltage	100–240 V, 50–60 Hz, ±10%
Transient over-voltages	Over-voltage category 2
Power consumption (maximum) (typical startup) (typical running)	400 W 250 W 120 W
Base Unit Dimensions (width x depth x height)	19.0" x 21.9" x 10.5" (483 x 556 x 267 mm)
Weight, Base Unit	63 lbs. (28.5 kg)
IEC 60529 rating	IP20
Altitude	Up to 2000m
Pollution degree	2

Table 15. Base unit

#### 12.1.2 Base Unit (w/ NEMA 4x Enclosure Option)

Item	Description
Operating temperature (532 nm, 785 nm, 993 nm)	+5 to +50 °C
Storage temperature	-15 to +50 °C
Relative humidity	Up to 80% for temperature range +5 °C to +31 °C, decreasing linearly to 20% at 50 °C.
Warm-up Time	240 minutes
Operating voltage	120 V ± 10%, 60 Hz OR 230 V ± 10%, 50/60 Hz
Transient over voltages	Over-voltage category 2
Power consumption (maximum)	1560 W
Base Unit Dimensions (width × depth × height)	46.25" x 58.21" x 32.5" (1175 x 1480 x 826 mm)
Weight, enclosed Rxn4 with trolley option	409 lbs. (185.52 kg)
IEC 60529 rating	IP66

Table 16. Base unit (w/ NEMA 4x enclosure option)

### 12.1.3 Spectrograph

Item	Description
Type	Proprietary axial transmissive
Aperture ratio	f/1.8
Focal length	85 mm
Grating (1 or 4 channels, 532 nm, 785 nm)	HoloPlex transmissive (Rxn4-785 Hybrid analyzers use HoloSpec transmissive)
Grating (1 or 4 channels, 993 nm)	HoloSpec transmissive
Spectral coverage (532 nm)	150 to 4350 $\text{cm}^{-1}$
Spectral coverage (785 nm)	150 to 3425 $\text{cm}^{-1}$
Spectral coverage – Rxn4 Hybrid (785 nm)	175 to 1890 $\text{cm}^{-1}$
Spectral coverage (993 nm)	200 to 2400 $\text{cm}^{-1}$
Slit	50 $\mu\text{m}$ fixed (< 64.0 dB, A-weighted for the Rxn4 Hybrid)
Spectral resolution (532 nm)	5 $\text{cm}^{-1}$ average
Spectral resolution (785 nm)	4 $\text{cm}^{-1}$ average
Spectral resolution (993 nm)	5 $\text{cm}^{-1}$ average

Table 17. Spectrograph

### 12.1.4 Laser

Item	Description
<b>532 nm Invictus</b> Excitation wavelength Maximum power output Warranty	532 nm 120 mW unlimited hours for 1 year
<b>785 nm Invictus</b> Excitation wavelength Maximum power output Warranty	785 nm 400 mW unlimited hours for 1 year
<b>993 nm Invictus</b> Excitation wavelength Maximum power output Warranty	993 nm 400 mW unlimited hours for 1 year

Table 18. Laser

### 12.1.5 Sound levels

Analyzer / Accessory	Sound Level from Operator's Position
Raman Rxn4	58.2 dB

Table 19. Sound levels

### 12.1.6 Probes

Item	Description
Raman Rxn4 (single channel and four channel)	Compatible with: Rxn-10 probe, Rxn-30, Rxn-40, Rxn-41, or Rxn-45 probes
Raman Rxn4 Hybrid	Compatible with: Rxn-20 probe and one other ALT probe including the Rxn-10 probe, Rxn-30, Rxn-40, Rxn-41, or Rxn-45 probes

Table 20. Probes

## 12.2 Hazard area rating (Probe type-dependent)

Item	Description
Rxn-10 Probe	None
Rxn-20 series probes can be classified to:	<p><b>ATEX</b>  <math>\langle \text{Ex} \rangle</math> II 2/1 G Ex ia op is IIA or IIB or IIB+H2 or IIC T4 or T3 or T6 Ga  <math>-20^{\circ}\text{C} \leq \text{TA} \leq +60^{\circ}\text{C}</math></p> <p><b>IECEX</b>  IECEX ITS 14.0015X</p> <p><b>North American</b>  Ex ia op is IIA or IIB or IIB + H2 or IIC T3 or T4 or T6 Ga  Class I, Division 1, Groups A, B, C, D T3/T4/T6  Class I, Zone 0 AEx ia op is IIA or IIB or IIB + H2 or IIC T3 or T4 or T6 Ga</p>
Rxn-30 series probes can be classified to:	<p><b>ATEX</b>  <math>\langle \text{Ex} \rangle</math> II 2/1 G Ex ia op is IIA or IIB or IIB+H2 or IIC T3 or T4 or T6 Ga  <math>-20^{\circ}\text{C} \leq \text{TA} \leq +60^{\circ}\text{C}</math></p> <p><b>IECEX</b>  IECEX ITS 14.0015X</p> <p><b>North American</b>  Ex ia IIB+H2 T4  Class I Zone 0 AEx ia IIB+H2 T4  Class I Division 1 Groups B, C, &amp; D T4</p>
Rxn-40 and Rxn-41 series probes can be classified to:	<p><b>ATEX</b>  <math>\langle \text{Ex} \rangle</math> II 2/1 G Ex ia op is IIA or IIB or IIB+H2 or IIC T3 or T4 or T6 Ga  <math>-20^{\circ}\text{C} \leq \text{TA} \leq +60^{\circ}\text{C}</math></p> <p><b>IECEX</b>  IECEX ITS 14.0015X</p> <p><b>North American</b>  Ex ia IIC T4  Class I Zone 0 AEx ia IIC T4  Class I Division 1 Groups A, B, C, &amp; D T4</p>
Rxn-45 Probe	None

