BA02179C/66/EN/03.23
70212045

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)** 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)** 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** Consequences of non-compliance (if applicable) ▸ Action/note	This symbol alerts you to situations which may result in damage to property.

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 Rxn5 analyzer 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 CSA Certification Mark indicates that the product was tested against and met the applicable North American standards requirements.
	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).

1.3 U.S. export compliance

The policy of Endress+Hauser is strict compliance with U.S. export control laws as detailed on the website of the Bureau of Industry and Security at the U.S. Department of Commerce.

1.4 List of abbreviations

Term	Description
A	ampere
AC	alternating current
A/D	analog-to-digital
ANSI	American National Standards Institute
ATEX	atmosphère explosible (explosive atmosphere)
AWG	American wire gauge
°C	Celsius
CAT	category
CCD	charge coupled device
CFM	cubic feet per minute
cm	centimeter
COM	communications
CSA	CSA Group
DAQ	data acquisition
DC	direct current
DCS	distributed control system
DHCP	dynamic host configuration protocol
EEA	European economic area
°F	Fahrenheit
FNPT	female national pipe thread
HVAC	heating, ventilation, and air conditioning
Hz	hertz
I/O	input/output
IEC	International Electrotechnical Commission
IP	internet protocol
IS	intrinsically safe
ISA	International Society of Automation
LED	light emitting diode
mA	milliampere
mW	milliwatt
Nd:YAG	neodymium-doped yttrium aluminum garnet
NEC	National Electrical Code
NPT	national pipe thread
PCB	printed circuit board
psi	pounds per square inch
RPM	revolutions per minute
SATA	serial ATA

Term	Description
SCFM	standard cubic feet per minute
TCP	transmission control protocol
UL	UL Solutions
USB	universal serial bus
V	volt
VGA	video graphic array
W	watt
WEEE	waste electrical and electronic equipment

2 Basic safety instructions

Read this section carefully to avoid danger to individuals or the facility. Additional laser safety information and hazardous area certification and safety instructions are contained in the *Raman Rxn5 Safety Instructions (XA02746C)*. See *Supplementary documentation* → 🖹.

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.
- 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 herein.
- 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 Intended use

The Raman Rxn5 analyzer is designed for use in chemical composition measurements of gases and some liquids in a process development environment.

The Raman Rxn5 is particularly suited for measuring the composition of 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, facilities using gas turbines, and LNG liquefaction and regasification terminals:

- Steam methane, partial oxidation, and autothermal 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
- Gas turbine fuel feed

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 Workplace safety

- 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, or in areas where damage to the integrity of the power cord may occur.
- 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 allow emitted laser light to reflect off 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 attached and unused probes uncapped or unblocked while they are still attached to the analyzer.

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 not damaged.
3. Do not operate damaged products. 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 conducting service and maintenance work.

⚠ CAUTION

Activities while the analyzer is in operation introduce risk of exposure to hazardous 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 following the appropriate site policies and cleaning procedures.

2.5 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, and users should follow the probe-specific product safety instructions.

2.6 IT security

Our warranty is valid only if the device is installed and used as described in the Operating Instructions. The device is equipped with security mechanisms to protect it against any inadvertent changes to the settings.

IT security measures, which provide additional protection for the device and associated data transfer, must be implemented by the operators themselves in line with their security standards.

3 Product description

3.1 The Raman Rxn5 analyzer

The Raman Rxn5 analyzer, powered by Kaiser Raman technology, is a turnkey, laser-based Raman analyzer with an embedded controller with built-in Raman RunTime control software. Raman spectroscopy provides the chemical specificity of mid-infrared (IR) spectroscopy and the sampling simplicity of near-infrared (NIR) spectroscopy. Raman spectroscopy allows vibrational spectra to be collected *in situ*, using fiber-coupled probes. The Raman Rxn5 analyzer was developed specifically optimized for gas-phase applications in the petrochemical and other process industries.

In these applications, the Raman Rxn5 analyzer produces simple spectra that resemble gas chromatograms, allowing for the use of univariate methods of analysis. The Raman Rxn5 analyzer can be used to determine the composition of gas mixtures, but without the need for valves, ovens, columns, or carrier gases that often lead to higher operational expenses.

The Raman Rxn5 is designed to use between one and four laser sources, each coupled to a separate fiber-optic probe interface to a process sample. This configuration allows for simultaneous operation, replacing the need for mechanical stream switching that is often used in multi-stream analyses with a single instrument. The RunTime software allows each channel to use an independent software method for analyzing different stream compositions. It is like having four analyzers in one unit.

The Raman Rxn5 analyzer can measure gas mixtures containing several components. Typical gases that can be analyzed include: 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.

3.2 Raman RunTime software overview

Raman RunTime embedded software is the control platform for the suite of Raman Rxn analyzers. Raman RunTime software on the Raman Rxn5 is intended for easy use with built-in univariate software methods based on a built-in library of standard gas Raman spectra 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. Refer to the *Raman RunTime Operating Instructions (BA02180C)* for descriptions of analyzer operations including analyzer operation, calibration, verification, methods, and error reports.

3.3 Product design

3.3.1 Front exterior

The exterior of the analyzer consists of a painted steel (or optional 316L stainless steel) enclosure. On the front of the instrument are the standard user interfaces. These include an integrated touch screen interface, light emitting diode (LED) indicators, laser interlock switches, and a purge indicator.

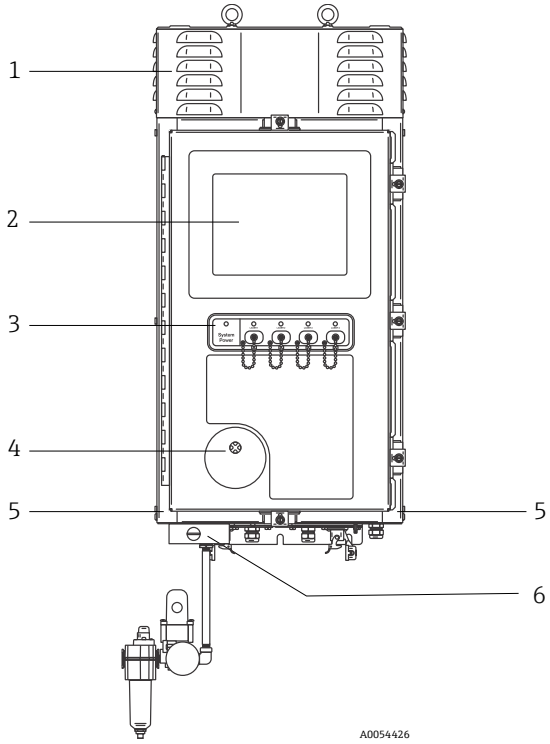


Figure 1. Exterior of the Raman Rxn5 analyzer

#	Name	Description
1	Cooling exhaust vent shroud	Cooling air exhausts through the vents in this cover. Do not block.
2	Touchscreen monitor	The built 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. Red and fast flashing indicates system is powered, but internal temperature is too warm. Red and slow flashing indicates that the system is too cold. Red and slow is normal upon startup in colder environments. ▪ **Laser on/off keys and indicators.** Magnetically coupled switches control laser power for each channel. Switches are lockout/tagout compatible. Yellow indicators for each channel indicate if laser is on.
4	Purge indicator	A **Green** indicator light that indicates that the pressure inside the enclosure is above 5.1 mm (0.20 in) water column
5	Cooling air inlet	Cooling air enters in this location in both sides of enclosure. Do not block.
6	Purge valve and purge 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. This position is used to purge enclosure of potentially hazardous gases prior to power-up. Dilution time is > 9.5 minutes. ▪ **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. This position is used to reduce purge air consumption after initial dilution.

3.4 Probe connectors

The probes attach to a panel on the bottom of the base unit for simple connectivity. This design also allows for the installation of more Raman Rxn5 analyzer units in the same analyzer shelter space than process gas chromatographs can accommodate.

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 electrical connection contained within the fiber optics is an intrinsically safe interlock loop which will turn off the laser for the probe in case of fiber breakage. Ensure the latch is engaged after inserting the EO fiber connector.

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, refer to our website (https://endress.com/contact) for the list of local sales channels in your area.

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 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*
- *Raman RunTime Operating Instructions*
- Raman Rxn5 Certificate of Product Performance
- Local declarations of conformity, if applicable
- Certificates for hazardous zone use, if applicable
- Raman Rxn5 optional accessories, if applicable

If you have any questions regarding the items delivered, or if anything appears to be missing, refer to our website (https://endress.com/contact) for the list of local sales channels in your area.

4.3 Certificates and approvals

The Raman Rxn family of base analyzer units are CE-marked as being compliant with the laser performance requirements of U.S. 21 CFR, Chapter I, Subchapter (J), the low-voltage directive (LVD), the electromagnetic compatibility (EMC) directive, and the applicable laser eye and skin safety standards as indicated below.

- 21 CFR 1040
- LVD 2014/35/EU
- EMC Directive 2014/30/EU
- IEC 60825-1

The Raman Rxn5 base unit has been certified for installation in a Class 1, Division 2 hazardous area under various standards.

The Raman Rxn5 must be installed following all federal, state, and local codes required for the region of installation. Many regions around the world require specific certificates of type review such as IECEx or ATEX before they can be used in the region. See *Certifications* → 🖹 to view specific certification approvals for the Raman Rxn5.

5 Installation

5.1 Site requirements

The base unit enclosure contains all functional components of the analyzer. The enclosure is designed for wall or trolley mounting in a vertical orientation. The unit is purged and sealed. An impeller on the top of the unit draws air in from below the unit along the sides to dissipate heat from multiple heat sinks. To allow for air flow, the open inlets on the bottom of either side of the unit must be free of obstructions. See *Thermal control* → 🖹 for more details on the cooling system and installation requirements.

5.1.1 Electrical power

The supply voltage should be regulated and free of voltage spikes. It is recommended, but not required, that an uninterruptible power supply (UPS) is used with the analyzer to prevent potential data loss due to instrument power cycling in response to mains power loss. A UPS capable of providing the analyzer's maximum power consumption, but at least the typical running power of the Raman Rxn5 is highly recommended. See the *Electrical and communications* → 🖹 technical data for details on power consumption.

For the Raman Rxn5 analyzer, the location selected is only required to have 1 voltage power outlet capable of supplying the maximum power required by the analyzer.

5.1.2 Location

The Raman Rxn5 base unit enclosure is designed for wall or trolley mounting in a vertical orientation. To allow for air flow, the open inlets on the bottom of either side of the unit must be free of obstructions. In addition, the location selected should be:

- Protected from rain, direct sunlight, and temperature extremes
- Protected from exposure to corrosive gas
- Protected from dust and static electricity

5.1.3 Ventilation

The location selected should allow for adequate ventilation below and on the sides and top of the base unit. A minimum space of 450 mm (18 in) should be provided around the bottom of the analyzer. A minimum space of 152.4 mm (6 in) must be provided on the sides and top of the base unit to allow access for cleaning the heat sinks and cooling impeller maintenance.

5.1.4 Temperature

The Raman Rxn5 unit and integrated touchscreen monitor are designed to operate within a temperature of −20 to 50 °C (−4 to 122 °F). In any installation, care must be taken to keep the instrument inlet air and surrounding air within this temperature range.

5.1.5 Relative humidity

The Raman Rxn5 base unit and integrated touchscreen are designed to operate within an ambient relative humidity of 0 to 90 %, non-condensing.

5.2 Initial hardware setup

5.2.1 Installation of the Raman Rxn5 analyzer

In many cases, Endress+Hauser requires that installation and initial analyzer setup is performed by trained service personnel from Endress+Hauser or its affiliated channel partners. This section provides only a basic overview of the analyzer setup process and does not facilitate a full onsite installation. Before the installation, refer to *Site requirements* → 🖹 to prepare the site.

5.2.2 Connecting a probe

Two input/output (I/O) panels on the Raman Rxn5 each provide sampling probe connections for two of the four channels available. The gray locking connector is the hybrid fiber-optic connector that contains both the excitation and collection fiber optics as well as the electrical laser interlock. Exercise appropriate care when making these connections to ensure clean fiber-optic connections.

NOTICE

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

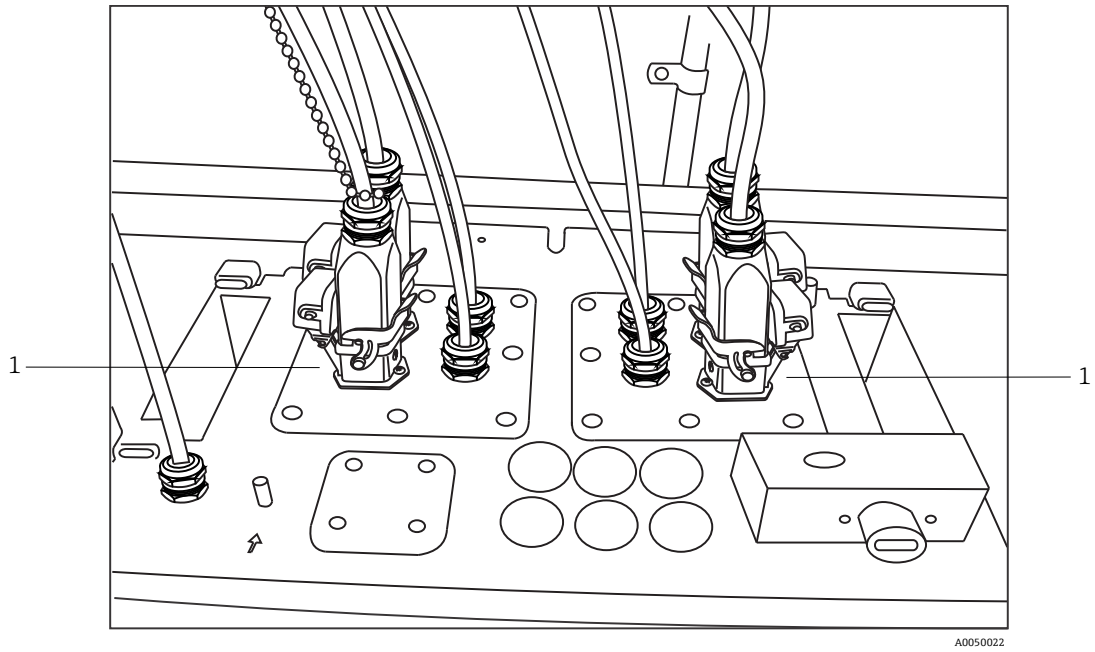


Figure 2. I/O panels provide sampling probe connections (1)

5.2.3 Connecting temperature and pressure sensors

In certain applications, each sampling probe is complemented with two environmental sensors: sample temperature and pressure sensors. These sensors are installed into the sampling system adjacent to each sampling probe. The sensors have 4–20 mA outputs and their ranges are configured to order.

The sensors are interfaced to the analyzer by up to 4 IS barriers with1 per channel. One IS barrier interfaces to a temperature sensor and a pressure sensor. The IS barriers are installed on the lower DIN rail to the left of the electrical laser interlock IS barrier. Going from left to right, the IS barriers correspond with the sensors for channels 1 through 4. The electrical cables are installed through the appropriate cable gland.

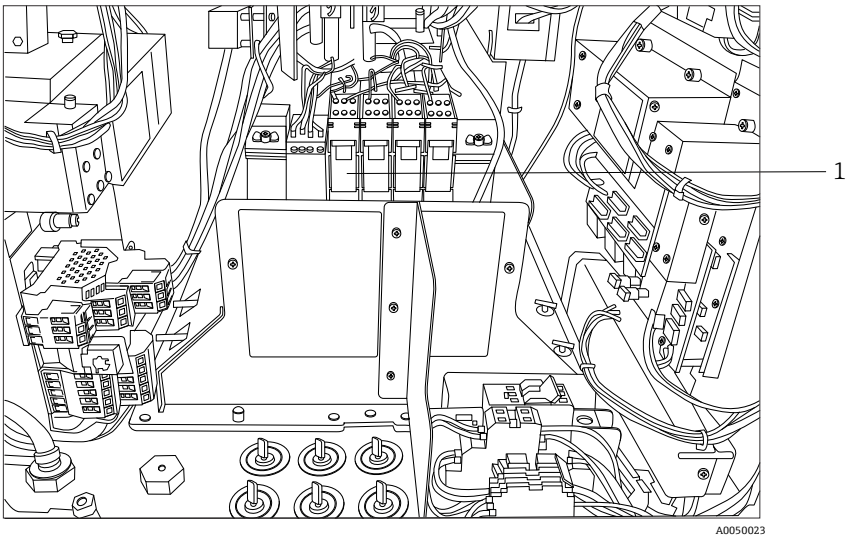


Figure 3. Temperature and pressure IS barriers (1)

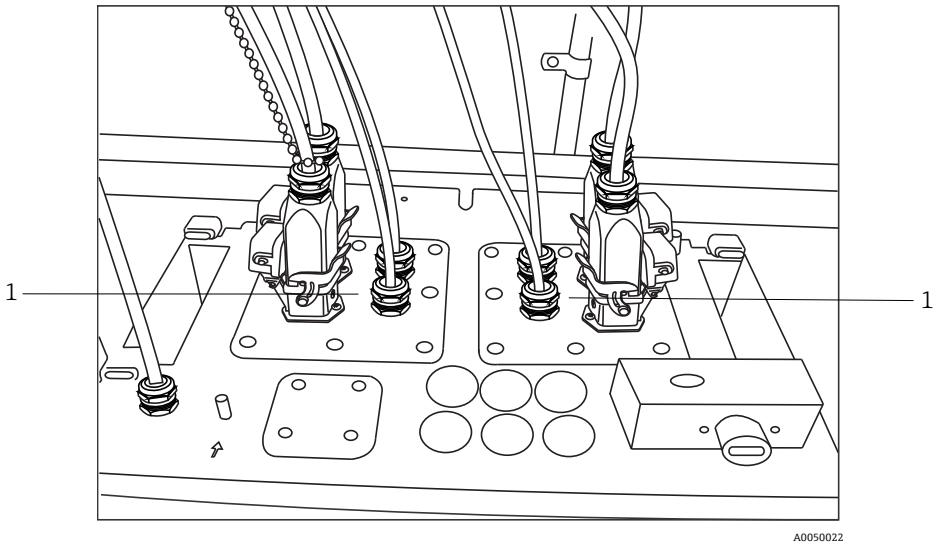


Figure 4. Temperature and pressure cable glands (1)

5.2.4 Sample solenoid valve driver

⚠ CAUTION

- The following outputs are extra low voltage circuits and are not IS. These outputs must be terminated in a nonhazardous location.

