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Brief Operating Instructions
Raman Rxn5

Endress+Hauser
People for Process Automation

Table of Contents

1 About this document

1.1 Warnings

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

Table 1. Warnings

1.2 Symbols

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 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.

2 Safety

2.1 Requirements for personnel

- Installation, commissioning, operation, and maintenance of the measuring system may be carried out only by specially trained technical personnel.
- Technical personnel must be authorized by the plant operator to carry out the specified activities.
- Electrical connections may be performed only by an electrical technician.
- Technical personnel must have read and understood these Operating Instructions and must follow the instructions contained therein.
- Faults at the measuring point may only be rectified by authorized 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 Rxn5 Analyzer is designed for use in the following applications:

- Chemical composition measurements of gases and some liquids in a process development environment. The Raman Rxn5 is particularly suited for use for measuring the composition gases at the input and output of the following process units and processes that are often found in refineries, ammonia plants, methanol plants, captive and merchant hydrogen plants, and LNG liquefaction and regasification terminals:
  - Steam methane reformers
  - Partial oxidation reformers
  - Coal, petcoke, biomass, and waste gasifiers
  - Primary and secondary shift converters
  - Acid gas removal
  - Methanators
  - Ammonia and methanol synthesis loops
  - Hydrotreaters
  - Hydrocrackers
  - Rundown to LNG storage tanks
  - Mixed refrigerant composition optimization

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 is not permitted.

2.3 Electrical safety

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

- Installation guidelines.
- Local standards and regulations electromagnetic compatibility.
- The product has been tested for electromagnetic compatibility in accordance with the applicable international standards for industrial applications.
- The electromagnetic compatibility indicated 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 hose connections are undamaged.
3. Do not operate damaged products, and protect them against unintentional operation.
4. 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.
2. Keep the door closed when not carrying out service and maintenance work.

⚠ CAUTION

Activities while the analyzer is in operation introduce risk of exposure to measured materials.

- ▶ Follow standard procedures for limiting exposure to 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.

2.5 Product safety

The product is designed to meet state-of-the-art safety requirements, has been tested, and left the factory in a condition in which it is safe to operate. The relevant regulations and international standards have been observed. Devices connected to the analyzer must comply with the applicable safety standards.

2.6 Important safeguards

- Do not use the Raman Rxn5 for anything other than its intended use.
- Do not drape the power cord over counters or on hot surfaces.
- Do not open the enclosure of the Raman Rxn5 while it is actively collecting data.
- Do not look directly into the laser beam.
- Do not stare or focus a laser in a diffused direction.
- Do not point a laser at a mirrored surface.
- Do not leave attached and unused probes uncapped or unblocked.
- Avoid shiny surfaces and always use a laser beam block.

2.7 Health and safety considerations

It is the user's responsibility to understand and comply with all applicable safety regulations. These will be variable based on the installation location of the instrument. Endress+Hauser takes no responsibility for determining the safe use of the instrument based on this qualification procedure.

The following actions and laser safety precautions must always be observed while using the Raman Rxn5:

- The Raman Rxn5 is a Center for Devices and Radiological Health (CDRH) Class 3B device. The user should wear appropriate eye protection.
- The Raman Rxn5 should only be used in a location with a suitable and stable power supply.
- If an interlock is required, all entryways to the room or area housing the Raman Rxn5 analyzer must be fitted with warning signs on doors into the Class 3B area.

2.8 Safety and handling notice

Raman Rxn5 analyzers incorporate a 532 nm laser excitation source. Take the following precautions when handling the analyzer and probes when the laser is **ON**:

- Turn **OFF** the laser power (using the laser on/off key for the appropriate channel, located on the front of Raman Rxn5) before making fiber connections and probe inspections.
- Do not look directly into the fiber probe output (when the optic is disconnected) or the output (window) of any probes.

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.

2.9 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 Rxn5 and the properties of intense laser radiation will aid in the safe operation of the Raman Rxn5. The Raman Rxn5 may contain one to four 532 nm lasers. Refer to your system specification information to determine how many lasers you have and which channels they are associated with. 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 Rxn5 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 bottom panel of the instrument via a fiber optic cable using an industial quality electrooptic connector. In the unlikely event that the fiber optic probecable is removed, the interlock is overridden, and the spring-loaded protective cap is overridden, there will be a laser beam exiting the analyzer unit. The beam emerges from a fiber with core diameter of 103 µm and 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 Rxn5 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 – 1×10^{-3} W·cm^{-2}		
Φ = Maximum Power in Watts (W)		

Table 3. 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 Rxn5 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.

2.9.1 Optical safety

The Raman Rxn5 is outfitted with one to four Class 3B lasers. Always be aware of the initial direction and possible scattering paths of the laser. The use of OD3 safety glasses is highly recommended for a 532 nm excitation wavelength.

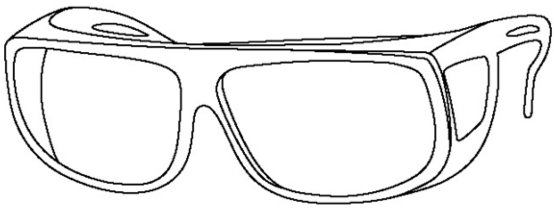

Figure 1. Laser safety glasses

2.9.2 Electrical safety

The Raman Rxn5 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.

2.9.3 CDRH compliance

The Raman Rxn5 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.

2.9.3.1 Protective housing

The Raman Rxn5 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.

2.9.3.2 Remote interlock connector

The Raman Rxn5 is supplied with a remote interlock connector for each channel. These connectors allow the operator to utilize an external interlock circuit in conjunction with Raman Rxn5 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.

2.9.3.3 Compliance labels

The Raman Rxn5 analyzer is certified to comply with the U.S. Federal Regulation 21 CFR, Chapter I, Subchapter (J), as administered by the CDRH.

2.9.4 WEEE directive compliance

The Raman Rxn5 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 2. 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 the Endress+Hauser Service Department at support.kosi@endress.com.