Table 21. Hazardous area rating

### 12.2.1 Hazard area certification

Item	Description
Certification – Base Unit (fiber optic and interlock outputs only)	<p><b>ATEX</b>  <math>\langle \text{Ex} \rangle</math> II (2)(1) G Ex [ia Ga] [op sh Gb] IIC  CE 0035 <math>\langle \text{Ex} \rangle</math> II (2)(1) G</p> <p><b>IECEX</b>  Ex [ia Ga] [op sh Gb] IIC</p> <p><b>North American</b>  Intrinsically Safe output for probe and sensors used in Class I, Division 1, Groups A, B, C, and D.  Ambient Temperature Range: <math>+5^{\circ}\text{C} \leq T_{\text{amb}} \leq 35^{\circ}\text{C}</math></p>

Table 22. Hazardous area certification

## 13 Index

- ac
  - power, 33
  - safety, 10
- air
  - filter, 43, 82
  - ventilation, 19, 20, 21
- altitude, 84
- analyzer
  - calibration window, 28
  - four channel, 12
  - hybrid, 12
  - one channel, 12
  - probe, 22
  - rear panel, 16
  - status, 70
- aperture
  - laser, 39
  - numeric, 9
  - ratio, 85
- asynchronous updates, 32
- automatic
  - calibration, 44, 45
  - calibration wizard, 77
  - connection, 31
  - dark exposures, 51
  - user privilege, 64
- automation, 31
- base unit
  - air filter, 43
  - laser, 39
  - raman rxn4, 12
  - rear panel, 16
  - specifications, 84
- basic connectivity, 31
- batch data export, 60
- calibration
  - internal, 44, 78
  - module, 39
  - probe, 78
  - probes, 46
  - reports, 50
  - verification, 28
  - wizard, 77
- camera
  - alignment, 77
  - interface, 71
  - saturation, 72
  - temperature, 72
- cdrh compliance, 11
- certification
  - atex, 86
  - compliance label, 11
  - hazardous area, 86
  - ua, 62
- clean, 77
- commissioning, 31
- compliance labels, 11
- conditions of use, 11
- contact information, 81
- continuous mode, 55
- dark exposures, 51
- data
  - batch export, 60
  - collection, 50
  - tag, 75
  - technical, 84
  - transfer, 60
- dc
  - fuses, 39
  - safety, 10
- diagnostics
  - environment, 67
  - exports, 69
  - trends, 68
- electrical
  - block diagram, 34
  - connection, 30
  - safety, 10
- errors, 70
- export, 66
  - batch data, 60
  - compliance, 4
  - diagnostics, 69
  - spc file network, 60
- external, 33
- eye
  - optical safety, 10
  - protection, 8
- focal length, 85
- focus, 52, 77
- four channel
  - analyzer, 12
  - calibration window, 28
  - probe, 22
  - rear panel, 16
- front panel, 14
- fuses, 39
- glossary, 5
- grating, 85
- health, 8
- humidity, 21
- hybrid
  - analyzer, 12
  - calibration window, 28
  - probe, 22
  - rear panel, 16

- i/o panel, 33
- interlock connector, 11, 37
- invictus, 85
- key control, 11
- laser
  - apertures, 39
  - base unit, 39
  - interlock circuit, 39
  - low power, 71
  - safety, 9
  - safety notice, 9
- lens, 77
- manual mode, 54
- mini display port, 33
- modbus, 62
- models
  - loading, 57
  - results, 58
- network configuration, 27
- numeric aperture, 9
- on/off button flashing, 71
- opc
  - connection, 73
  - ua, 31
- operating voltage, 84
- optical safety, 10
- optimization, 77
- password management, 65
- periodic mode, 56
- pollution degree, 84
- port
  - ethernet, 73
  - exc, 26
  - rs-485, 16
- power
  - consumption, 84
  - grounding, 33
  - switch, 14
  - up, 27
- probe
  - calibration, 46
  - installation, 7
  - laser apertures, 39
  - on/off, 9
  - verification, 78
- protective housing, 11
- raman runtime
  - initial setup, 44
  - network configuration, 27
  - overview, 13
- raman rxn4
  - air filter, 43
  - humidity, 21
  - interior, 38
  - location, 19, 20, 21
  - ventilation, 19, 20, 21
- rear panel, 16
- recovery console, 73
- relative humidity, 21
- remote
  - access, 60
  - interlock connector, 11, 37
- repair, 82
- restart, 73
- safety
  - electrical, 10
  - health, 8
  - optical, 10
- sample position, 77
- security
  - additional features, 65
  - basic connectivity, 31
  - password, 65
  - software, 63
  - user privileges, 64
- single channel analyzer, 12
  - calibration window, 28
  - probe, 22
  - rear panel, 16
- slit, 85
- snapshot mode, 53
- software
  - raman runtime, 13, 44
  - requirements, 66
  - security, 63
  - user privilege, 64
- spare parts, 82
- spc
  - file network, 60
  - hybrid, 47
  - probe calibration, 46
- specification, 84
- spectrograph, 39
- status
  - bar, 70
  - indicator, 61
- support, 81
- symbols, 4
- test server, 73
- touchscreen, 33
- trends, 68
- us export compliance, 4
- user privileges, 64
- ventilation, 19, 20, 21
- verification
  - calibration, 28
  - probe, 78
  - reports, 50
  - wizard, 77
- warm-up time, 84
- warnings, 70
- weee directive, 11
- weight, 84

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