The Raman Rxn5 is configured with an optional solenoid driver to drive up to four solenoids at the sampling system. One solenoid per stream can be driven, the timing of which is configured to order and set up at the factory. Each output provides DC 24 V at 0.5A maximum (12 W maximum). The maximum wire size the terminal blocks will accept is 18 American wire gauge (AWG). It is the installer's responsibility to route solenoid power cables from the terminal blocks to the sampling solenoid valves through approved glands.

5.2.5 COM port

The Raman Rxn5 system can be configured at the factory to communicate with the customer's distributed control system (DCS) via Modbus over RS-485. Endress+Hauser will provide the Modbus map. It is the installer's responsibility to route the communications cable from the computer to the DCS interface through an approved gland. The pinout for the Raman Rxn5 RS-485 COM port is labeled on the terminal blocks and referenced on the IS shield label. Refer to the *Rxn5 Modbus Specification* manual for more information on Modbus configuration.

5.2.6 Ethernet ports

Two Ethernet ports are provided. The Raman Rxn5 can also communicate with the customer's DCS via Modbus over TCP/IP. Refer to the *Rxn5 Modbus Specification* manual for more information on Modbus configuration. An RJ45 connector is provided on the terminal block DIN rail.

5.2.7 Purge alarm

A purge alarm is provided to indicate positive pressure in the enclosure. There are two connections on the I/O terminal blocks.

5.2.8 Purge indicator and valve system

The purge indicator installed on the Raman Rxn5 analyzer is of the Z-Purge variety from Purge Solutions, Inc. The indicator is certified for use in Division 2/Zone 2 hazardous areas. The Z-Purge indicator has a **green** indicator light that indicates that the pressure inside the enclosure is purge time water column. The indicator provides a dry contact alarm relay for a remote alarm if needed; it is the installer's or customer's responsibility to interface to the alarm contacts.

The Z-Purge indicator is paired with a Purge Solutions manual leakage compensation valve. There are two modes of operation for the valve-dilution and leakage compensation. For a 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. Once the manual dilution has been performed for the specified time, the valve may be switched to the leakage compensation mode by turning the dial so the slot in the dial is vertical. Leakage compensation mode allows the enclosure to remain pressurized with a much smaller usage of purge air after the manual dilution has occurred.

Refer to the Purge Solutions *CYCLOPS Z-Purge Indicator IOM Manual* for more detailed information.

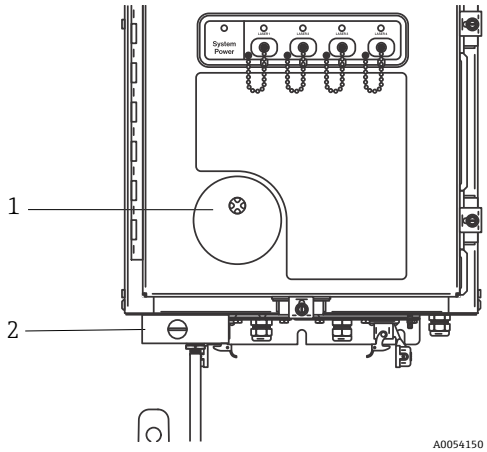


Figure 5. Purge indicator and valve system

#	Description
1	Z-Purge indicator
2	Manual leakage compensation valve

5.2.8.1 Air supply requirements

- Inlet fitting: ¼-18 NPT
- ISA grade: Hydrocarbon free
- Water and oil free: −40 °C (−40 °F) dew point
- Particle size: 5 micron maximum
- Pressure range: 50 to 120 psi
- Max flow rate for purging: 2.0 SCFM
- Max flow rate for leakage compensation: 0.75 SCFM

5.2.8.2 Installation

The Raman Rxn5 is shipped without the purge regulator and filter assembly installed. It is the installer's responsibility to install the purge regulator and filter assembly and interface the purge air supply to the assembly. The inlet to the filter is ¼-18 NPT. Appropriate thread sealant must be used.

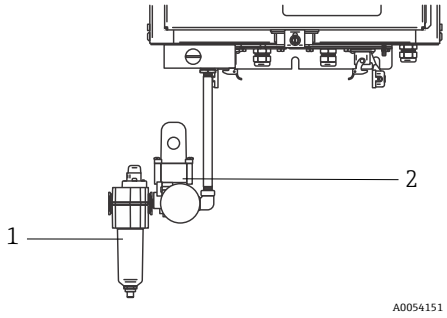


Figure 6. Purge regulator and filter assembly

#	Description
1	Filter
2	Regulator and gauge

5.2.8.3 Operation

The purge regulator has been pre-set at the factory to 2.0 psi during the high flow dilution. It may be necessary to reset the operating pressure at installation. The normal operating range for the regulator is 2.0 to 2.5 psi during high flow dilution (ON position). Operating in the pressure range will ensure appropriate air flow into the enclosure.

Follow these steps for power application after commissioning and the analyzer is ready to be put into service:

1. Tighten the door clamps in five places with a flat blade screwdriver or 3/8" nut driver to ensure a proper seal.

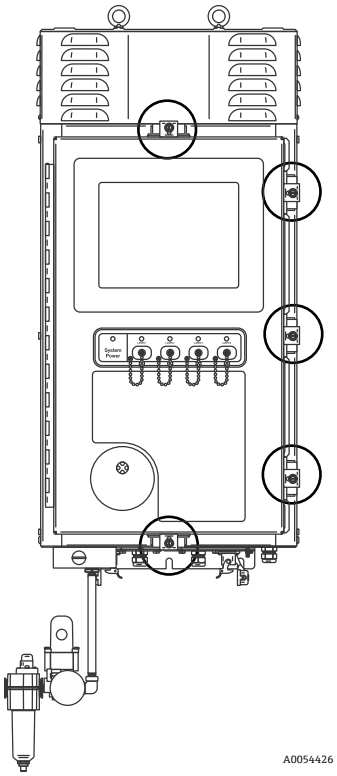


Figure 7. Door clamps

2. Apply purge air to inlet filter assembly.
3. Turn the dial on the purge valve to the **ON** position.

4. Purge for a minimum of 9.5 minutes.
5. Apply power to the analyzer and observe the indicator light. If the indicator light does not turn **ON**, immediately power down the system and check for air leaks in the door seal and cable glands. Restart at step 4.
6. Turn the valve to the leakage compensation position and observe the indicator light. In the leakage compensation position, the knob on the purge valve will have its slot positioned 90 degrees from the **ON** label.

5.2.9 Thermal control

Heat removal is a challenge in all devices that consume electrical power. The major power consuming and heat producing components in the Raman Rxn5 are conductively cooled through their heat sinks into plenums on either side of the analyzer into the external ambient environment. The external fan pulls air through each plenum and over all heat sinks. This design maximizes heat removal from the devices and minimizes reliance on active devices to remove heat from the enclosure.

NOTICE

- It is crucial that the plenum covers remain installed at all times except for heat sink cleaning; their removal causes no air to be moved across the heat sinks and devices may overheat. The covers may be removed for no more than five minutes for cleaning.

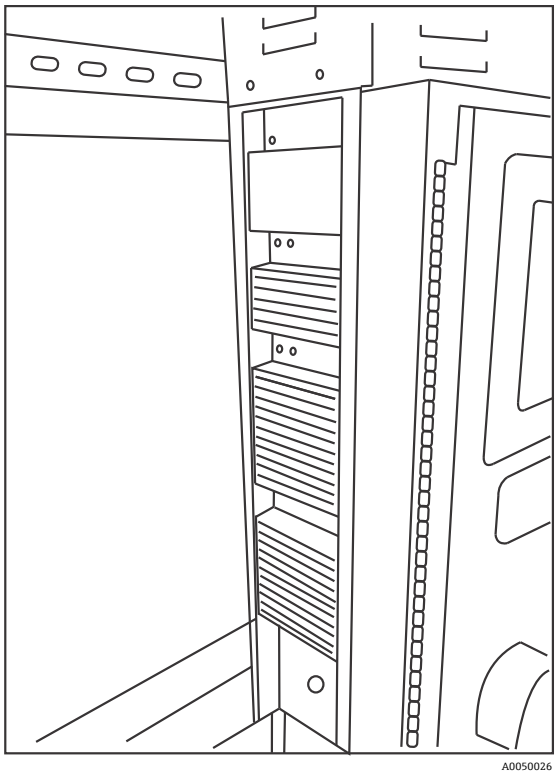


Figure 8. Heat sinks on the side of the Raman Rxn5

The Raman Rxn5 is specified to operate in ambient temperatures between −20 to 50 °C. The Raman Rxn5 has a sophisticated microprocessor-based thermal control system to regulate its internal temperature. Not only does the system regulate internal temperature, but it also controls power to several key components inside the Raman Rxn5.

The nominal setpoint for thermal control is 35 °C (95 °F). The sensor used in the feedback loop for the thermal control algorithm is mounted inside the detection module and is referred to as the “grating” temperature sensor.

Between ambient temperatures of approximately 15 to 33 °C (59 to 91 °F), the system will regulate its internal temperature at 35 °C (95 °F).

Above ambient temperatures of approximately 33 °C (91 °F), the system internal temperature will simply track external temperature with a delta of 2 to 3 °C (35 to 37 °F).

Below temperatures of approximately15 °C (59 °F), the system will simply track external temperature with a delta of approximately 20 °C (68 °F).

The levers the thermal control system uses to control its internal temperature are the main fan speed at the top of the enclosure and the two internal heating, ventilation, and air conditioning (HVAC) modules. The fan speed is controlled by a feed-forward function based on external air temperature.

At external temperatures of 15 ˚C (59 ˚F) and below, the fan will be turned off. At temperatures of 33 ˚C (91 ˚F) and above, the fan will operate at maximum speed. The fan speed will increase linearly from off to full speed between external temperatures of 15 to 33 ˚C (59 to 91 ˚F). The fan speed provides coarse thermal control and the internal HVAC modules provide fine tuning of the internal temperature.

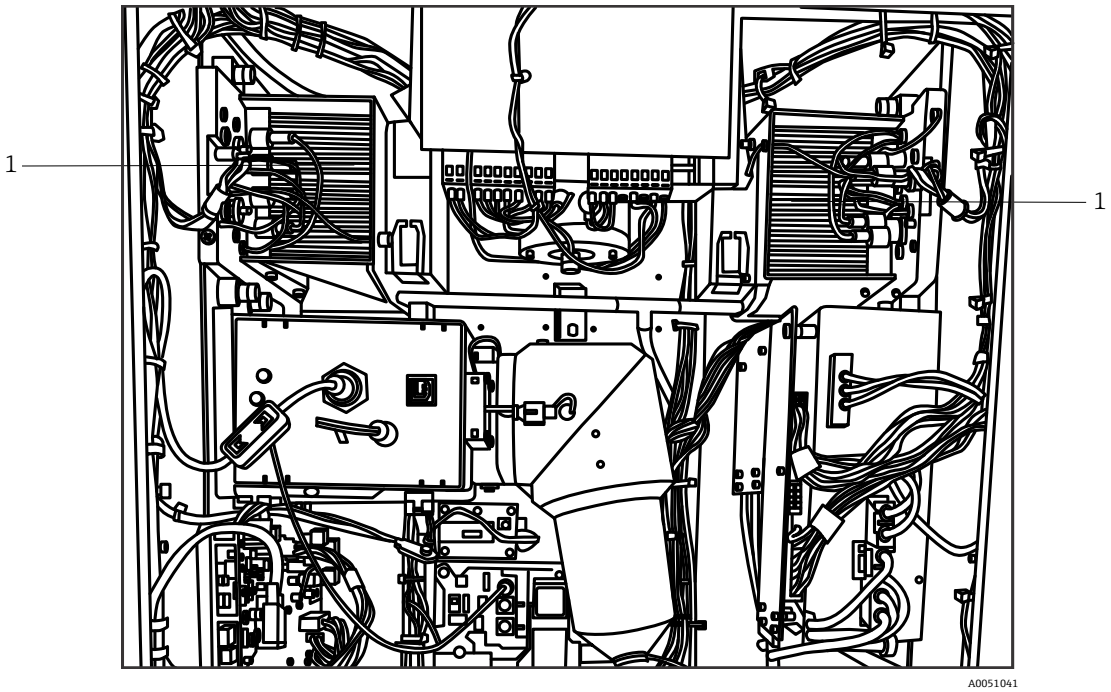


Figure 9. HVAC modules (1)

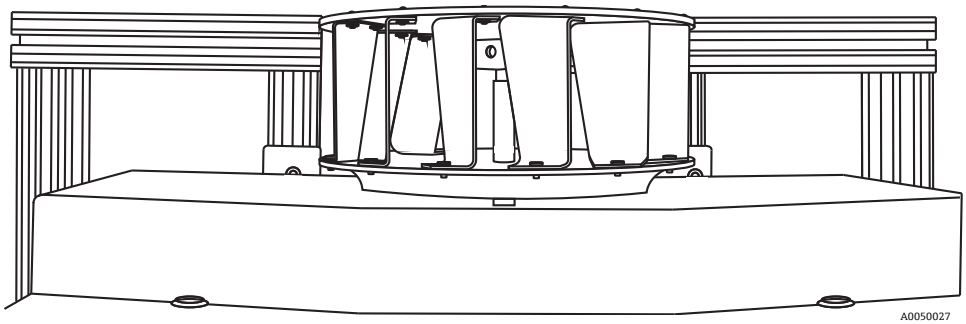


Figure 10. Top-mounted fan impeller with shroud removed

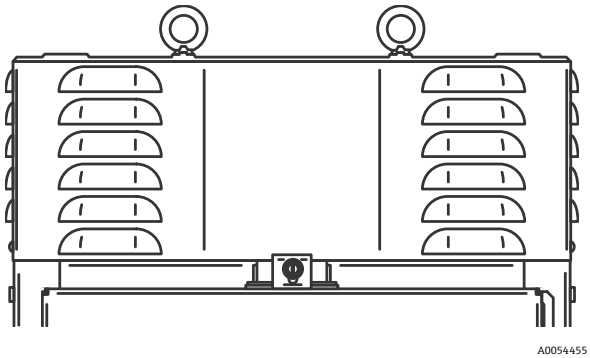


Figure 11. The fan housing or shroud

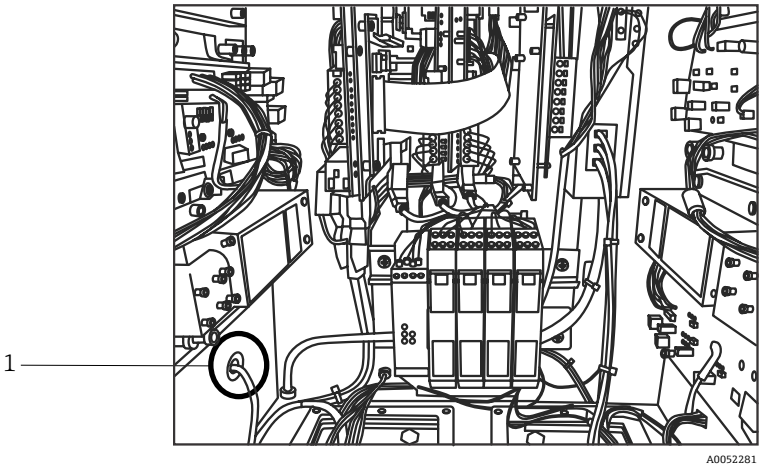


Figure 12. External temperature sensor (1) mounted in bottom of left plenum

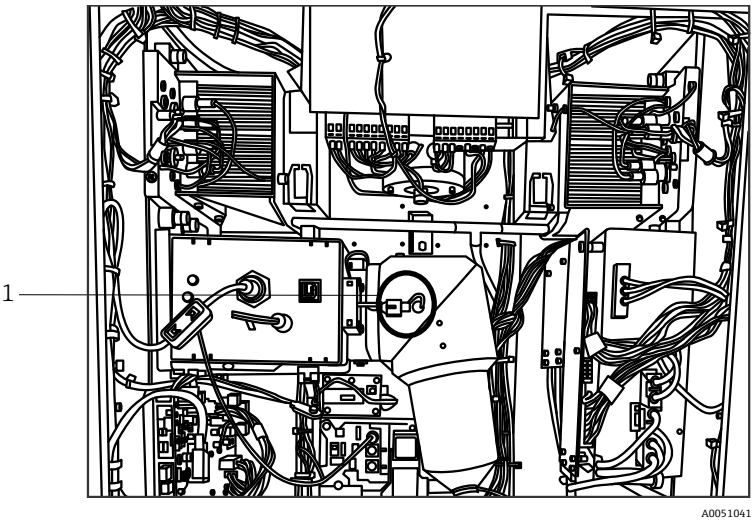


Figure 13. Grating sensor (1) for thermal control

5.2.9.1 Electrical power control

The Raman Rxn5 thermal control system maintains power application to modules that may be temperature sensitive. The thermal control system has control over the electrical power of the following components: lasers, detection module and touch screen monitor. The computer/hard drive, universal serial bus (USB) hub, purge indicator, calibration board, and all other miscellaneous electronic devices are always on if the systems is powered. The HVAC modules are controlled by the temperature control servo loop and can be turned on or off at any time by the control loop.