2.9.5 Specific conditions of use

1. The fiber optic cable linking the laser output to any Raman probe shall be installed so that the minimum bend radius specified by the cable manufacturer is not exceeded.
2. Where it is necessary to monitor the process level to ensure that the optical beam is not exposed to a potentially explosive atmosphere, the devices used to monitor the level shall be intrinsically safe or classed as simple apparatus, and be installed so as to provide a fault tolerance of 2 for category 1 equipment. The functional safety of this arrangement has not been assessed as part of this certification and it is the responsibility of the installer or user to ensure that an appropriate mechanism is in place.
3. The user shall purge the enclosure prior to start-up and upon loss of pressurization in accordance with the instructions marks on the Raman Rxn5 enclosure. An appropriate means of isolation shall be provided by the user, appropriately certified for the area of use and correctly installed.
4. 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

60°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 this certification and this certificate is not to be taken as indication that these IS circuits comply with relevant requirements.

2.10 Explosion hazard safety

The Raman Rxn5 is designed for use in potentially explosive atmospheres with an output designed for use in explosive atmospheres when purged per the procedures detailed in See the *Raman Rxn5 Operating Instructions*. Usage parameter limits vary based upon the processed material and probe head used.

The Raman Rxn5 must be installed following all federal, state, and local codes for equipment located in a potentially explosive area classified as Class 1, Division 2, or Zone 2. The protective gas shall not exceed 40°C at the inlet to the Raman Rxn5.

2.11 Construction materials

Materials used in the construction of the Raman Rxn5 enclosure, including all sealing materials, are compatible with the chemicals that the enclosure would typically encounter in the field. The enclosure surfaces have been designed and evaluated to ensure that they do not present hazards such as static buildup.

2.12 Protective gas

See *Installation* in Chapter 7 of the *Raman Rxn5 Operating Instructions* for warnings and information on the protective gas supply.

3 Product description

The Raman Rxn5 Analyzer is a turnkey laser-based Raman analyzer developed for applications in the petrochemical market. In these applications, the Raman Rxn5 analyzer produces spectra that resemble a chromatogram from a Gas Chromatography (GC) system, which can be analyzed using similar univariate methods commonly used in the analysis of chromatographic data. The Raman Rxn5 analyzer can be used to determine the composition of gas mixtures, but without the need for any valves, ovens, columns, or carrier gases that lead to the higher operational expense of GC systems.

Fiber-optic probes (for both gases and liquids) are used to interface the Raman Rxn5 analyzer to the process sample. The Raman Rxn5 features four independent probes operating simultaneously, replacing the need for mechanical stream switching often used in multi-stream analyses with a single instrument. In addition, the analyzer allows for the application of four independent software methods for analyzing different stream compositions. In essence, it represents four analyzers in one unit.

The Raman Rxn5 analyzer and can measure gas mixtures containing several components, with concentrations as low as 0.1 vol%. Typical gases that can be analyzed inlcude: H_2, N_2, O_2, CO, CO_2, H_2S, CH_4, C_2H_4, C_2H_6, Cl_2, F_2, HF, BF_3, SO_2, and NH_3. In addition, the Raman Rxn5 has a wide linear dynamic range and can measure components at levels typically from 0.1 mol % up to 100 mol%.

The Raman Rxn5 analyzer incorporates a flat screen, touch-sensitive display that is utilized for all user interactions. A simple tap with a finger is the equivalent of a mouse click.

3.1.1 Raman spectroscopy

In Raman spectroscopy, a sample is excited with a laser source of a specific wavelength, or color. The laser light is often transmitted to the sample via a fiber-optic cables and an optical probe Laser excitation causes the sample molecules to vibrate and absorb some of the laser energy, which causes some light to be re-emitted from the sample at lower energy levels, or wavelengths (colors), than that of the laser excitation source. This Raman-shifted light is carried back to the Raman Rxn5 through a separate fiber optic for analysis. Each chemical species in the gas sample can scatter one or more discrete wavelengths, or colors, of light. The number of colors and their intensity are unique to each chemical species. Each peak in a Raman spectrum corresponds to a different wavelength of light (Figure 3).

3.1.2 Lasers

The unique design of the Raman Rxn5 contains up to four lasers and four sample probes, each operating independently. This allows the analyzer to measure four separate samples simultaneously. Inside the analyzer, each of the four lasers launches light into a discrete fiber optic patch cable, which is routed to one of four I/O panels on the bottom of the analyzer. At each I/O panel, this patch cable is coupled to one side of the main fiber optic transport cable by way of an industrial hybrid connector, which delivers the laser to the sampling probe for sample excitation. The Raman shifted light is then collected in the probe and coupled to a separate fiber optic for transport back to the analyzer, where it is coupled to a separate patch cable inside the analyzer for delivery to the detection module. All four returns from the sampling probes are multiplexed into one connector at the detection module for analysis.

3.1.3 Detection module

The Raman Rxn5 detection module is where the collected Raman scattered light from the sample is measured. There are four analysis channels in the Raman Rxn5 detection module, one for each of the four streams. The Raman scattered light from these four streams enters the detection module where it is dispersed onto four separate regions of a Charge Coupled Device (CCD) array in a similar manner to how a prism breaks up light into separate colors. The Raman Rxn5 detection module measures the intensities of the various colors of light that make up the Raman light collected from the sample. The X-axis of the Raman spectrum represents the different color components of the Raman scattered light and the Y-axis represents the intensities of these colors.

The native data format that the CCD outputs to the system software is simply number of Analog/Digital (A/D) counts (intensity) for a given X-axis region of the CCD. We need to correlate these X-axis regions to the colors of light that are impinged upon them. This is where wavelength calibration comes into play. Nested under the detection module is a wavelength calibration module. In addition to the four stream analysis channels, there are two calibration channels presented to two additional regions on the CCD array. For each sample acquisition, a wavelength calibration module emits light that is collected onto these additional calibration regions. The atomic emission light source in the wavelength calibration module contains many discrete colors that are extremely stable. Since the exact wavelength, or color, is known for the discrete color lines emitted by the module, it is possible to correlate a CCD camera region with a particular wavelength of light, which is used to analyze the Raman spectrum.