Upon a cold start, only the lasers will be selectively powered up, while power is immediately applied to the remaining components. The requirement for the lasers to be powered is that their base plate temperatures must be greater than 0 ˚C (32 ˚F). Upon a cold start in ambient conditions less than 0 ˚C (32 ˚F), the system enters a warming-up state where the red indicator light emitting diode (LED) on the front of the analyzer flashes slowly (1 Hz) and the system heaters turn on. Once all laser base plate temperatures have reached 0 ˚C (32 ˚F), then power is applied to all lasers and the indicator LED stops flashing red and turns solid green.

In addition to the cold start power application rules, the thermal control system can turn off power to the lasers, detection module and HVAC modules if their base plate temperatures are too high. The upper temperature limit for the laser base plates, detection module base plate, and HVAC base plates is 75 ˚C (167 ˚F). If one of these devices has been powered down because of an over-temperature event, the indicator LED on the front of the analyzer flashes red (2 Hz). Currently, the system software does not indicate if the power has been turned off to any of these modules, so the only indication is manual inspection of the base plate temperatures in the software diagnostic panel.

6 Installation

6.1 Safety considerations

Familiarity with the Raman Rxn5 analyzer and the properties of intense laser radiation will aid in the safe operation of the Raman Rxn5. The Raman Rxn5 contains a frequency doubled Nd:YAG laser with Class 3B output beam.

Raman Rxn5 users are advised to follow the recommendations described in the most current revision of ANSI Z136.1. Raman Rxn5 users outside of the United States are encouraged to follow the recommendations described in whichever document provides guidance in laser safety for the area in which they are working.

6.1.1 Protective gas

The protective gas shall be essentially free of contaminants or foreign matter and shall contain no more than trace amounts of flammable gas or vapor. If using compressed air, the air intake of the compressor must be located in a nonhazardous zone. The temperature of the protective gas shall not exceed 40 °C (104 °F).

WARNING

- The protective gas supply shall have an alarm that is located at a constantly attended location.
- Power must not be restored after enclosure has been opened until enclosure has been purged for 9.5 minutes with a minimum pressure of 2.0 psi as read at the inlet regulator.
- FOLLOW INSTRUCTIONS BEFORE CLOSING THE PROTECTIVE GAS SUPPLY VALVE.

If the protective gas supply to this enclosure has an isolation valve, that valve must have the following label:

Warning – PROTECTIVE GAS SUPPLY VALVE – This valve must be kept open unless the area atmosphere is known to be below the ignitable concentration of combustible materials, or unless all equipment within the protected enclosure is de-energized.

NOTICE

- The protective gas pressure shall be set between 2.0 psi to 2.5 psi at the inlet regulator. Pressure below 2.0 psi will result in inadequate purge rates.
- Pressure above 2.5 psi may result in exceeding the maximum rated overpressure as specified on the nameplate.
- Inlet pressure must always be monitored during the purging operation.

6.1.2 Pressurizing system

Refer to the Purge Solutions *CYCLOPS Z-Purge Indicator IOM Manual* for additional information on installation, operating, and maintenance instructions for the pressurizing system. For ease of use it is recommended that the installation instructions found in this section are used.

6.2 Preparing for installation

When determining where to install the analyzer, include the following location criteria:

- Protection from rain, direct sunlight, and temperature extremes.
- Protection from exposure to corrosive gas
- Protection from dust and static electricity
- Space of at least 450 mm (18 in) around the bottom of the analyzer
- Space of at least 152.4 mm (6 in) on the sides and top to allow access for cleaning the heat sinks and cooling impeller maintenance
- Operating temperature range of −20 to 50 °C (−4 to 122 °F)
- Storage temperature range of −30 to 60 °C (−22 140 °F)
- Relative humidity 0 to 90 %, non-condensing

6.3 Unpacking the Raman Rxn5 analyzer

It is recommended that the Raman Rxn5 is 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.

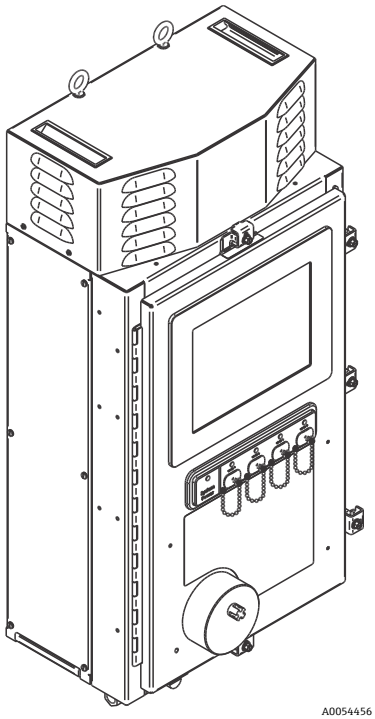


Figure 14. View of the Raman Rxn5 after the box is removed

6.4 Lifting the Raman Rxn5 analyzer

The Raman Rxn5 may be lifted by mechanical means using the two lifting rings. The Raman Rxn5 may also be lifted by two people using the lift points. If the Raman Rxn5 is carried by two people 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 61.2 kg (135 lbs) and requires two people for lifting.

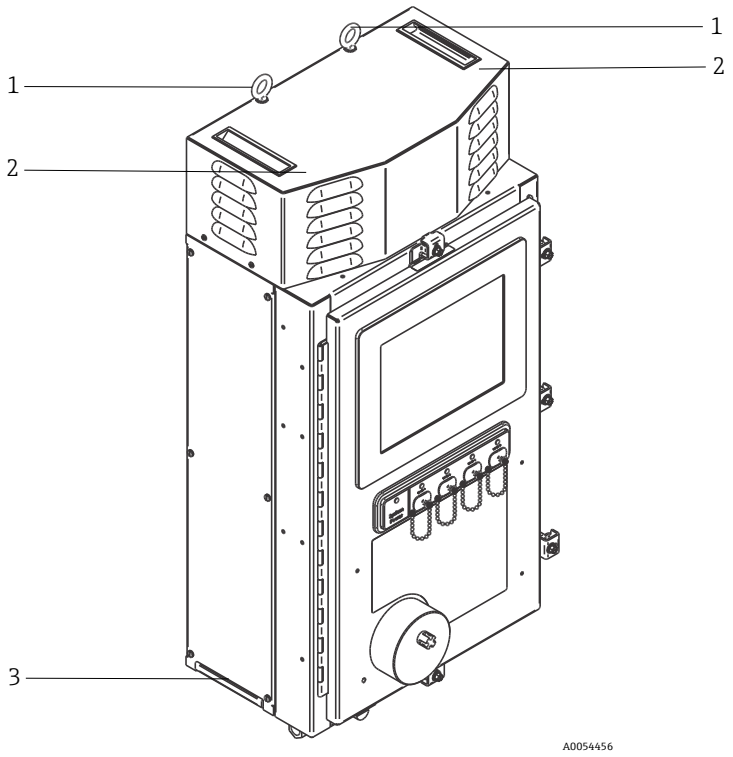


Figure 15. Lifting the Raman Rxn5

#	Description
1	Lifting rings for use with lifting equipment
2	Place free hand here to stabilize as lifting is performed. One person must be on each side of the enclosure.
3	Enclosure lift point for hand lifting. One person must be on each side of the enclosure.

6.5 Wall mounting the Raman Rxn5 analyzer

The mounting structure must be constructed as shown below, with upper mounting bolts fully tightened and properly spaced. Nut plates for the lower mounting points should be pre-installed. The unit should be lifted so that the upper mounting bolts engage in the upper mounting features. Install lower spacer plates, washers, and bolts.

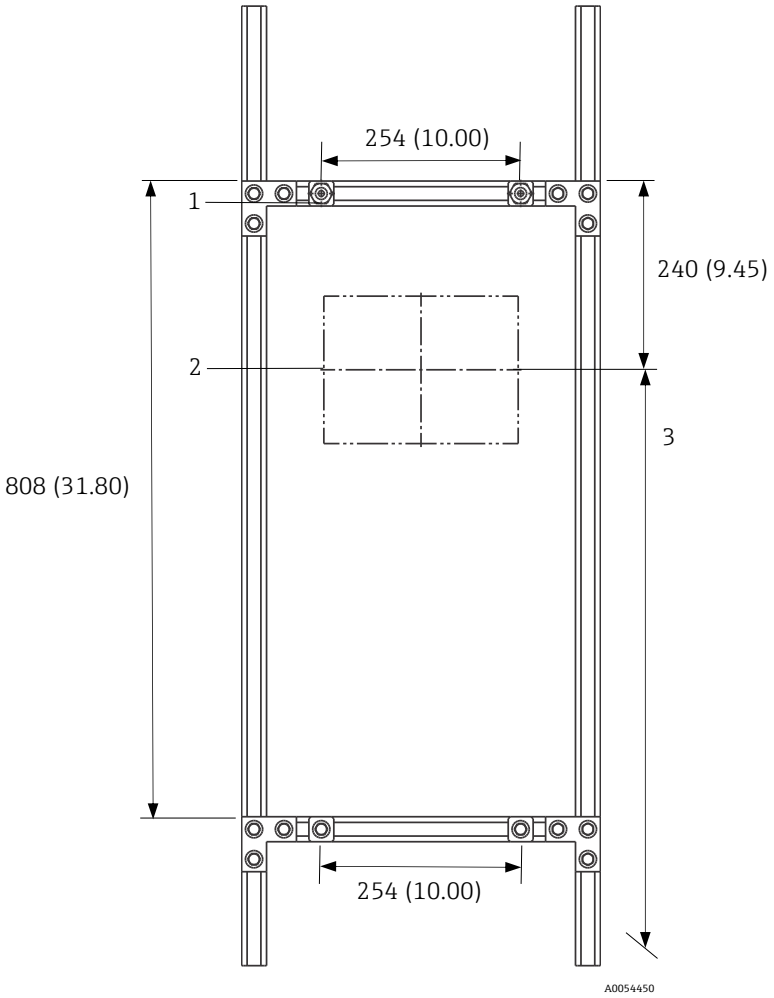


Figure 16. Hardware positioning for Raman Rxn5 mounting. Dimensions: mm (in)

#	Description
1	Top mounting points should be fully tightened to allow unit to hang while bottom bolts are tightened.
2	Center line of monitor
3	Position the monitor at standard viewing height.
Note: The framing may be configured several ways to provide the 254 x 808 mm (10.00 x 31.80 in) spacing of the mounting points.	

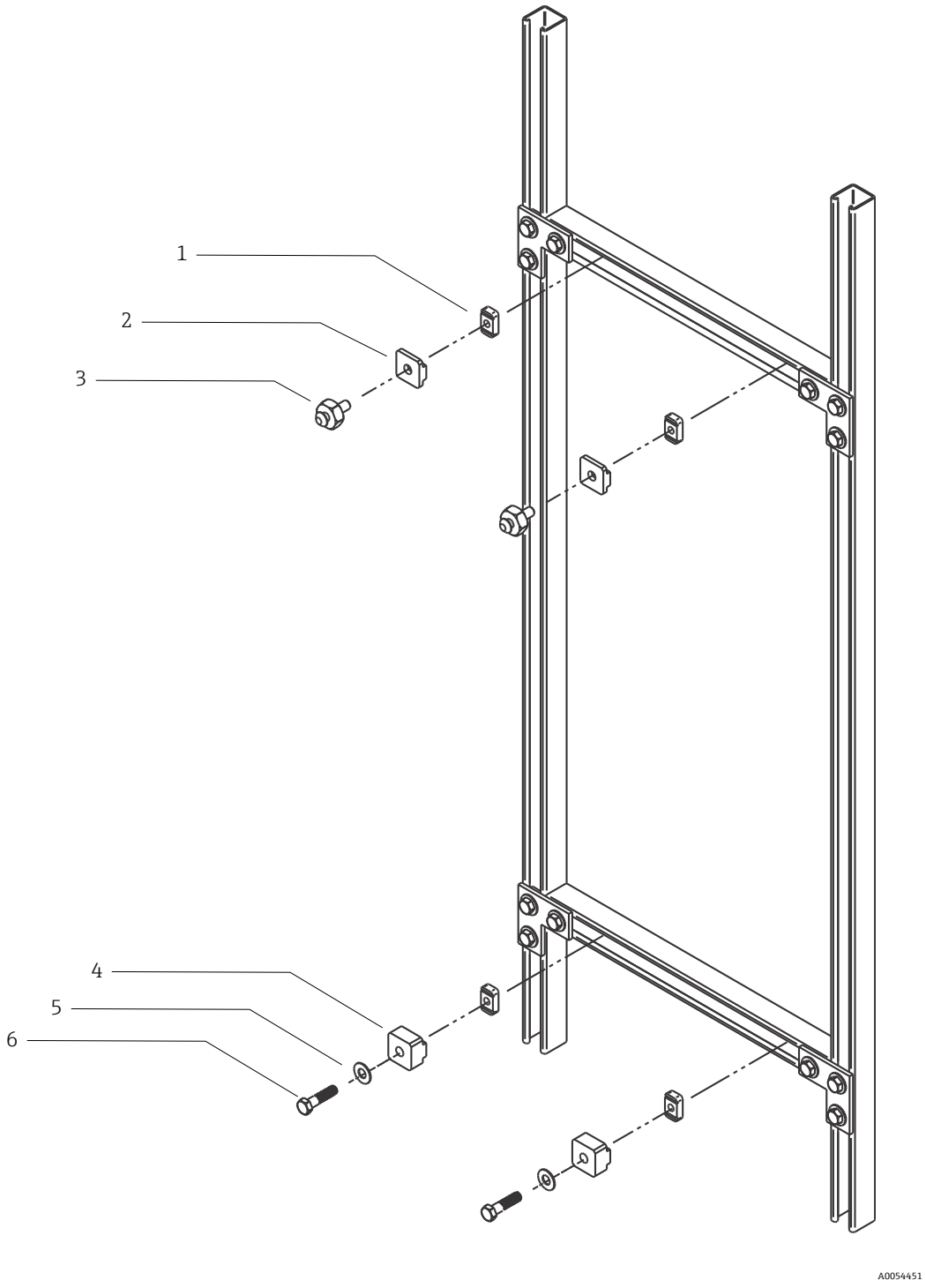


Figure 17. Mounting details

#	Description
1	(4) 3/8" 16 channel nuts with springs (Unistrut p/n A1008-SS)
2	(2) plates, Unistrut mount (supplied with Raman Rxn5 base unit)
3	(2) mounting bolts (supplied with Raman Rxn5 base unit)
4	(2) plates, Unistrut lower mount (supplied with Raman Rxn5 base unit)
5	(2) flat washers for 3/8" bolt diameter
6	(2) hex head cap screws 3/8" 16 x 1.50
Note: Mounting kit for Unistrut 1¼" width metal framing is shown in this drawing. A different kit is required for Unistrut P-Series (1⅝" width) or 42 mm framing.	

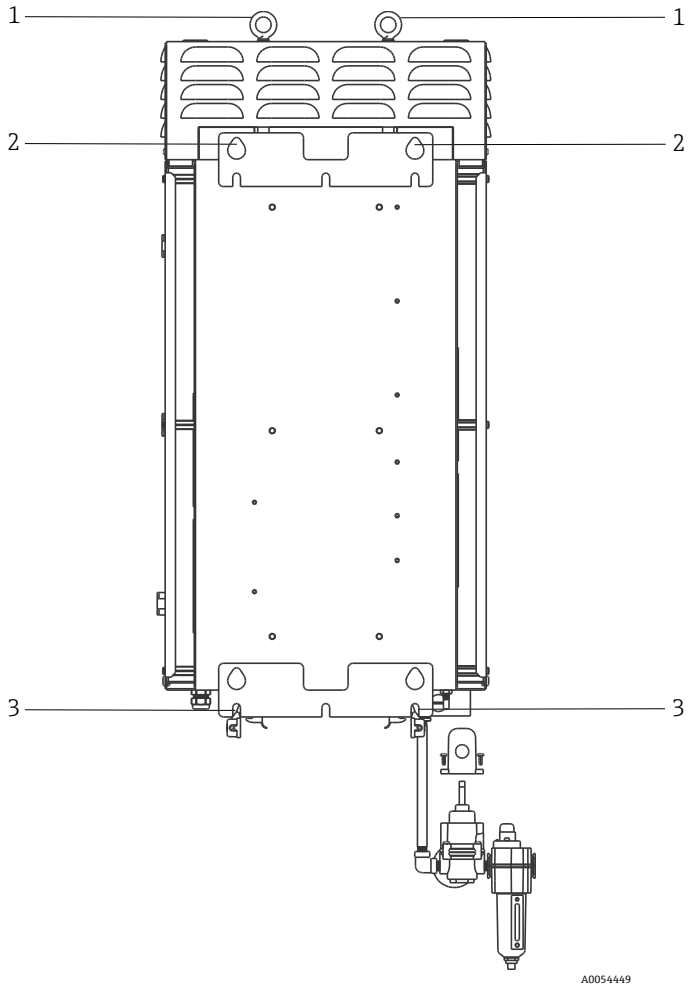


Figure 18. Mounting features on rear of analyzer

#	Description
1	Lift rings
2	Upper mounting points
3	Lower mounting slots

Clearance of 152.4 mm (6 in) is required on either side as well as the top of the analyzer to allow access to heat sinks and removal of the top cover.

Wall mounting instructions:

1. Do not set the Raman Rxn5 analyzer on the purge inlet or connectors. Instead, use the packing base or lay the Raman Rxn5 on its back with the touchscreen pointing up.
2. Using the lift points, hang the Raman Rxn5 from the Endress+Hauser mounting bolts (previously installed to the Unistrut framing) such that the tear drop shape cutouts on the rear of the enclosure engage the mounting bolts.
3. Secure the lower mounting bolts.

⚠ WARNING

▶ Stand or kneel to the side of the Raman Rxn5, not below it, while securing the lower mounting bolts.

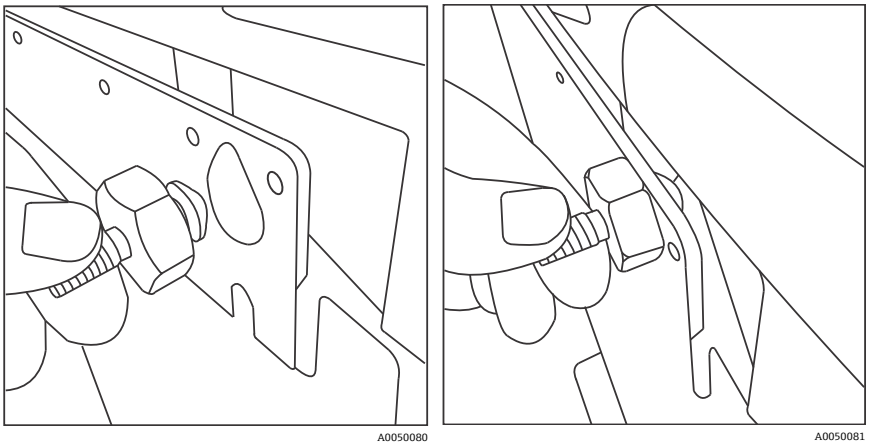


Figure 19. Cutouts on rear of enclosure engage the mounting bolts

6.6 Main power wiring

Installations in the United States shall be done in accordance with the National electrical code (NFPA 70). Installations in Canada shall be done in accordance with the Canadian electrical code (CSA C22.1).

The Raman Rxn5 employs an internal 10A circuit breaker in series with the line conductor for internal overcurrent protection. An easily reached switch or circuit breaker must be installed external to the Raman Rxn5 and must be marked as the disconnecting device for the Raman Rxn5. The disconnecting means must interrupt both current-carrying conductors (line and neutral) and must NOT interrupt the protective conductor (ground).

The protective conductor terminal is located on the bottom of the enclosure adjacent to the power entry cable gland. This terminal must be connected to earth ground.

WARNING

- To reduce the risk of electric shock, this equipment must be used with a grounding-type plug that has a third (grounding) pin. Do not operate the Raman Rxn5 without ground connection.

The main power connection specifications are listed below:

Item	Description
Supply voltage range	AC 90 to 264 V
Supply frequency range	47 to 63 Hz
Max inrush current	30A
Max steady-state current	7.0A
Cable jacket diameter	6 to 12 mm
Conductor gauge range	22 to 10 AWG
Conductor stripping length	9 mm (0.35 in)
Maximum cable service loop (internal to Raman Rxn5)	304.8 mm (12.0 in)

⚠ CAUTION

- This unit must be properly grounded and bonded at all times.

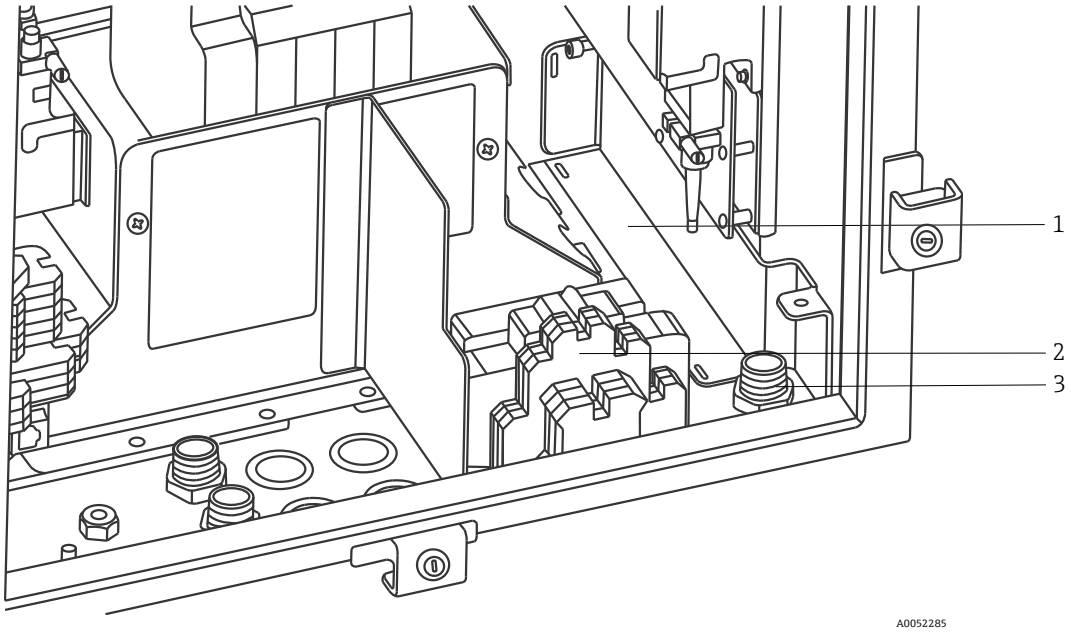


Figure 20. View of AC supply wiring area

#	Description
1	AC supply line isolation box (shown with cover removed)
2	AC supply terminal blocks
3	AC supply inlet

Refer to the figure above when connecting the Raman Rxn5 to line power.

6.7 Glands and connectors

The main glands and connectors on the Raman Rxn5 analyzer are shown below.

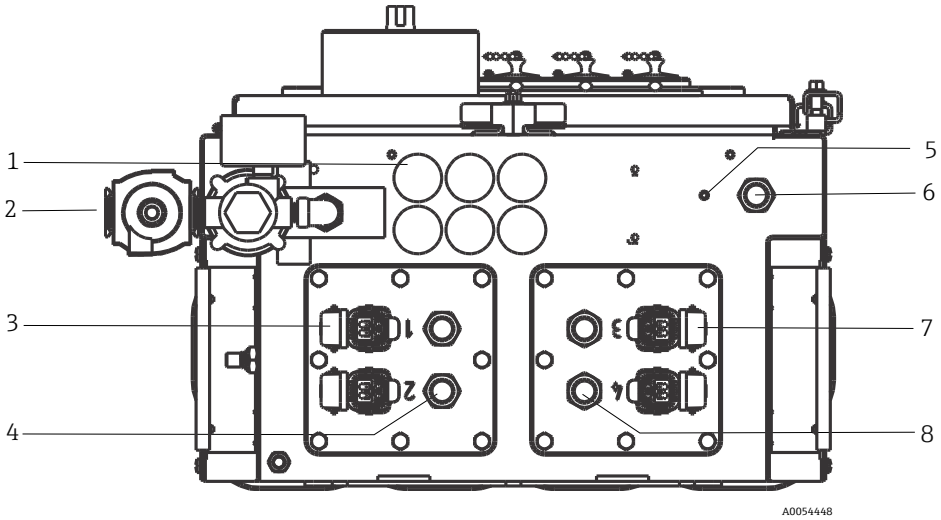


Figure 21. Glands and connectors on the bottom of the Raman Rxn5

#	Description
1	Non-IS communications and I/O 6 holes available for use
2	Purge air inlet
3	Channel 1 and 2 fiber-optic connectors
4	Channel 1 and 2 IS temperature and pressure sensor glands
5	Ground/bonding stud
6	AC inlet gland
7	Channel 3 and 4 fiber-optic connectors
8	Channel 3 and 4 IS temperature and pressure sensor glands

6.8 Non-IS communications and I/O wiring

The I/O connection points are shown below.

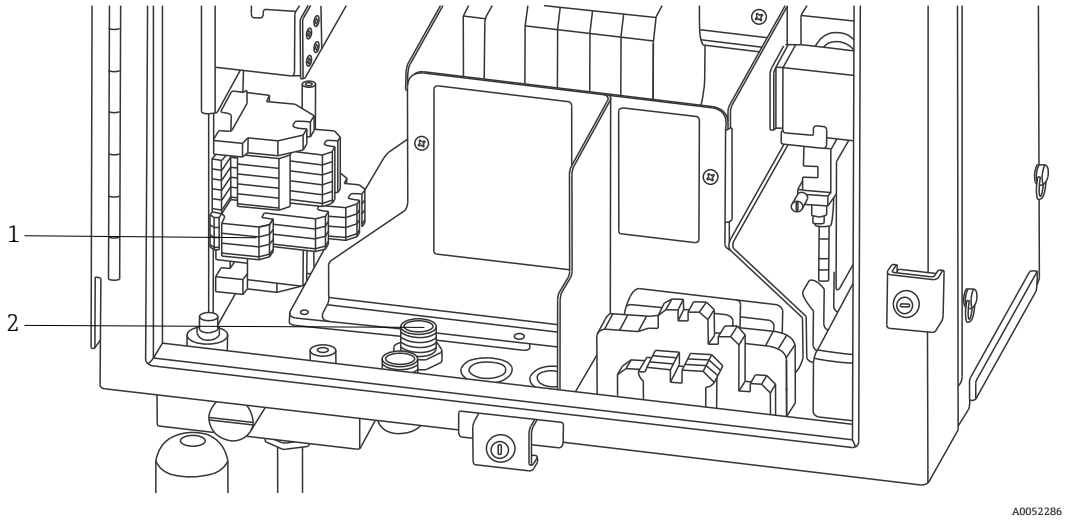


Figure 22. Internal view of non-IS communications and I/O wiring area

#	Description
1	All non-IS communications and I/O wiring terminate to this.
2	Cable entry area. Liquid-tight strain reliefs installed as needed.

The Raman Rxn5 supports the following non-IS communications and I/O:

- Relay loop for purge pressure alarm

  The purge indicator installed on the Raman Rxn5 analyzer is of the Z-Purge variety from Purge Solutions, Inc. The indicator is certified for use in Division 2/Zone 2 hazardous areas. The Z-purge indicator has a **Green** indicator light that indicates that the pressure inside the enclosure is above 5.1 mm (0.20 in) water column. The indicator provides a dry contact alarm relay for a remote alarm if needed and is rated for a maximum voltage of DC 30 V; it is the installer's or customer's responsibility to interface to the alarm contacts.
- (2) Modbus over RS-485 (2-wire + ground) communication to DCS
- (2) Modbus over TCP/IP via RJ45 connectors
- (4) points of DC 24 V (12 W maximum per channel) programmable output for driving solenoid valves in the sampling system. Must be configured at the factory and application-specific.

Refer to the *Rxn5 Modbus Specification* manual for more information on Modbus configuration.

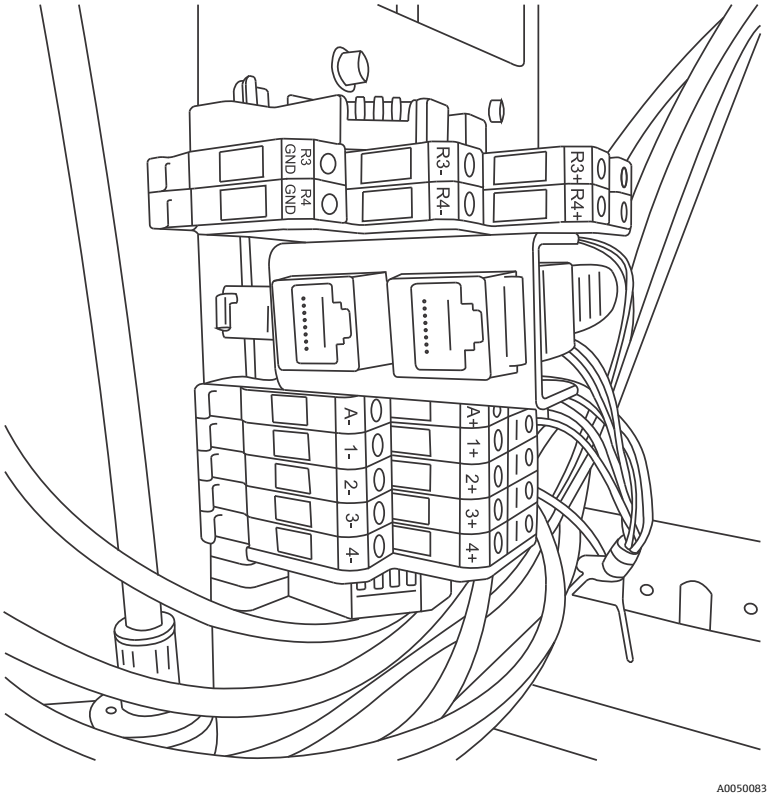


Figure 23. Connection points for non-IS communications and I/O wiring

The available connections and points of termination are summarized below:

Labels	Description	Signal Levels
R3+, R3-, R3 GND	RS-485 communication to DCS	DC −7 to +12 V
R4+, R4-, R4 GND	RS-485 communication to DCS	DC −7 to +12 V
No labels	(2) RJ45 optional TCP/IP to DCS or analyzer remove control	DC ±2.5 V per twisted pair
A+, A–	Purge alarm	DC 30 V, 150 mA maximum
1+, 1–	Sampling output 1	DC 24 V, 0.5 A maximum
2+, 2–	Sampling output 2	DC 24 V, 0.5 A maximum
3+, 3–	Sampling output 3	DC 24 V, 0.5 A maximum
4+, 4–	Sampling output 4	DC 24 V, 0.5 A maximum

6.8.1 Purge inlet connection and purge alarm connection

The purge indicator installed on the Raman Rxn5 analyzer is of the Z-Purge variety from Purge Solutions, Inc. The indicator is certified for use in Division 2/Zone 2 hazardous areas. The Z-purge indicator has a **Green** indicator light that indicates that the pressure inside the enclosure is above 5.1 mm (0.20 in) water column. The indicator provides a dry contact alarm relay for a remote alarm if needed; it is the installer's or customer's responsibility to interface to the alarm contacts.

6.9 Intrinsically safe wiring installation

6.9.1 Input for up to four temperature and pressure 4-20 mA transducers

A set of sensors, one temperature sensor and one pressure sensor, is used per active stream on the Raman Rxn5. Each set is interfaced to the Raman Rxn5 using a four-conductor cable: two conductors are used for the temperature sensor and two conductors are used for the pressure sensor.

These circuits are protected by 4-20 mA current loop repeater IS barriers. The electrical interfaces are made directly to the IS barrier terminals. The GM International D1014D IS barrier is standard equipment. The Stahl 9167/21-11-00 or GM International D5014D may be substituted as alternatives.

6.9.2 Fiber breakage detection safety loop

The fiber optics for each channel contains a 2-wire current loop that will detect if the fiber-optic has been severed. The interruption of the current loop will cause the laser for the affected channel to be turned off. The current loop is integrated into the hybrid fiber-optic connecting the Raman Rxn5 to its sampling probes. The fiber breakage detection current loop is protected by a switch repeater IS barrier. The GM International D1032Q IS barrier is standard equipment. The connections between the IS barrier and the I/O panels internal to the Raman Rxn5 have been pre-wired at the factory; no end user wiring is necessary.