The X-axis of an Raman spectrum is most commonly displayed in units of Raman shift (cm - 1), which represents the energy difference between the wavelength of the excitation source and the wavelength of each Raman-scattered peak. Therefore, it is necessary to accurately calibrate the exact wavelength of the laser source. The Raman peak of one or more of the chemicals that are known to be present in the sample is used to calculate the exact wavelength of the laser, which represents ‘0’ on the Raman shift X-axis.

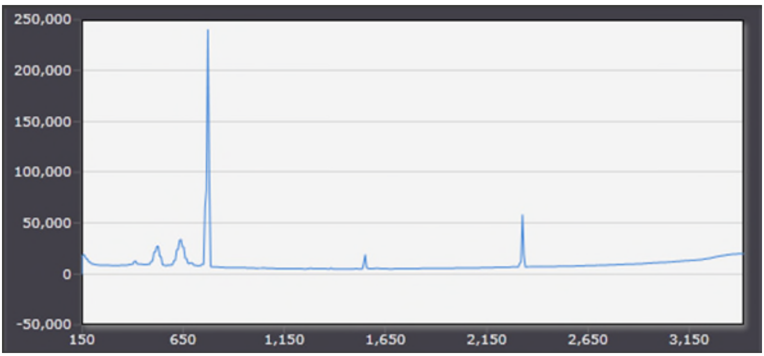

Figure 3. Typical spectrum from a Raman Rxn5 analyzer

3.2 Product Design

3.2.1 Raman Rxn5 Analyzer exterior

The exterior of the Raman Rxn5 consists of a painted steel (or optional 316 Stainless Steel) enclosure.

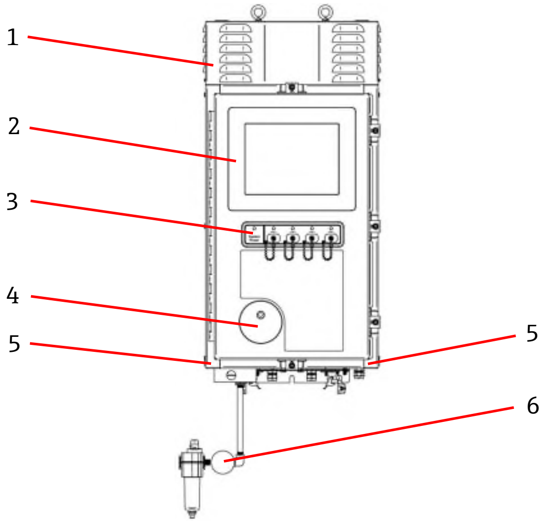

Figure 4. Exterior of the Raman Rxn5 analyzer

#	Name	Description
1	Cooling Exhaust	Cooling air exhausts through the vents in this cover. Do not block.
2	Monitor	The built in in Raman RunTime interface and touchscreen monitor.
3	Switch Indicator Panel and Laser On/Off Keys	▪ **System power indicator.** Green and steady indicates system is powered and operating normally. ▪ **Laser on/off keys and indicators.** Magnetically coupled switches control laser power for each channel.
4	Purge Indicator	A Green indicator light that indicates that the pressure inside the enclosure is above 0.20" water column.
5	Cooling Air Inlet	Cooling air enters in this location in both sides of enclosure. Do not block.
6	Purge Valve and Air Conditioning	The dilution and leakage compensation includes two modes: ▪ **High Flow Dilution.** The dial on the valve should be turned so the slot in the dial is horizontal and lined up with the "ON" position ▪ **Leakage Compensation Mode.** After manual dilution has been performed, the valve can be switched to this mode by turning the dial so the slot in the dial is vertical.

Table 4. Raman Rxn5 analyzer interior view

3.2.2 Raman Rxn5 Analyzer interior features

Interior features within the Raman Rxn5 analyzer are shown below:

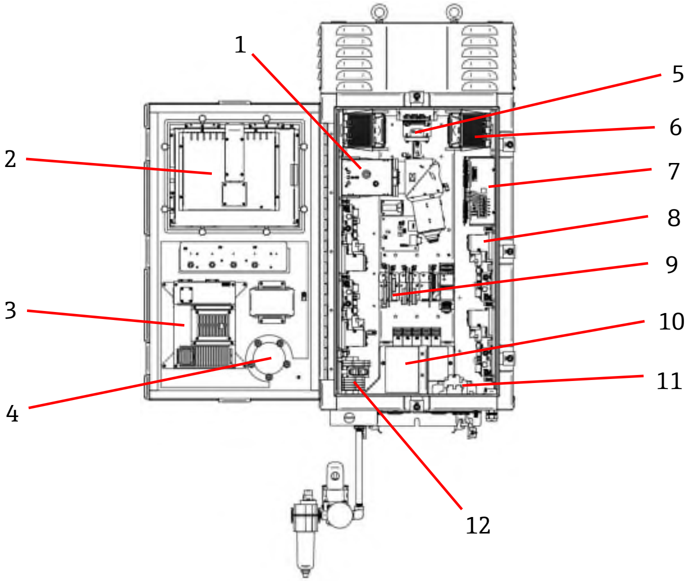

Figure 5. Raman Rxn5 analyzer interior view

#	Name	Description
1	Detection Module	The location where collected Raman scattered light from the sample is analyzed. There are four analysis channels in the detection module.
2	Monitor	Touchscreen monitor for Raman RunTime interface.
3	Controller	System controller with Raman RunTime.
4	Relief Valve	Monitors internal enclosure purge pressure.
5	Motor Controller	A device that regulates the speed and direction of the cooling fan motor.
6	Coolers	Peltier cooling devices to remove waste heat from inside the enclosure.
7	Power Supply	Main DC power supply for all electronics inside the enclosure.
8	Lasers (4)	The Rxn5 includes up to four lasers, depending on configuration ordered.
9	Control Electronics	Analyzer internal sensor signal conditioning and digitization electronics. Thermal control electronics and IS barrier power supply also reside here.
10	IO Area	Probe fiber interlock and temperature/pressure sensor connection area.
11	AC Mains	Customer supplied mains power is connected here.
12	Non-IS Low Voltage IO Area	Connection area for: Qty 2 RS-485 Modbus RTU, Qty 2 TCP/IP for Modbus TCP and/or remote control, Qty 4 24VDC sampling valve driver.