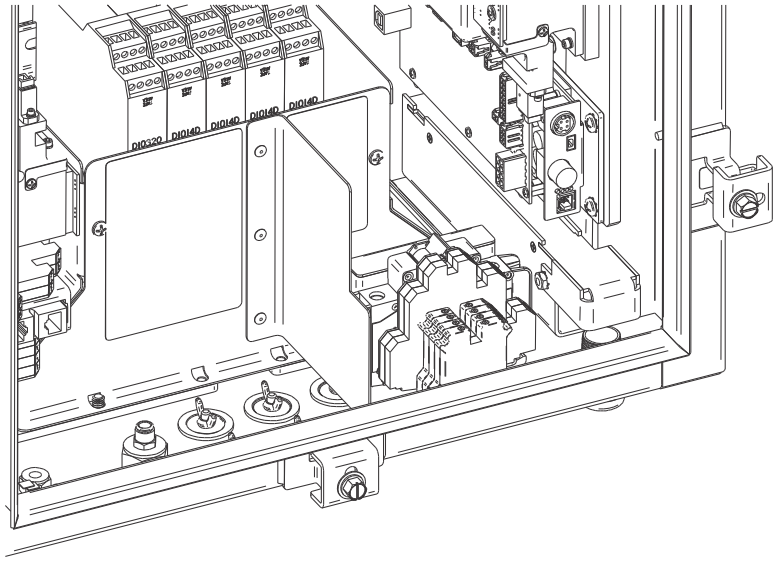


Figure 24. View of IS wiring area with shield in place

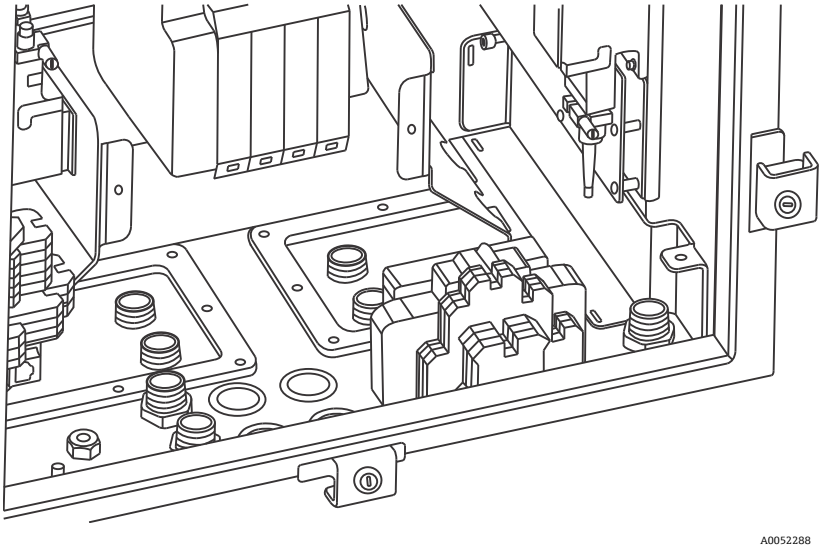


Figure 25. View of IS wiring area with shield removed

6.9.3 Installation instructions for IS probe fiber breakage detection circuit

Refer to drawing 4002396 for installation guidelines of the IS probe circuit. There are no end-user connections inside the Raman Rxn5 to be made for this circuit. The circuit is contained with the hybrid fiber-optic connecting the Raman Rxn5 to the sampling probe and is active upon latching of the fiber-optic cable hybrid connector to the Raman Rxn5 fiber-optic receptacle.

6.10 Purge inlet connection

The Raman Rxn5 is shipped without the purge regulator and filter assembly installed. It is the installer's responsibility to install the purge regulator and filter assembly and interface the air supply to the assembly. The inlet to the filter is ¼-18 NPT. Use appropriate thread sealant.

See *Purge indicator and valve system* → 🖹 for information about the system and the air supply requirements.

Commissioning of the system is required to validate that the protective gas supply system is functioning properly after initial installation. This procedure must be followed:

- After initial installation
- After any maintenance operation requiring removal or replacement of protective gas system components
- After initial commissioning is complete and any operation requiring opening the enclosure is performed
- Prior to re-energizing the system

6.11 Desiccant modules and condensate drain

The Raman Rxn5 system contains two silica gel desiccant modules and a condensate drain system. The drain system is a water trap design, initially filled with non-toxic baby oil.

If the humidity approaches dew point, an internal relative humidity monitor will raise a warning. At this point, you should replace the desiccant modules.

In addition, if condensate comes out of the port, the internal humidity is too high, and the desiccant cartridges should be replaced or recycled. The desiccant cartridges are blue when they are initially activated and turn pink when they are no longer able to absorb moisture. The desiccant cartridges may be recycled by heating in a microwave oven for 15 to 20 seconds or until blue again.

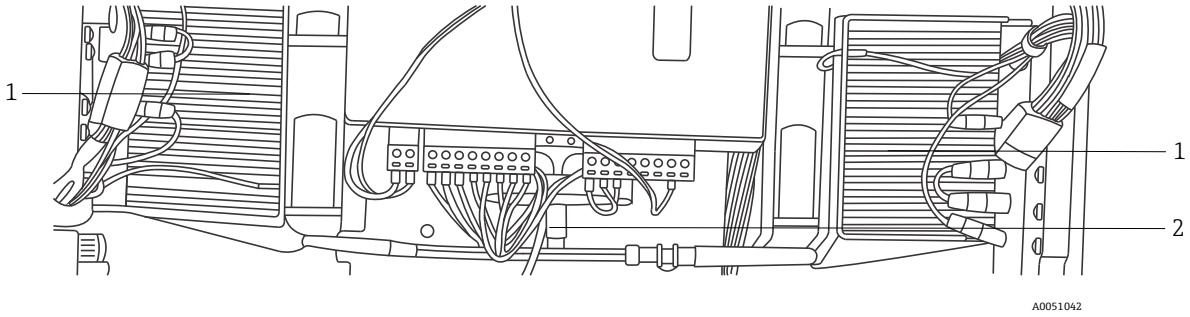


Figure 26. Condensate drain system

#	Description
1	Thermoelectric cooler modules
2	Condensate drain line

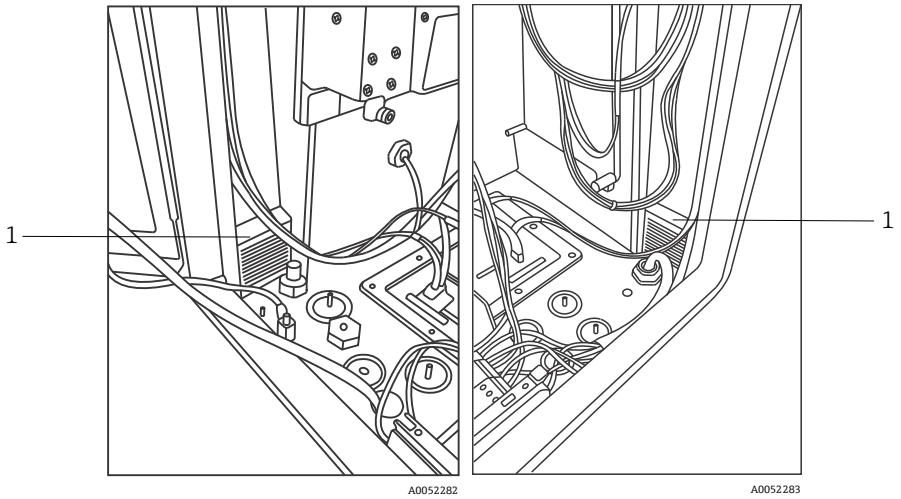


Figure 27. Desiccant cartridges (1)

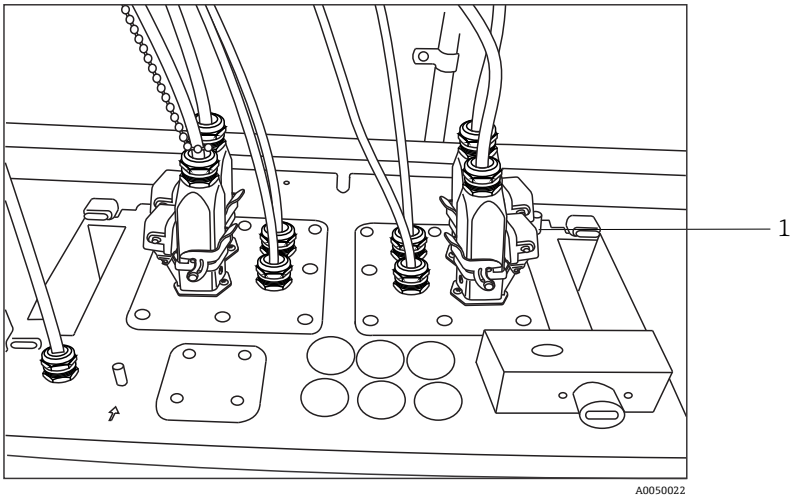


Figure 28. Condensate drain port

6.12 AC mains power distribution

Incoming power is brought into the analyzer through an approved gland on the bottom right side of the analyzer. AC power is installed to the analyzer by a customer installer per applicable local codes.

The Raman Rxn5 can accept single phase AC voltages between AC 90 to 264 V and 47 to 63 Hz. The enclosure must be grounded according to local codes using the ground stud on the external enclosure adjacent to the power entry cable gland.

The Raman Rxn5 is supplied with a 10A C Curve circuit breaker, Automation Direct, WMZT1C10. Power wires shall be installed to the right of the terminal blocks. The enclosure MUST be grounded using the ground stud provided adjacent to the power entry gland. An optional grounding cable may be connected to any **Green** terminal block on the DIN rail. As long as the enclosure is properly grounded at the external ground stud, the ground terminal blocks will pick up good ground through the enclosure.

The incoming AC power is routed first through two thermal snap switches at the rear of the DIN rail. The thermal switches will open if the enclosure internal air temperature rises above 57 ˚C (135 ˚F). The main purpose of the thermal protection is to ensure that the IS barriers used for I/O will not be subjected to temperatures higher than their rating. If the instrument has shut down because one or both of the thermal snap switches has opened, the instrument will not be powered regardless of whether power is applied to the analyzer.

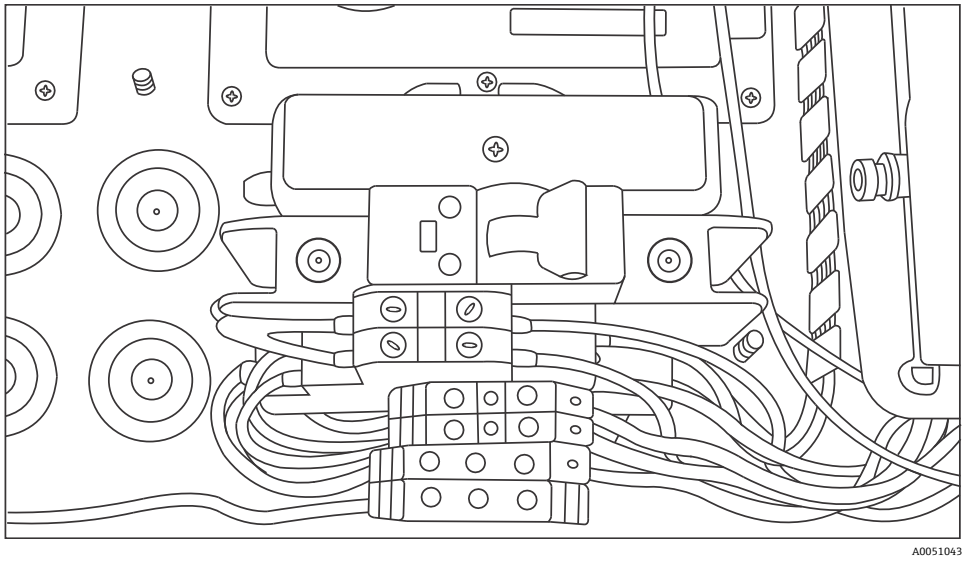


Figure 29. AC mains DIN rail distribution

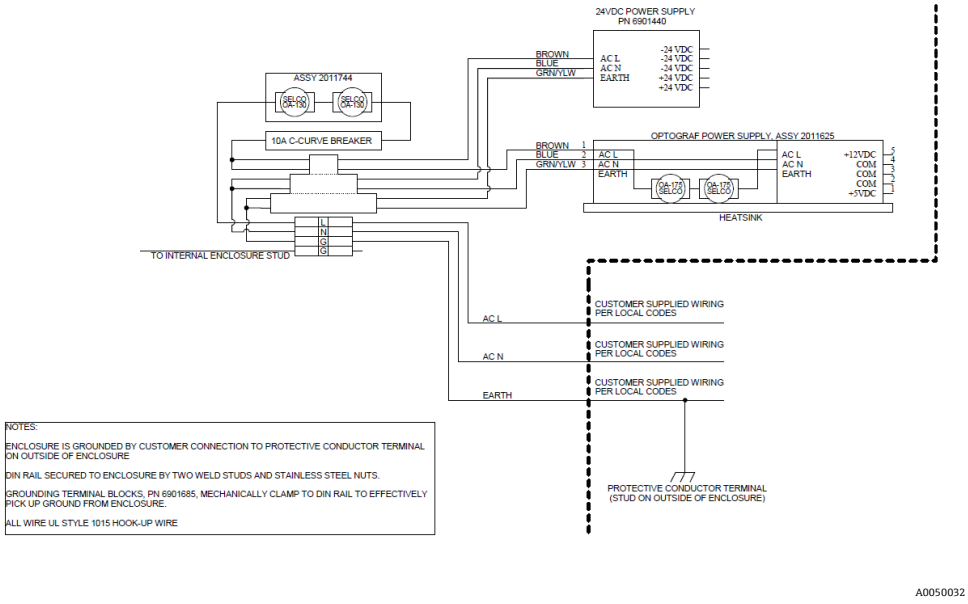


Figure 30. Schematic, AC mains distribution

6.13 Main power supply low voltage distribution

The main power supply provides DC 12 V and DC 5 V to the main subsystems. The low voltage output from the power supply is immediately fed into printed circuit board assembly attached to the top of the power supply. The printed circuit board then distributes the low voltage to the sub-assemblies. The thermal control system has control over the power distribution for key items based on environmental conditions. Refer to *Thermal control* → 🖹 for additional details.

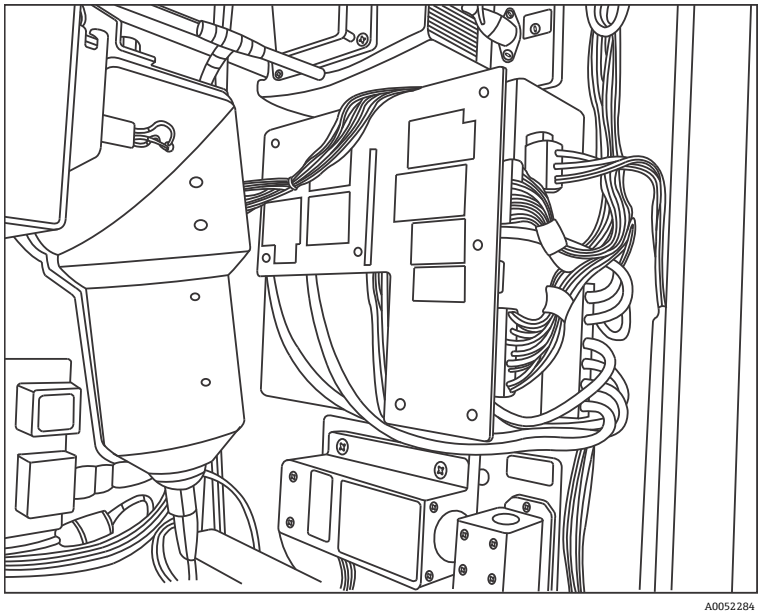


Figure 31. Printed circuit board assembly attached to the top of the power supply

6.14 DC 24 V low voltage power distribution

The DC 24 V power supply resides on the upper DIN rail on the back panel of the Raman Rxn5. The DC 24 V power supply is a supplementary power supply and only powers three subsystems: the electrical interlock IS barriers, the temperature and pressure sensor IS barriers, and the optional external sample solenoid driver.

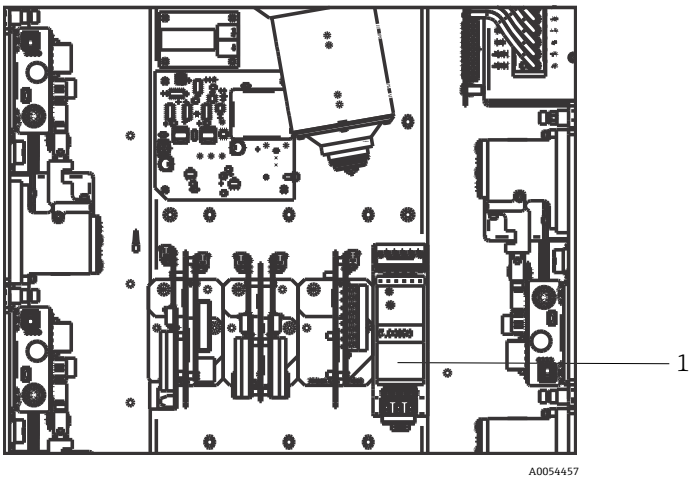


Figure 32. DC 24 V power supply (1)

6.15 Electrical laser interlock

A key safety feature of the Raman Rxn5 is the electrical laser interlock system. To meet several laser safety standard requirements, such as EN60825 and ANSI Z136.1, an interlock must be provided to protect operators from unsafe laser radiation exposure. The lasers employed in the Raman Rxn5 analyzer are considered Class 3B lasers; the laser output power must be less than 500 mW to be classified as a Class 3B laser.

Endress+Hauser lasers typically emit approximately 150 mW, which is not harmful to skin, but can be harmful to the eye. Therefore, if an operator unplugged the fiber-optic connector at the I/O panel without first pulling the laser switch, a system must be in place to turn the laser off. In addition, if a fiber-optic cable was severed somewhere between the Raman Rxn5 and the sample system, the severed cable may create an explosion hazard. Also, an indicator must be present at the sampling probe to indicate that the laser is on.

Our laser systems use a low-voltage current loop that must be closed for the laser to emit light. Endress+Hauser's fiber-optic cables are called hybrid because they contain two fiber optics and two copper wires.

NOTICE

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

Each of the Endress+Hauser probes contains a small, printed circuit board (PCB) with a resistor and an indicator LED. The current loop begins with an isolated DC to DC converter on the laser, and current travels from this supply to the relay side of a GM International D1032Q switch repeater IS barrier and back to the source laser DC to DC converter.

The switch repeater IS barrier then sources a low voltage current loop on the hazardous side and current runs to the I/O panel, through the transport fiber-optic, through the sampling probe indicator LED and back along the same path is a second copper wire for return back to the IS barrier source. The IS barrier repeats the status of the external interlock loop on its relay contacts to the loop generated by the internal laser. If the external loop is opened for any reason, the internal loop will open causing the laser to turn off.

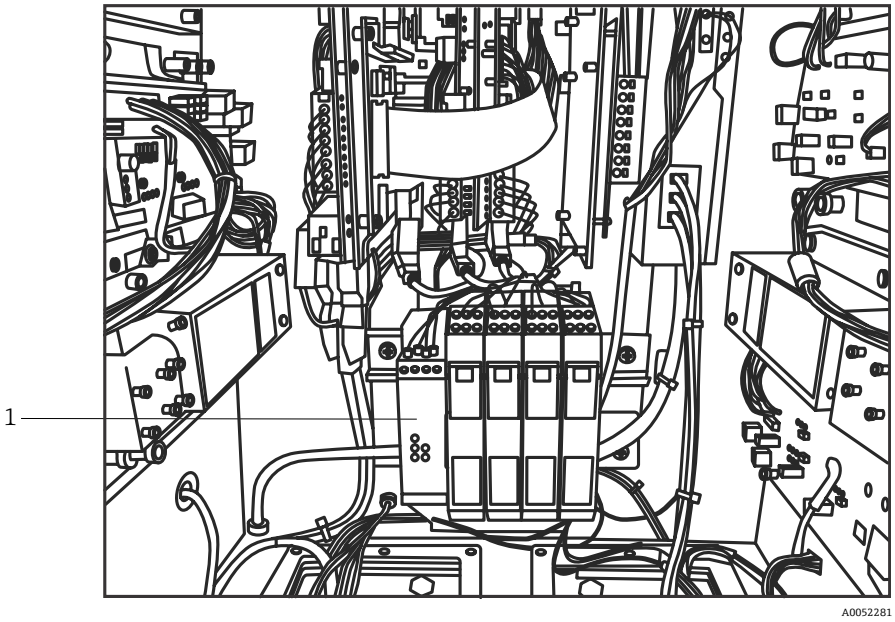


Figure 33. Interlock IS barrier (1)

6.16 USB bus

The detection module, thermal controller, sensor data acquisition (DAQ) systems, touch screen monitor and USB hub all operate on the USB bus generated by the single board computer.

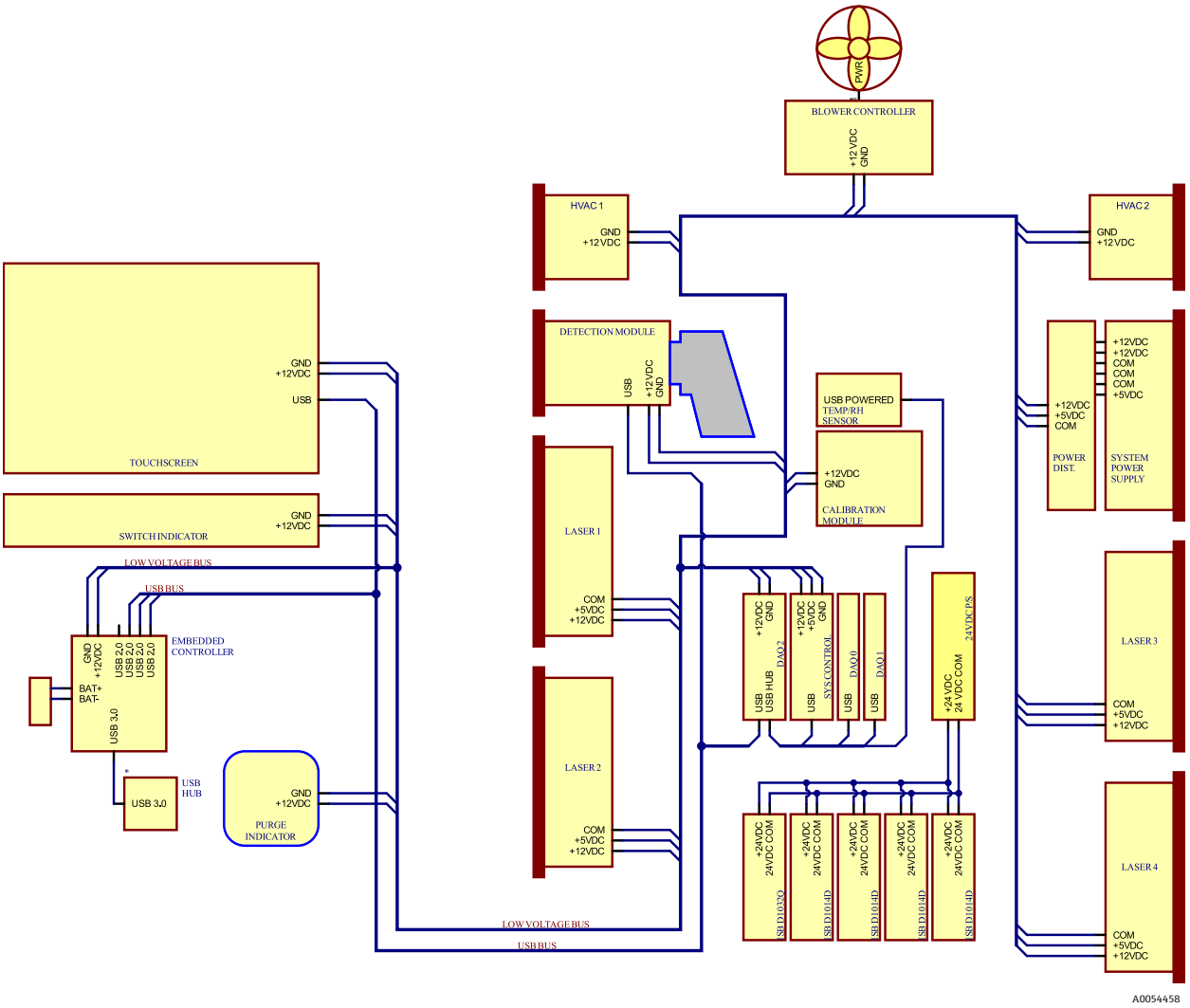


Figure 34. Schematic, low voltage power, and USB distribution

6.17 Probes and fiber optics

Endress+Hauser offers an optical service kit for the Raman Rxn5 (p/n 70208240), 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.

For probes and fiber optics, refer to the applicable Raman probe or fiber-optic cables Operating Instructions for more information about a specific product.

7 Commissioning

7.1 Commissioning the protective gas supply system

Commissioning is required to verify that the air supply will provide an adequate flow during purging and that the minimum internal overpressure is maintained when in the leakage compensation mode (the dial on the valve is turned so the slot in the dial is vertical).

7.2 Resetting operating pressure

The purge regulator has been pre-set at the factory to 2.15 psi during the purging. It may be necessary to reset the operating pressure at installation. The normal operating range for the regulator is 2.0 to 2.5 psi during purging (**ON** position). Operating in the pressure range will ensure appropriate air flow into the enclosure. Checking or resetting of the operating pressure should be considered before putting back into service:

- After commissioning has taken place
- Anytime the enclosure has been opened

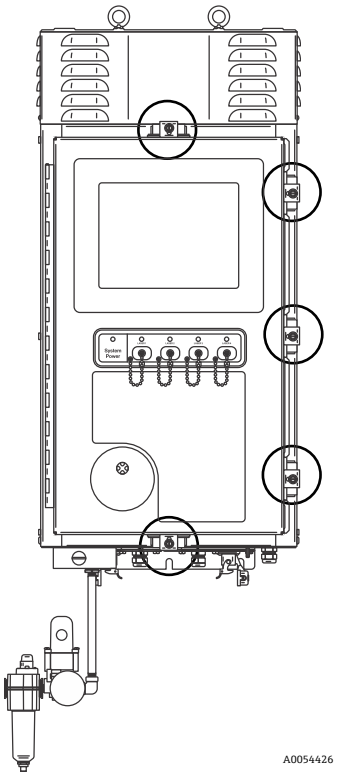


Figure 35. Door closure points

7.3 Temperature and pressure IS circuit

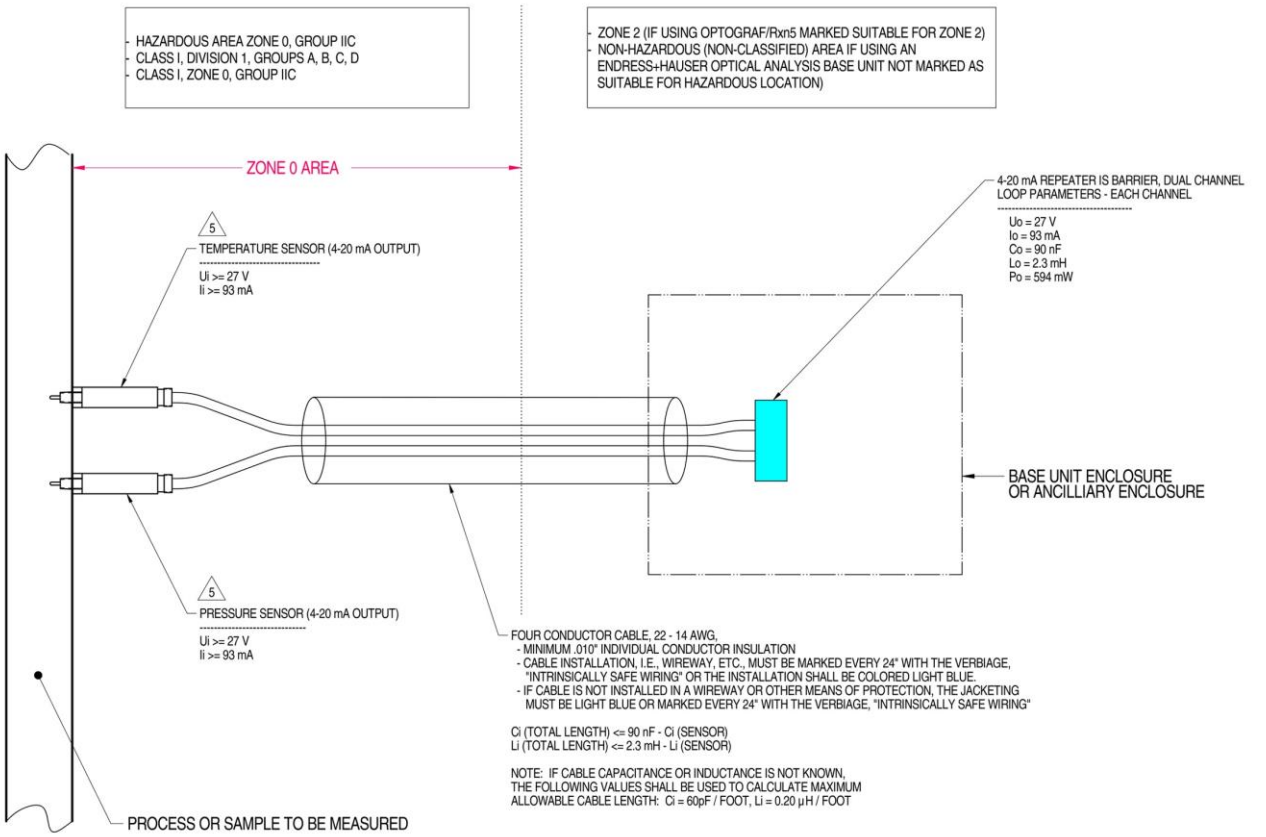
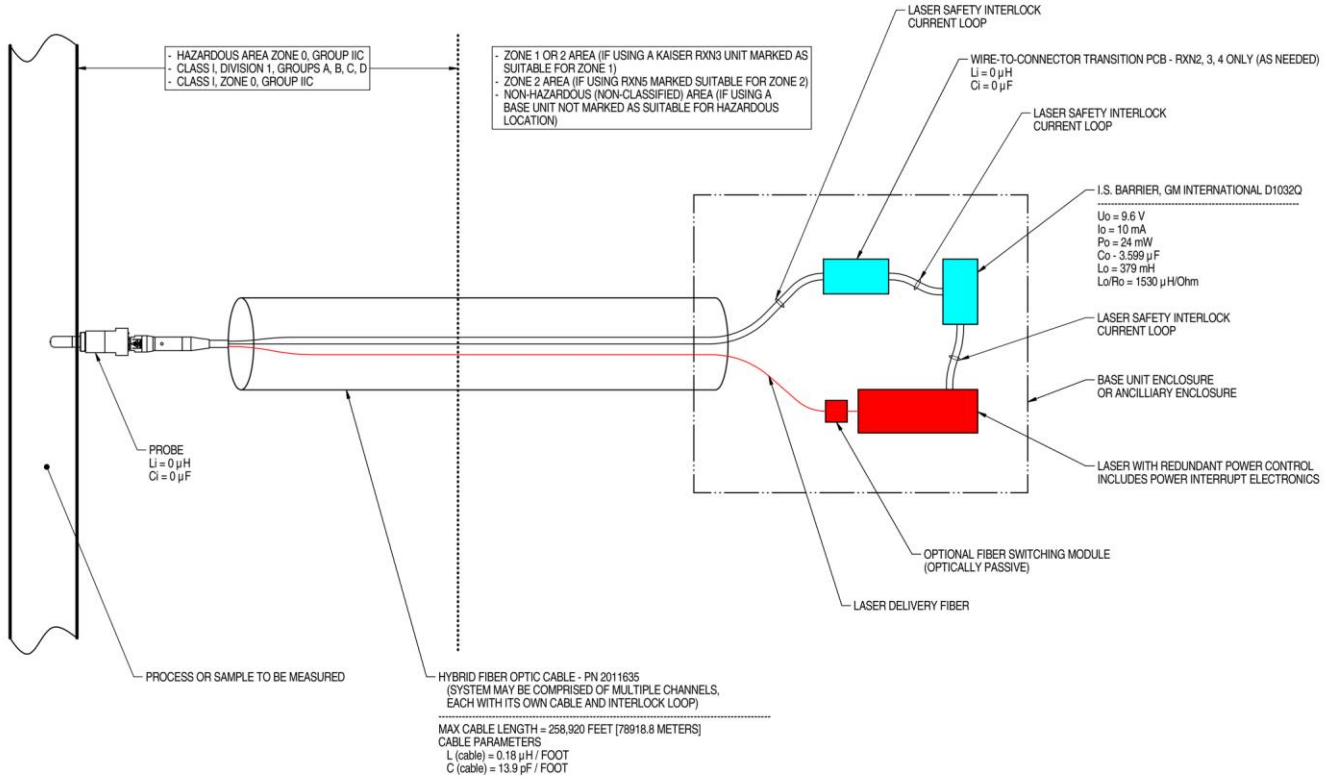


Figure 36. Control drawing for temperature and pressure IS circuit (2012682 X7)

7.4 Probe IS circuit



NOTES:

1. CONTROL EQUIPMENT CONNECTED TO THE ASSOCIATED APPARATUS MUST NOT USE OR GENERATE MORE THAN 250 VRMS OR VDC.
2. INSTALLATION IN THE U.S. SHOULD BE IN ACCORDANCE WITH ANSI/ISA RP12.6 "INSTALLATION OF INTRINSICALLY SAFE SYSTEMS FOR HAZARDOUS (CLASSIFIED) LOCATIONS" AND THE NATIONAL ELECTRICAL CODE® (ANSI/NFPA 70) SECTIONS 504 AND 505.
3. INSTALLATION IN CANADA SHOULD BE IN ACCORDANCE WITH THE CANADIAN ELECTRICAL CODE, CSA C22.1, PART 18, APPENDIX J18.
4. ASSOCIATED APPARATUS MANUFACTURER'S INSTALLATION DRAWING MUST BE FOLLOWED WHEN INSTALLING THIS EQUIPMENT.
5. FOR U.S. INSTALLATIONS, THE PROBE MODELS RXN-30 (AIRHEAD), RXN-40 (WETHEAD) AND RXN-41 (PILOT) ARE APPROVED FOR CLASS I, ZONE 0 APPLICATIONS.
6. NO REVISION TO DRAWING WITHOUT PRIOR CSA APPROVAL.
7. WARNING: SUBSTITUTION OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY.