Table 5. Raman Rxn5 analyzer interior view

4 Incoming product acceptance and identification

4.1 Incoming acceptance

1. Verify that the packaging is undamaged. Notify the supplier 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 your supplier or your local sales center.

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:

- Manufactuer 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 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 Rxn5 analyzer in the configuration ordered
- Raman Rxn5 Operating Instructions (electronic copy)
- Raman Rxn5 Certificate of Product Performance (electronic copy)
- Local declarations of conformity, if applicable (electronic copy)
- Certificates for hazardous zone use, if applicable (electronic copy)
- Raman Rxn5 optional accessories, if applicable

If you have any queries: Please contact your supplier or local sales center.

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 Rxn5 is designed for use in potentially explosive atmospheres with an output designed for use in explosive atmospheres. Usage parameter limits vary based upon the processed material and probehead used.

The Raman Rxn5 must be installed following all federal, state, and local codes for equipment located in a potentially explosive area classified as Class 1, Division 2 or Zone 2. The protective gas shall not exceed 40°C at the inlet to the Raman Rxn5.

5 Electrical connection

5.1 System power light

The system power light (Figure 6) may be in one of the following three states:

Status	Description
Green and steady	The system is powered and operating normally.
Red and fast flashing	The system is powered but the temperature is too warm.
Red and slow flashing	The system is warming up.

Table 6. Power light

5.2 Laser ON/Off keys

The four laser lights may be in one of the following two states:

Status	Description
Yellow and steady	The laser interlock is closed, the diode is on and active.
Off	The laser interlock is open and the diode is off.

Table 7. Laser ON/OFF keys

The system features a lock out tag out system. A laser key may be removed and a customer-supplied lock inserted below it. When the lock is in place, the laser key may not be inserted, preventing power to that laser.

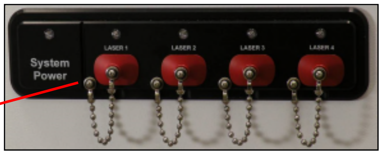

Figure 6. System power light and laser on/off keys

5.3 Purge indicator

The CYCLOPS purge indicator is shown is shown in Figure 7. The light will be on if there is positive purge pressure. See the *Raman Rxn5 Operating Instructions* for more information.

Figure 7. Purge indicator

5.4 Glands and connectors on the bottom of the Raman Rxn5

Figure 8 shows the temperature and pressure glands for all four channels is shown below, the fiber optic connectors for all four channels, as well as the Alternating Current (AC) power input, the ground stud, the purge valve, and gauge.

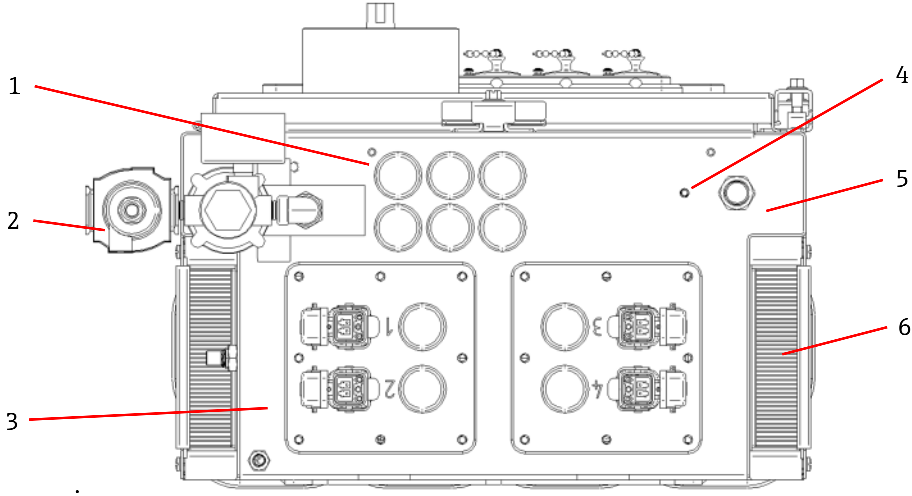

Figure 8. Glands and connectors on the bottom of the Raman Rxn5

#	Name	Description
1	Low voltage IO location	Six holes for low voltage communications and process control wiring. Cord grips provided by customer and shall meet local electrical and hazardous area safety standards.
2	Purge air inlet	¼" NPT connection point for purge air supply.
3	Intrinsically safe IO location	IO panels include up to four electro-optical connectors for sampling probes and cord grips for sample environmental sensors.
4	Earth ground stud	¼-20 x .75" enclosure earth ground stud.
5	AC mains inlet	Cord grip location for AC mains power connection.
6	Cooling air inlet	A cooling air inlet on each side of the enclosure. Do not block.

Table 8. Raman Rxn5 analyzer bottom view

6 Commissioning

6.1 Unpacking the Raman Rxn5 Analyzer

It is recommended that the Raman Rxn5 be unpackaged in front of the location where the Raman Rxn5 will be wall mounted. If the Raman Rxn5 is unpackaged in a separate location and transported to the wall mounting location, the Raman Rxn5 should be transported laying on its back with the touchscreen panel pointing up. See *Lifting the Raman Rxn5 Analyzer* in *Section 6.2* for more information.

To unpack the Raman Rxn5 analyzer:

1. Stand the box up following the labels on the box. Make sure the arrows are pointing up.
2. Cut the banding off the box.
3. Slide the box up and off the Raman Rxn5 analyzer. The analyzer will remain standing in the foam bottom as shown in Figure 9.
4. Save the packaging for future use.