A0049010

Figure 37. Control drawing for probe IS circuit (4002396 X6)

7.5 Interior of the Raman Rxn5

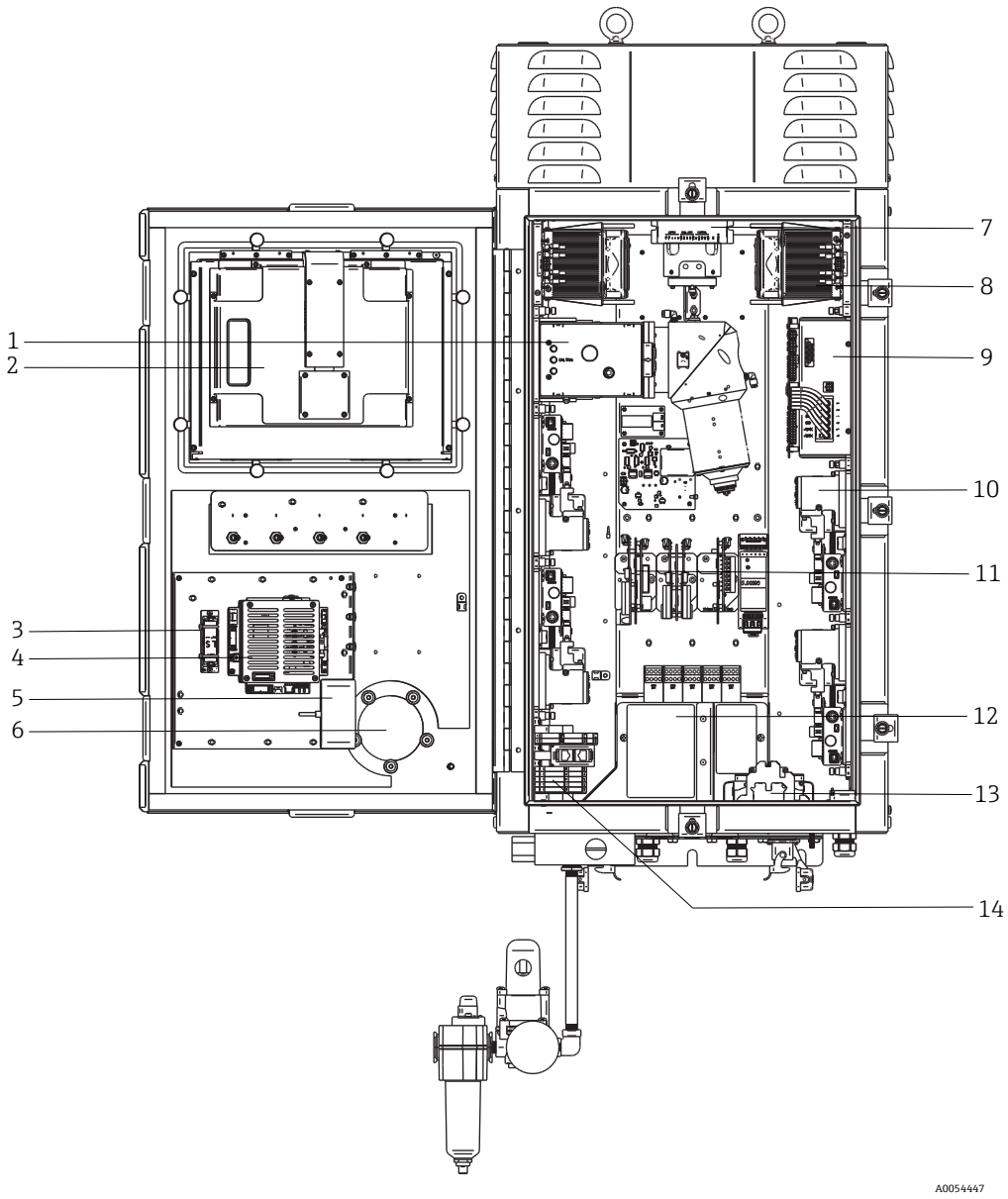


Figure 38. Raman Rxn5 analyzer interior view

#	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	Touchscreen monitor	Touchscreen monitor for Raman RunTime interface.
3	Real time clock backup battery	Backup battery for real time clock in the embedded controller. Cell type: 3.6V AA sized Li-SOCl2 The warning label on the front of the analyzer is in reference to this battery. Use only the manufacturer and type listed below for the Raman Rxn5. WARNING THIS ASSEMBLY CONTAINS A BATTERY MFR/TYPE: SAFT/LS 14500. REPLACEMENT BATTERIES MUST BE IDENTICAL. FAILURE TO OBSERVE THIS WARNING WILL INVALIDATE THE GOVERNING CERTIFICATES.
4	Embedded controller	System controller with Raman RunTime.

#	Name	Description
5	USB hub	USB ports for attachment of USB flash drive and input devices during service procedures.
6	Purge indicator/relief valve	Monitors internal enclosure purge pressure and provides enclosure over-pressure relief valve. A **Green** indicator light that indicates that the pressure inside the enclosure is above 5.1 mm (0.20 in) water column.
7	Motor controller	A device that regulates the speed and direction of the cooling fan motor.
8	Coolers	Peltier cooling devices to remove waste heat from electronics inside the enclosure.
9	Power supply	Main power supply which provides DC power for all electronics inside the enclosure.
10	Lasers (4)	The Rxn5 includes up to 4 lasers, depending on the configuration ordered.
11	Control electronics	Analyzer internal sensor signal conditioning and digitization electronics. Thermal control electronics and intrinsically safe (IS) barrier power supply also reside here.
12	IS I/O area	Probe fiber interlock and temperature/pressure sensor connection area.
13	AC mains distribution	Customer supplied mains power is connected here. Mains power is distributed to additional internal components via factory installed terminal blocks and wiring.
14	Non-IS low voltage I/O area	Connection area for the following non-IS I/O: • (2) RS-485 Modbus RTU • (2) TCP/IP for Modbus TCP or remote control • (4) DC 24 V sampling valve driver

7.6 Raman Rxn5 hardware components

7.6.1 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 input/output (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 by 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.

7.6.2 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 horizontal, or x-axis of the Raman spectrum represents the different color components of the Raman scattered light and the vertical, or 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-to-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 a Raman spectrum is usually 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.

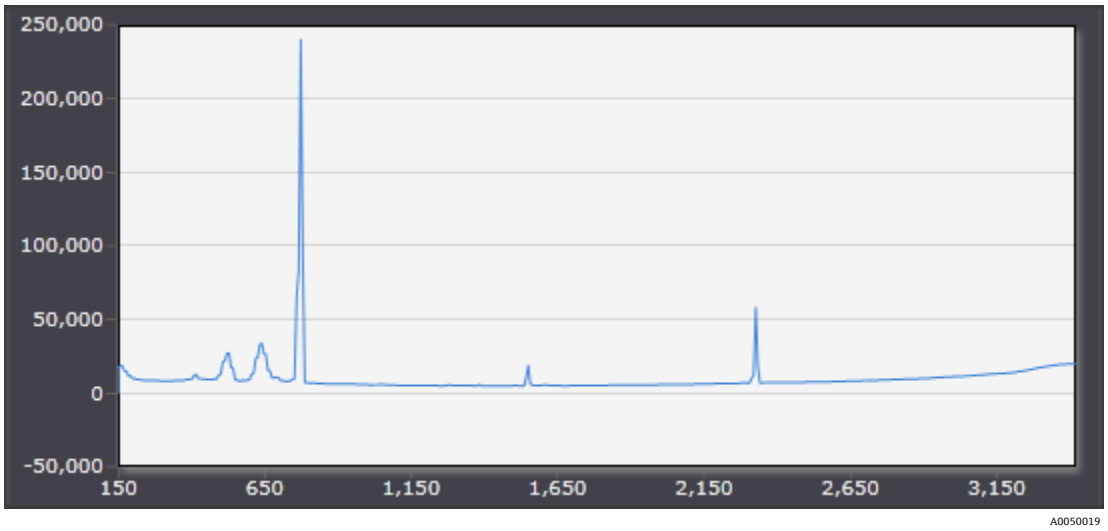


Figure 39. Typical spectrum from a Raman Rxn5 analyzer

7.7 Raman Rxn5 system interfaces

The laser control electronics and coolers are powered on with the system.

7.7.1 System power light

The system power light 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. Take action to correct.
Red and slow flashing	The system is warming up.

7.7.2 Laser on/off keys

The four laser on/off keys are magnetically coupled switches that can put the laser in standby mode and remove power to diode.

The 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.

The system features a lockout/tagout 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.

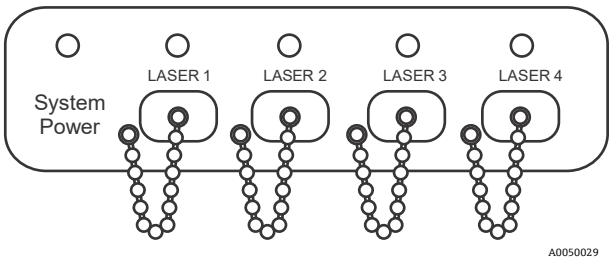


Figure 40. System power light and laser on/off keys

7.7.3 Purge indicator

The CYCLOPS purge indicator is shown is shown below. The light is on if there is positive purge pressure. For more information, refer to *Purge indicator and valve system* → 🖹.

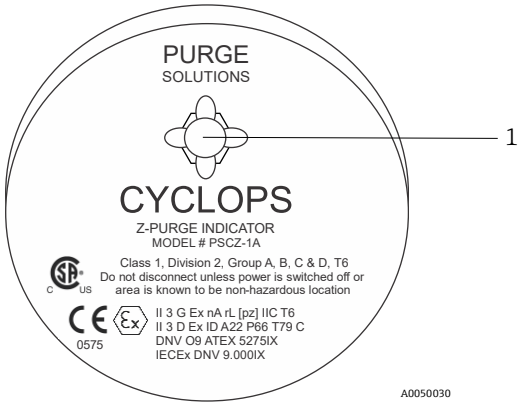


Figure 41. Purge indicator with light (1)

7.7.4 Glands and connectors

The bottom view of the Raman Rxn5 is shown below.

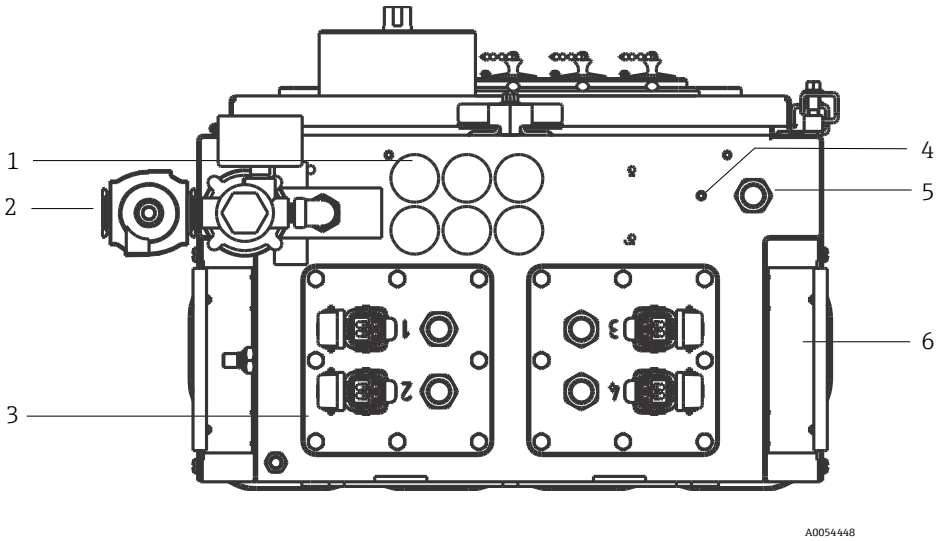


Figure 42. Glands and connectors on the bottom of the Raman Rxn5

#	Name	Description
1	Low voltage I/O 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	IS I/O location	I/O 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 0.75" enclosure earth ground stud
5	AC mains inlet	Cord grip location for AC mains power connection
6	Cooling air inlet	A cooling air inlet is located on each side of the enclosure. Do not block.

8 Operation

NOTICE

- Conduct a normal shutdown and de-energize the system prior to isolation of the protective gas from the enclosure.

8.1 Raman RunTime embedded software

Raman RunTime is the embedded control software installed on all the Raman Rxn5 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. Refer to the *Raman RunTime Operating Instructions (BA02180C)* for complete instructions on configuring and using the Raman Rxn5 with Raman RunTime.

8.2 Initial Raman RunTime setup

To perform initial Raman RunTime software setup, follow the instructions below.

1. Customize the analyzer name. The default name is “Raman Analyzer”:
   - From the Raman RunTime dashboard, navigate to **Options > System > General**.
   - Click the **Instrument Name** field.
   - Enter a custom name, for example, Raman Rxn5 sn0012345, then click **Apply**. The analyzer name is how the system is identified in diagnostic exports and within calibration reports.
2. (Optional) Calibrate the touch screen:
   - From the dashboard, navigate to **Options > System > General > Calibrate Touch Screen**.
   - Follow the on-screen prompts. To achieve better calibration, use the edge of your fingernail when following on screen prompts and touching the requested touch points.
3. Customize the identity for communication protocols, and customize network settings:
   - Navigate to **Options > System > Network.**
   - Click the **Hostname** field.
   - Enter a custom name and click **Apply**. This is a critical step because the hostname is how the Raman Rxn system is identified through communication protocols.

     If using DHCP, the IP address is obtained automatically.
   - (Optional) Enter the static IP information, as applicable, then click **Apply**.
4. Set the date and time:
   - From the dashboard, navigate to **Options > System > Date & Time**.
   - Specify the time, date, and time zone, or
   - Enable **Time Synchronization**. Provide a time server address on the local network.
   - Click **Apply**.
     - If setting the date and time manually, ensure the time zone is set up correctly before proceeding to other adjustments.
     - This is another critical step because spectral acquisition and resulting files and communication protocols are managed by the system’s date/time.

5. Specify names for each probe/quadrant such as Probe 1, Probe 2:
   - From the dashboard, click the title bar of the probe you wish to name. The stream or probe detail view displays.
   - Select the **Settings Tab** and click **Name**.
   - Enter the name of the probe and click **Apply**.
   - Let the system stabilize for at least two hours before proceeding to calibration.
6. Refer to the *Raman RunTime Operating Instructions (BA02180C)* for initial calibration and verification instructions.

8.3 Calibration and verification

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.

There are two distinct types of calibration for Endress+Hauser Raman instruments. Internal calibration is used to calibrate both the spectrograph and laser wavelengths. Probe calibration corrects for differences in overall throughput of the analyzer at different wavelengths.

8.3.1 Internal calibration

The Raman RunTime control software automatically performs internal calibrations with each analysis without user intervention or configuration. As such, the Calibration screen only displays Probe Calibration functions.

The Calibration screen shows each channel with the date of the most recent calibration and verification. On that screen you can access channel calibration and or verification, including the date and time of calibrations and verifications, pass or fail results, and details of each calibration.

The Calibrate and Verify buttons located at the top of each channel are used to run a new verification or calibration. The recommended operating procedure for an installed measurement channel is to verify first and calibrate only if the verification fails.

Running a new calibration is typically recommended under the following conditions:

- During installation and commissioning of a new analyzer or analyzer measurement channel
- After a failed verification
- After cleaning, repair, or replacement of major system components (laser, probe, detection module, fiber-optic cable)

8.3.2 Probe calibration

The sensitivity of the Raman Rxn5 varies with wavelength due to variations in the throughput of the optics and the quantum efficiency of the CCD. The probe calibration function in Raman RunTime can be used to remove the effects of this variation from measured spectra.

Probe calibration for the Raman Rxn5 analyzer is performed using a calibration gas. The calibration gas composition is chosen based on the application for which the channel is being used. Each channel may have its own calibration gas. Refer to the Operating Instructions for Raman RunTime and the Raman Rxn-30 probe for details on the calibration process.

8.3.3 Probe verification

The probe verification wizard may be used to verify that the Raman Rxn5 is performing within specifications. Probe verification acquires a Raman spectrum of a standard Raman sample, typically the current calibration gas, calculates the composition using the software method, and determines if the measured concentration of each gas is within a specified tolerance. Method verification confirms that the spectrograph and laser wavelength calibrations are within specification and the calibrated response factors for each gas provide results within specification. A report is generated showing the results of the verification steps along with a Pass/Fail indication.

9 Diagnostics and troubleshooting

9.1 Warnings and errors

9.1.1 System status

The **Status** button in the middle of the main view Status bar displays the current state of the system.

Symbol	Description
	When the system is fully calibrated and operating as expected, the **Status** button in the middle of the main view status bar reads OK and appears **Green**.
	If a system warning is encountered, the **Status** button changes to **Yellow**. Warnings should be acknowledged but immediate action may not be necessary. Click the **Status** button to view details of the warning. The most common warning occurs when all the channels are not occupied. The button pulses continuously until the problem is resolved. Click the **Status** button to view details about the warning.
	If a system error is encountered, the **Status** button changes to **Red**. An error requires immediate action to restore system performance. Click the **Status** button to view details about the error.

9.1.2 Uncalibrated channels

In some cases, users may choose not to utilize all available channels on a Raman Rxn5 analyzer. These unused/uncalibrated channels may result in warnings generated, thereby putting the whole system in a warning state. 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 select the **ON/OFF** marker beneath each probe's number.

If a system error is encountered, the **Status** button changes to **Red**.

1. Click the **Red** status indicator to view details about the warning or error.
2. In the event the analyzer stops communication with the interface, go to **Options**, select **System**, choose **Restart** and the analyzer reboots. This re-establishes camera/interface communication.

9.1.3 Low laser power

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

A laser should register between 90 to 100 mW of laser power. The laser diode current should be less than 2.1A and will increase over time due to normal diode aging.

When the laser diode current exceeds 2.1A, Raman RunTime provides a warning recommending service of the laser module soon to avoid downtime. Once the laser diode current reaches the 2.1A limit, the laser is in a failure state and laser power gradually starts decreasing. For Technical Service, refer to our website (https://endress.com/contact) for the list of local sales channels in your area.

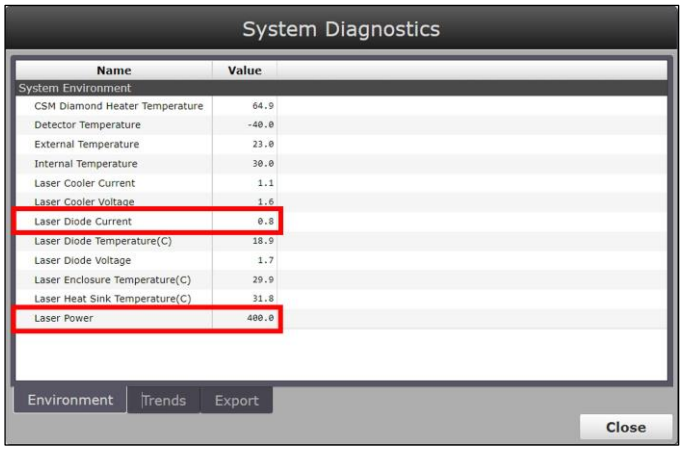


Figure 43. Environment tab to view laser diode current and laser power

9.2 Diagnostics

Several hardware diagnostics are available in the Raman Rxn5 control software. To access the systems diagnostics, select **Options > Diagnostics** from the main screen. Refer to the System warnings and errors section of the *Raman RunTime Operating Instructions (BA02180C)* for detailed diagnostic information.

9.3 Troubleshooting

9.3.1 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 below.

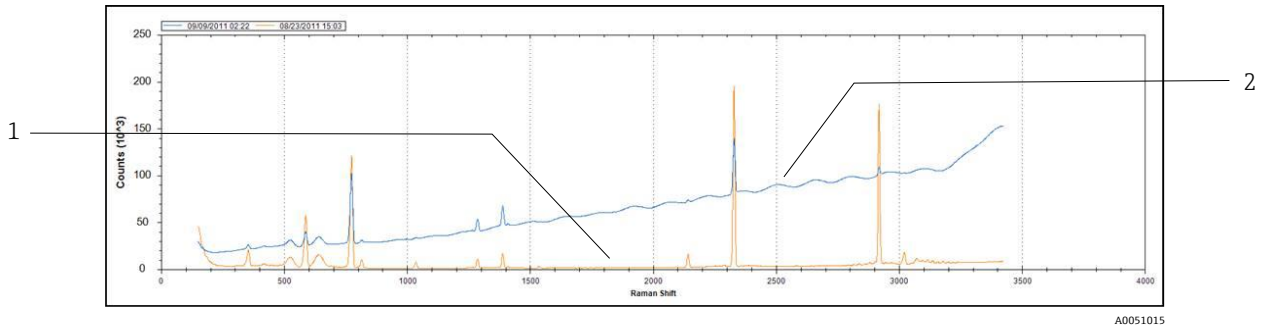


Figure 44. Spectrum with fouled probe

#	Description
1	Original spectrum
2	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. Refer to the applicable Raman probe Operating Instructions manual for cleaning instructions. 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.

9.3.2 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. Contact Technical Service, if needed.

9.3.3 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.

9.3.4 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 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 a **Red** light to appear at the fiber-optic connector for 2 to 3 seconds at the beginning of each acquisition. If the light does not turn on, replace the calibration module.

9.3.5 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.

9.3.6 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. 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.

9.3.7 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.

9.3.8 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 fan speed has been compromised, the airflow in one or both plenums has been restricted, or one or both 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 (59 ˚F) delta (plenum temp – inside temp) when in full cool mode with external temperature > 33 ˚C (91 ˚F). If the deltas are much less than 15 ˚C (59 ˚F), 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.

9.3.9 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.

9.3.10 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.

10 Maintenance

10.1 Cleaning the heat sink fins

The heat sink fins are located on either side of the analyzer.

1. Shut down the computer and then power down the analyzer.
2. Remove 14 screws on the side panels and then remove the side cover.

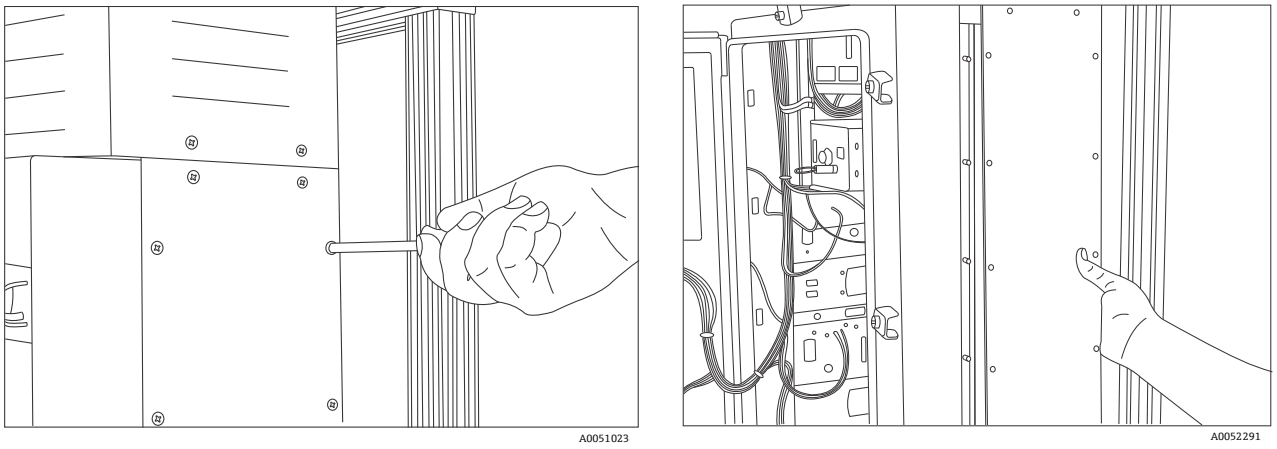


Figure 45. Removing screws and side cover

3. Blow compressed air or spray water on the exposed heat sinks to clean them.

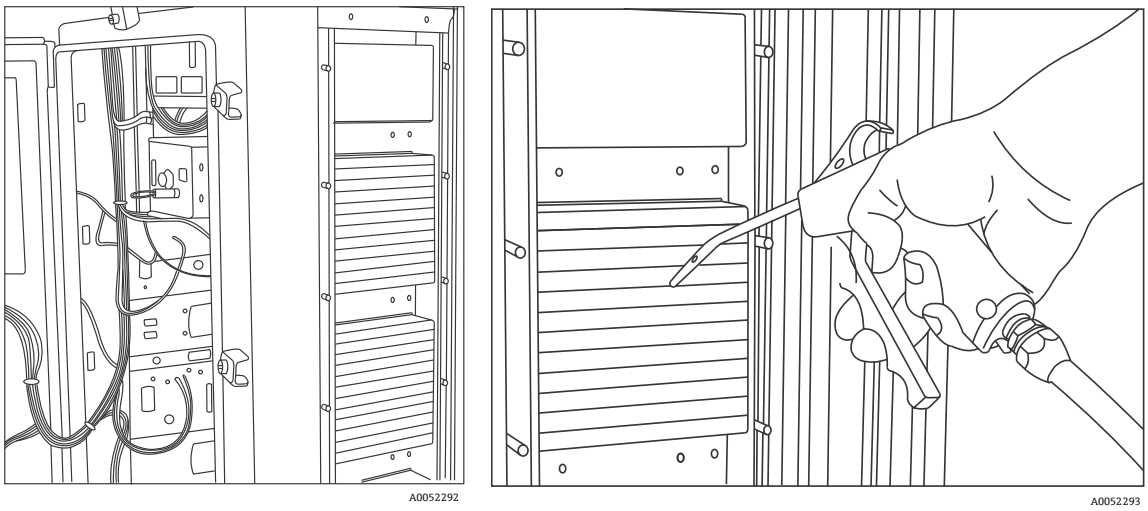


Figure 46. Cleaning heat sinks with compressed air or water

4. Replace the side cover.

10.2 Replacing the real time clock backup battery

The battery is located on the inside of the door. The warning label on the front of the analyzer is in reference to this battery. Use only the manufacturer and type listed below for the Raman Rxn5.

Cell type: 3.6V AA sized Li-SOCl2

WARNING
THIS ASSEMBLY CONTAINS A BATTERY
MFR/TYPE: SAFT/LS 14500.
REPLACEMENT BATTERIES MUST BE IDENTICAL.
FAILURE TO OBSERVE THIS WARNING WILL INVALIDATE
THE GOVERNING CERTIFICATES.

1. Clip and remove the 2 cable ties around the battery and PCB.
2. Remove the Saft LS 14500 battery from the battery holder.

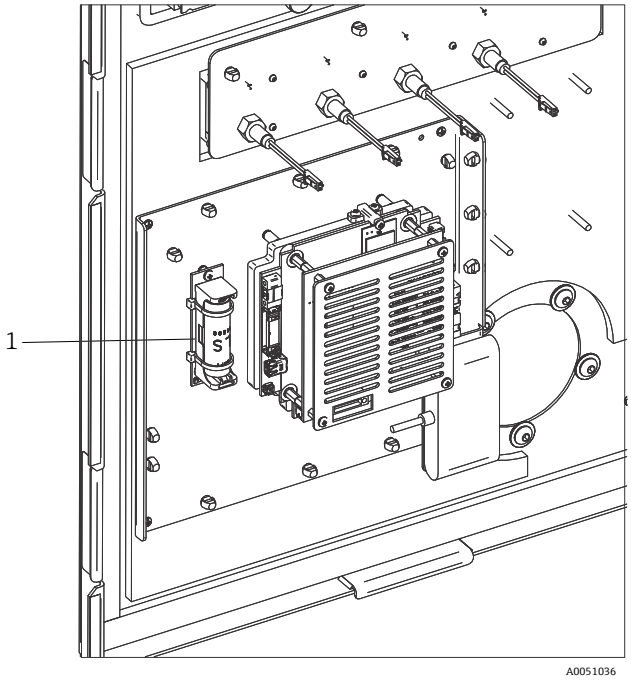


Figure 47. Real time clock backup battery (1)

3. Insert a new Saft LS 14500 battery into the battery holder with the positive end pointing down.
4. Install 2 new cable ties around the battery and PCB to secure the battery.

10.3 Replacing the desiccant cartridges

1. Shut down the computer and then power down the analyzer.
2. Remove the desiccant cartridges and replace with new or recycled cartridges.

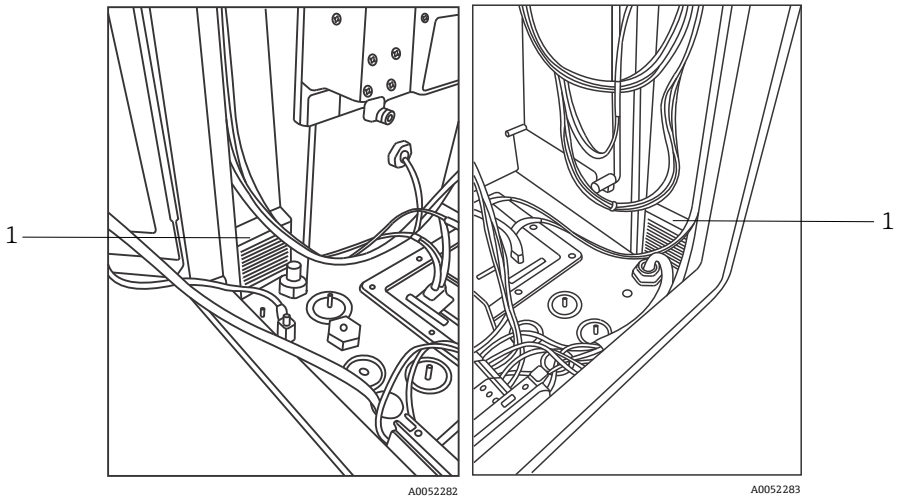


Figure 48. Desiccant cartridges (1)

11 Repair

Repairs not described in this document must be carried out only directly at the manufacturer's site or by the service organization. For Technical Service, refer to our website (https://endress.com/contact) for the list of local sales channels in your area.

12 Technical data

12.1 Electrical and communications

Item	Description
Input voltage	AC 90 to 264 V, 47 to 63 Hz standard
Automation interface	Modbus (TCP/IP or RS485)
User interface	Touchscreen color LCD display
Power consumption	< 300 W (maximum) < 300 W (typical start-up) < 200 W (typical running)
Sound level (from operator's perspective)	60.1 dB maximum, A-weighted

12.2 Physical

Item	Description
Enclosure type	Painted steel or optional 316 stainless steel, (IP56)
IEC 60529 rating (ingress protection)	IP56
Dimensions	457 x 834 x 254 mm (18.00 x 32.84 x 10.00 in)
Weight	61.2 kg (135 lbs)
Operating temperature (base unit)	−20 to 50 °C (−4 to 122 °F)
Recommended storage temperature	−30 to 60 °C (−22 to 140 °F)
Relative humidity	0 to 90 %, non-condensing
Warm-up time	120 minutes
Sampling probe compatibility	Raman Rxn-30
Number of probes	Up to 4 (simultaneous operation)

12.3 Purge air supply

Item	Description
Purge air maximum temperature	40 °C (104 °F)
Purge air dewpoint	−40 °C (−40 °F)
Purge air pressure range	20 to 120 psi
Inlet fitting	¼-18 FNPT
Maximum particle size	5 microns
Maximum flow rate during purge	2.0 SCFM
Maximum flow rate for steady-state operation	0.75 CFM

12.4 Area classification and ratings

Item	Description
Environmental temperature range	−20 to 50 °C (−4 to 122 °F)

12.5 Certifications

The Raman Rxn5 analyzer is certified for installation into hazardous areas. The certificate and approval information are listed below.

Certification	Marking	Temperature (ambient)
IECEx	Ex ec ic [ia Ga] [op sh Gb] pzc IIC T4 Gc	−20 to 50 °C (−4 to 122 °F)
ATEX	⟨Ex⟩ II 3(2)(1) G Ex ec ic [ia Ga] [op sh Gb] pzc IIC T4 Gc	−20 to 50 °C (−4 to 122 °F)
North America	Raman Rxn5 analyzer Class I, Division 2, Groups B, C, or D, T4 Class I, Zone 2; IIB + H2, T4	−20 to 50 °C (−4 to 122 °F)
UKCA	UK CA II 3(2)(1) G Ex ec ic [ia Ga] [op sh Gb] pzc IIC T4 Gc	−20 to 50 °C (−4 to 122 °F)
JPEx	Ex ec ic [ia Ga] [op sh Gb] pzc IIC T4 Gc	−20 to 50 °C (−4 to 122 °F)

13 Supplementary documentation

All documentation is available:

- On the media device supplied (not included in the delivery for all device versions)
- On the Endress+Hauser Operations App for smartphone
- In the Downloads area of the Endress+Hauser website: https://endress.com/downloads

Part Number	Document Type	Document Title
BA02180C	Operating Instructions	Raman RunTime Operating Instructions
KA01554C	Brief Operating Instructions	Raman Rxn5 Brief Operating Instructions
XA02746C	Safety Instructions	Raman Rxn5 Safety Instructions
TI01646C	Technical Information	Raman Rxn5 Technical Information

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