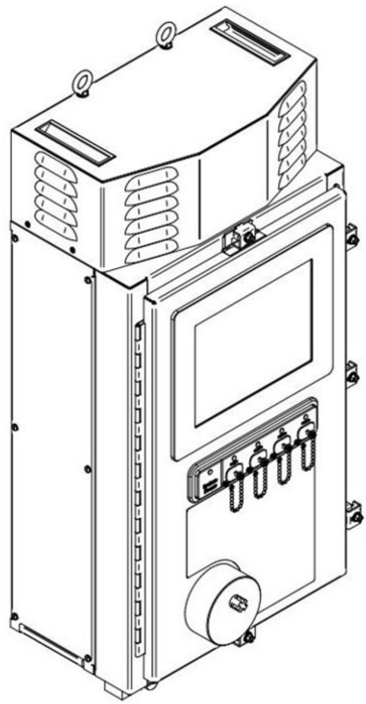

Figure 9. View of the Raman Rxn5 after the box is removed

6.2 Lifting the Raman Rxn5 Analyzer

The Raman Rxn5 may be lifted by mechanical means using the two lifting rings shown in Figure 10. The Raman Rxn5 may also be lifted by two persons using the lift points shown in Figure 10. If the Raman Rxn5 is carried by two persons from one location to another, it is recommended to lay the Raman Rxn5 on its back with the touchscreen pointing up, with a person on each side of the Raman Rxn5 grasping the bottom edge of the enclosure with both hands.

WARNING

The Raman Rxn5 weighs 135 lbs and requires two persons for lifting.

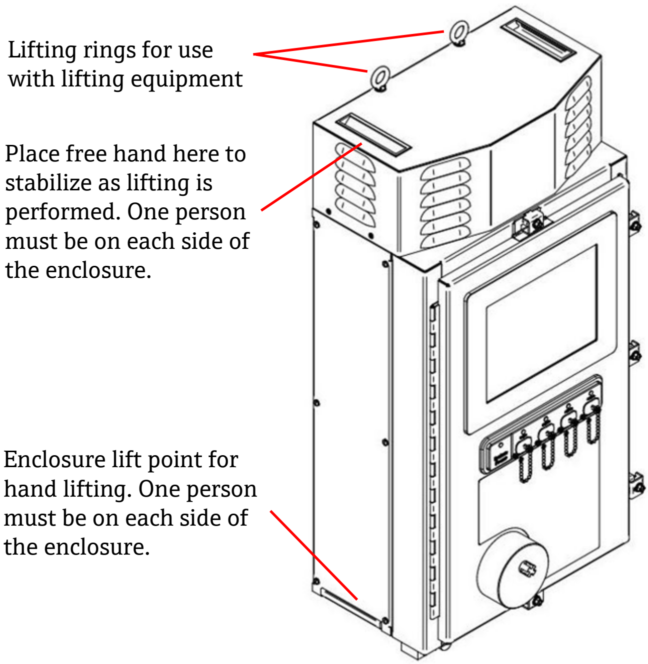

Figure 10. Lifting the Raman Rxn5

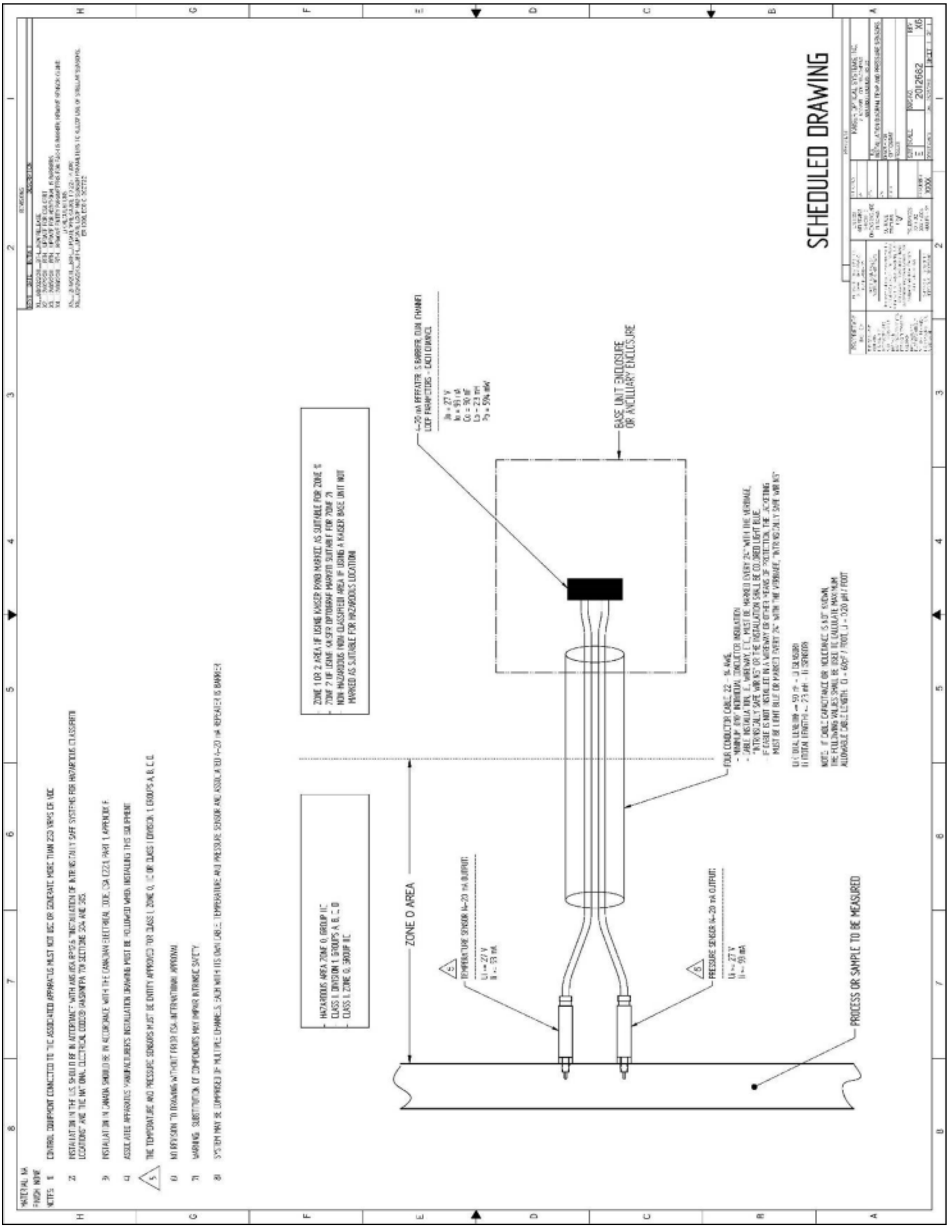

Figure 11. Control drawing for temperature and pressure I.S. circuit (p/n 2012682)

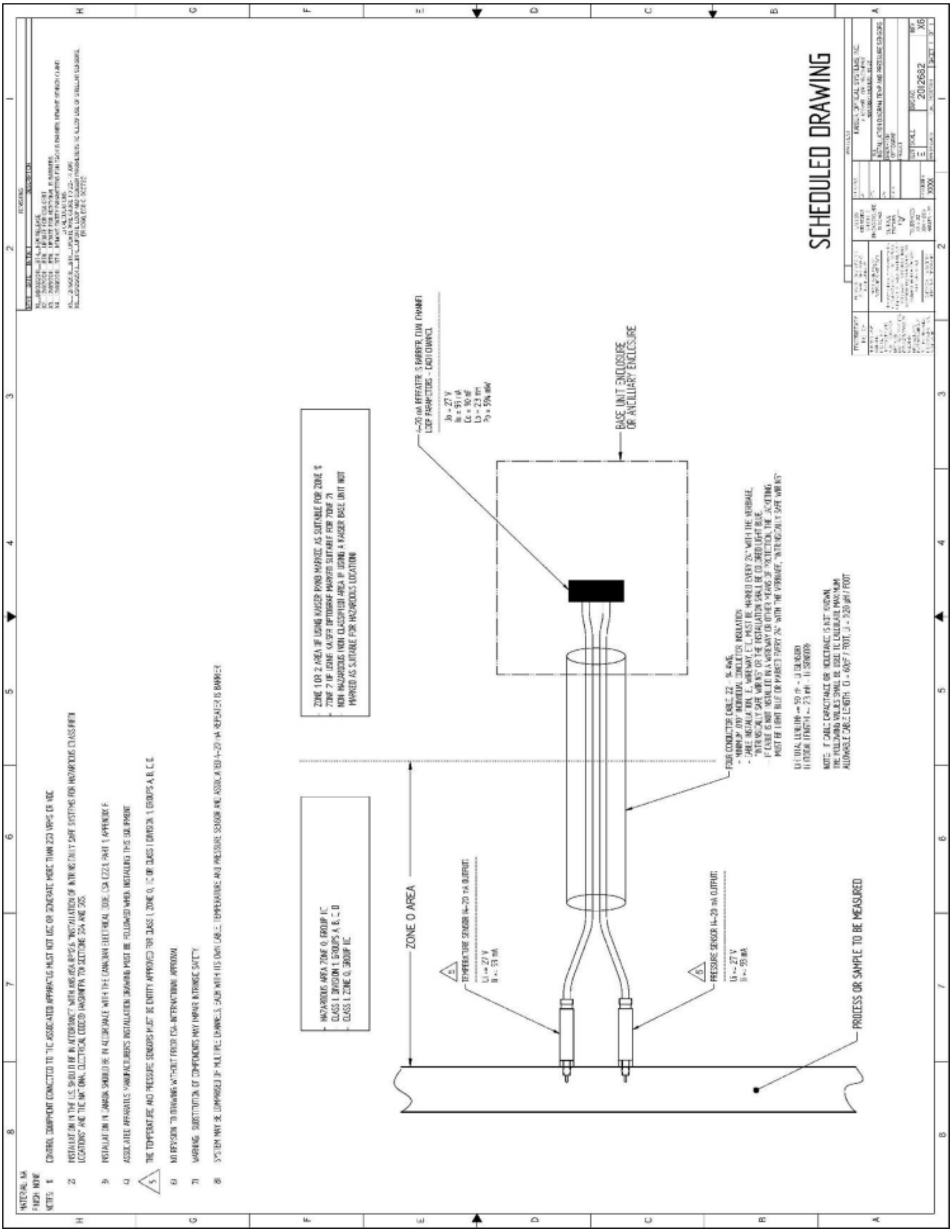

Figure 12. Control drawing for probe I.S. circuit (p/n 4002396)

7 Operation

7.1 Raman Rxn5 main screen

The main screen of the user interface displays the most recent results for each of the four streams. See Figure 13. Each stream's data is displayed in a separate quadrant.

The quadrant display for a given stream shows the percent of each component in that stream as determined from the last sample taken for that stream, as well as optional derived values such as Gross Heating Value and Wobbe Index. The time stamp of the last sample is also displayed. The **Options** menu provides access to system settings, diagnostics, and calibration.

Finally, a large indicator in the lower left corner of each quadrant displays the current sampling status of that stream. The indicator will display Ready with an orange background when a stream is ready to collect data, Disabled when a stream has been disabled, and Prepare when the Raman Rxn5 analyzer is preparing a sample for acquisition.

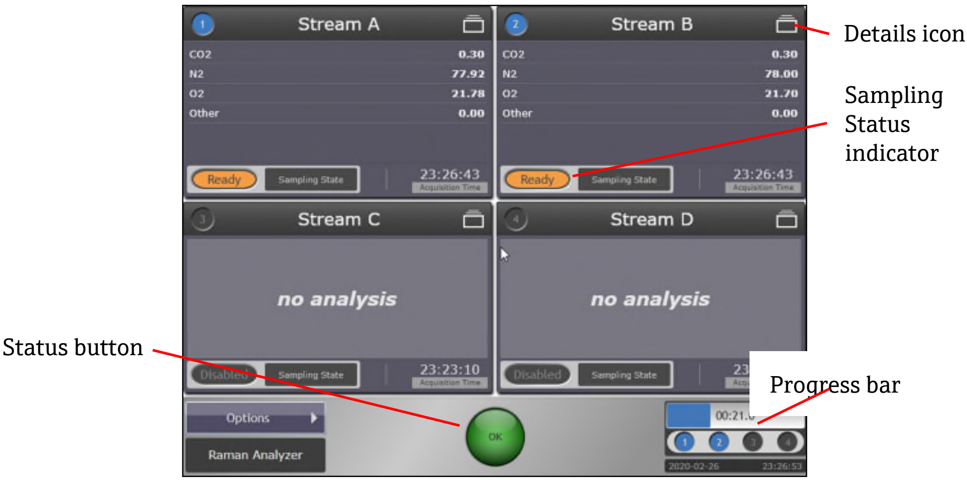

Figure 13. Raman Rxn5 main screen

7.2 Raman Rxn5 status indicators

Raman Rxn5 Status Button

The **Status** button is located at the center bottom of both the Main Screen and the Stream Detail View. See Figure 13. **Green** (OK) indicates the status is normal, **Yellow** (Warning) indicates at least one item is in a warning state while no items are in an error state, and **Red** (Error) indicates at least one item is in an error state.

Touch the **Status** button to display additional information on the analyzer status. Figure 14 shows the Analyzer Status screen that appears. To exit this screen, click the **X** at the top left of the Analyzer Status screen.

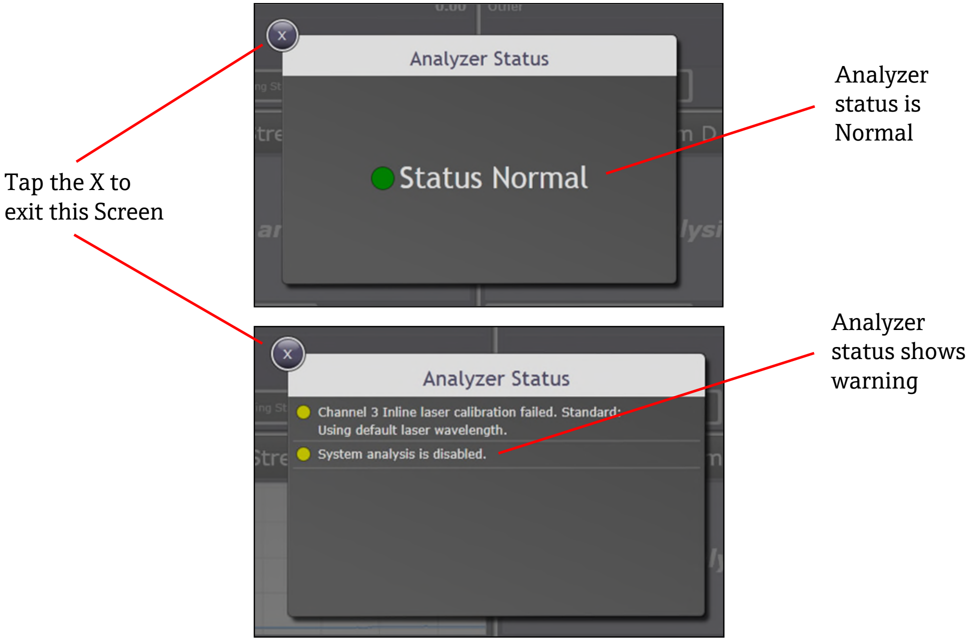

Figure 14. Examples of the analyzer status screen

Raman Rxn5 Progress Bar

The Raman Rxn5 progress bar (Figure 15) is shown in the lower right corner of both the Main Screen and the Detail View. The status bar continually updates to display the time remaining in the current acquisition.

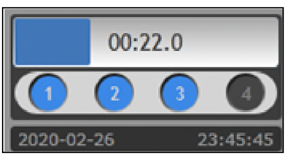

Figure 15. Progress bar

8 Diagnostics and troubleshooting

This section provides solutions to problems you may encounter as you work with the Raman Rxn5.

NOTICE

- Endress+Hauser offers an *Raman Rxn5 Optical Service Kit (p/n 2013270)*, which is intended for diagnosing and servicing the major field-serviceable optical paths and components of the Raman Rxn5 system. It is also intended to diagnose and identify components that may require replacement or factory service.

8.1 Diagnostics

Several hardware diagnostics are available in the Raman Rxn5 control software. To access the systems diagnostics, select **Options > Diagnostics** from the Main Screen. The following are the available diagnostics and their expected ranges. The system software will assert warnings and errors to the user and the DCS (if configured) at the detailed thresholds.

Diagnostic	Warning Threshold	Error Threshold	Expected Value
Air Temp External	48 °C	50 °C	-20 °C – +50 °C
Air Temp Internal	50 °C	55 °C	0 °C – 55 °C
Grating Temperature	53 °C	55 °C	0 °C – 55 °C
Heatsink HVAC 1 (left) Inside	N/A	N/A	At external > 30 °C Plenum minus 15 – 20 °C
Heatsink HVAC 1 (left) Plenum	73 °C	75 °C	At external < 25 °C Inside minus 15 – 20 °C
Heatsink HVAC 2 (left) Inside	N/A	N/A	At external > 35 °C Plenum minus 15 – 20 °C
Heatsink HVAC 2 (left) Plenum	73 °C	75 °C	At external < 25 °C Inside minus 15 – 20 °C
Heatsink Power Supply	73 °C		5 °C – 20 °C over external
Heatsink Spectrograph	58 °C	60 °C	5 °C – 8 °C over external
Relative Humidity	65%	85%	–
Channel <ch> Laser Diode Current	2.1 A	N/A	1.0A – 2.1A
Channel <ch> Laser Heatsink	63 °C	65 °C	2 °C – 5 °C over external
Channel <ch> Laser Power Out	N/A	N/A	130 mW to 170 mW
Channel <ch> Sample Pressure	N/A	N/A	–
Channel <ch> Sample Temperature	N/A	N/A	–

Table 9. Hardware diagnostics

In addition to diagnostics shown in the **Options > Diagnostics** screen, the software may produce the following diagnostic warnings and alarms during operation.

Diagnostic	Warning Threshold	Error Threshold	Expected Value
Detector Temperature too High	> -40 °C	> -38 °C	Not shown unless warning or error
Detector Temperature too Low	< -40 °C	< -42 °C	Not shown unless warning or error
Detector Saturation (Signal Strength) too High	> 80%	> 90%	30% – 80%
Detector Saturation (Signal Strength) too Low	NA	< 2%	30% – 80%
Warnings			
Blower Alarm: The cooling fan is not working properly. The analyzer might overheat.			
Inline Wavelength Calibration Warning. Neon pixel fill below warning level.			
Channel <ch> Inline wavelength calibration failed. Using default wavelength calibration.			
Channel <ch> Inline laser calibration failed. Using default laser wavelength.			
Channel <ch>: <analysis> calibration does not perform within tolerance.			
Channel <ch>: <analysis> calibration has not been verified in more than <x> days.			
System analysis is disabled.			

Table 10. Diagnostic warnings and alarms

8.2 Troubleshooting

8.2.1 Probe fouling

Probe fouling due to sample contamination can be a persistent problem in the absence of sound sample preparation. Typically, probe fouling presents itself with a rising baseline as shown in Figure 16.

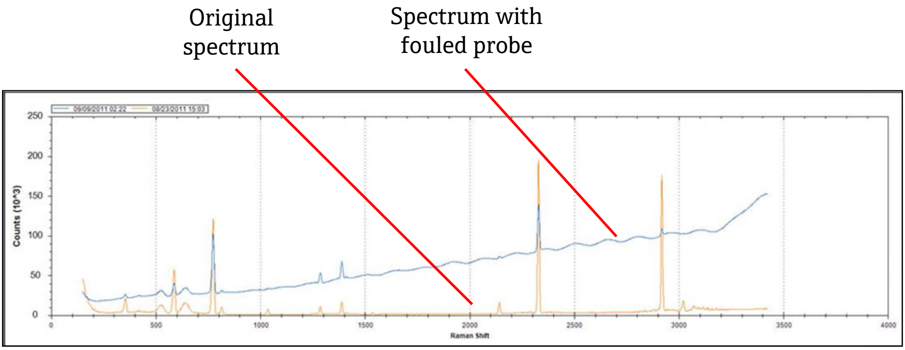

Figure 16. Spectrum with fouled probe

If contamination is suspected, first turn off the laser for the contaminated probe at the switch panel. Remove the probe from the process and clean its window and mirror using the procedures. See the *Raman Rxn5 Operating Instructions* for more information. If the problem persists after cleaning, it is likely that the probe optical surfaces have been damaged and the probe should be returned to Endress+Hauser for repair.

8.2.2 Low signal level

The software may display a warning or an error that the detector saturation is too low.

First check the sample pressure—the Raman signal is directly proportional to the sample pressure.

If the pressure is suitable, analyze the spectrum for probe fouling.

If probe fouling is not present, check the system diagnostic for laser power.

If laser power is good, check the laser delivery fiber optic train for power transmission. For a 150 mW laser, at least 100 mW should be delivered to the probe through its fiber optic. To check this, remove and clean the fiber cable at the probe interface before checking power levels.

8.2.3 High signal level

The software may display a warning or an error that the detector saturation is too high.

This is likely due to an increase in the sample pressure. Check that the sample pressure is in range.

8.2.4 Failing inline wavelength calibration

The system may display an error stating the inline wavelength calibration has failed and it is reverting to the factory calibration.

First check whether or not it coincides with a pixel fill alarm for the neon. If the system is failing this, the most likely scenario is that the neon board has failed. To verify, remove the fiber connector from the calibration module and, using a mirror, look for **Red** light to appear at the fiber optic connector for 2 to 3 seconds at the beginning of each acquisition. If the light isn't turning on, replace the calibration module.

8.2.5 Failing inline laser calibration

The system may display an error stating the inline laser calibration is failing.

First check the spectrum for probe fouling.

Next, check the gas sample peak that has been assigned for laser calibration and make sure the assigned peak is present in the spectrum, and is strong.

Check if backup component peaks have been assigned to be used when the species for the primary calibration peak is not present in the gas stream. Ensure that these backup component(s) are present, or expected to be present, in the stream at sufficient concentration to produce a strong peak for laser calibration.

8.2.6 Laser drive current too high

The software may display a warning stating that the laser diode current is too high.

The laser is beginning to fail and plans should be made to replace the laser. See the *Raman Rxn5 Operating Instructions* for more information. As a laser ages, the drive current required for a given power output will rise to the point where the drive electronics have reached current limit and the output power will begin to fall. As power levels begin to fall, Raman signal intensity will fall proportionally. The application will determine how much signal drop it can handle before affecting the accuracy of the predictions.

8.2.7 Excessive vibration (blower)

If the bearing in the fan motor is starting to fail, the first sign will be excessive vibration transmitted through the analyzer. The analyzer can withstand the vibration, but the fan motor must be replaced before it seizes rendering the cooling system ineffective. See the *Raman Rxn5 Operating Instructions* for more information.

8.2.8 Internal temperature too high

The software may display an error stating that the internal or grating temperature is too high.

If the software is not asserting that the external temperature is too high, then it is possible the either the fan speed has been compromised OR the airflow in one or both plenums has been restricted OR one or both of the HVAC units has failed.

First, look at the system diagnostic for the internal and plenum HVAC temperatures. The HVAC units should be able to maintain a 15 °C delta (plenum temp − inside temp) when in full cool mode (external temperature > 33 °C). If the deltas are much less than 15 °C, one or both HVAC units are likely in need of replacement.

Second, remove both plenum covers and check for fouled heat sinks. If necessary, clean the heat sinks with compressed air or water and re-install the plenum covers.

Third, check the fan motor for excessive vibration indicating wear and Revolutions Per Minute (RPM) loss.

8.2.9 Detector temperature too high

The software may display a warning or error that the detector temperature is too high.

The CCD array in the detection module is not being properly cooled.

Check for normal ambient temperature operating conditions.

Check for heat sink restrictions.

Check for normal thermal control diagnostics.

If the thermal control system is operating normally, then it is likely that the detection module needs to be replaced. See the *Raman Rxn5 Operating Instructions* for more information.

8.2.10 Relative humidity too high

The software may display a warning or error that the relative humidity is too high or condensate may be exiting the drain port.

Check to make sure the purge air supply is dry within specification.

Then, check the desiccant cartridges inside the analyzer. If they are pink, they should be replaced. See the *Raman Rxn5 Operating Instructions* for more information.