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Operating Instructions

Rxn-41 Raman spectroscopic probe

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 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 Rxn 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).

Table 2. Symbols

1.3 U.S. export compliance

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

1.4 Glossary

Term	Description
ANSI	American National Standards Institute
API	active pharmaceutical ingredient
ATEX	atmosphere explosible
BPVC	Boiler and Pressure Vessel Code
°C	Celsius
CDRH	Center for Devices and Radiological Health
CFR	Code of Federal Regulations
cm	centimeter
CSA	Canadian Standards Association
DIN	Deutsches Institut für Normung (German Institute for Standardization)
EO	electro-optical
EU	European Union
°F	Fahrenheit
ft.	feet
IEC	International Electrotechnical Commission
in.	inches
IPA	isopropyl alcohol
IS	intrinsically safe
kg	kilogram
lbs.	pounds
LED	light emitting diode
m	meter
mbar	millibar pressure unit
mm	millimeter
MPE	maximum permissible exposure
nm	nanometer
PAT	process analytical technology
psi	pounds per square inch
QbD	quality-by-design
RD	red
WEEE	Waste Electrical and Electronic Equipment
YE	yellow

Table 3. Glossary

2 Basic safety instruction

2.1 Requirements for personnel

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

2.2 Designated use

The Rxn-41 Raman spectroscopic probe is intended for liquid immersion sample analysis in a process plant setting.

Recommended applications include:

- **Chemical:** reaction monitoring, blending, feed, and final product monitoring
- **Polymer:** polymerization reaction monitoring, polymer blending
- **Pharmaceutical:** active pharmaceutical ingredient (API) reaction monitoring, crystallization, polymorph, drug substance production unit operation
- **Oil and gas:** any hydrocarbon analysis

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

2.3 Workplace safety

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

- Installation guidelines
- Local standards and regulations for 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 to the analyzer.

2.4 Operational safety

Before commissioning the entire measuring point:

1. Verify that all connections are correct.
2. Ensure that electro-optical cables are undamaged.
3. Ensure fluid level is sufficient for probe immersion (if applicable).
4. Do not operate damaged products, and protect them against unintentional operation.
5. 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. When working with laser devices, always follow all local laser safety protocols which may include the use of personal protective equipment and limiting device access to authorized users.

2.5 Laser safety

The Raman Rxn analyzers use Class 3B lasers as defined in the following:

- American National Standards Institute (ANSI) Z136.1, American National Standard for Safe Use of Lasers
- International Electrotechnical Commission (IEC) 60825-1, Safety of Laser Products – Part 1

⚠ WARNING

Laser radiation

- ▶ Avoid exposure to beam
- ▶ Class 3B laser product

⚠ CAUTION

Laser beams can cause ignition of certain substances such as volatile organic compounds.
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 dusts) to a critical point leading to ignition of the sample.

The laser configuration presents further safety concerns because the radiation is nearly invisible. Always be aware of the initial direction and possible scattering paths of the laser. The use of laser safety glasses with OD3 or greater is highly recommended for 532 nm and 785 nm excitation wavelengths and OD4 or greater for a 993 nm excitation wavelength.

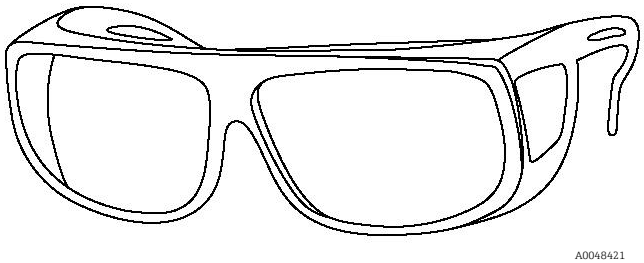

Figure 1. Laser safety glasses

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 Z136.1 or IEC 60825-14. See Section 12 → 📄 of this document for relevant parameters to enable calculation of maximum permissible exposure (MPE).

2.6 Service safety

Follow your company's safety instructions when removing a process probe from the process interface for service. Always wear proper protective equipment when servicing the equipment.

2.7 Important safeguards

- Do not use the Rxn-41 probe for anything other than its intended use.
- Do not look directly into the laser beam.
- Do not point the laser at a mirrored/shiny surface or a surface that may cause diffuse reflections. The reflected beam is as harmful as the direct beam.
- Do not leave attached and unused probes uncapped or unblocked.
- Always use a laser beam block to avoid inadvertent scatter of laser radiation.

2.8 Product safety

This product is designed to meet all current safety requirements, has been tested, and shipped from the factory in a safe operating condition. The relevant regulations and international standards have been observed. Devices connected to an analyzer must also comply with the applicable analyzer safety standards.

Endress+Hauser Raman spectroscopy systems incorporate the following safety features to conform to the United States Government requirements 21 Code of Federal Regulations (CFR) Chapter 1, Subchapter J as administered by the Center for Devices and Radiological Health (CDRH) and IEC 60825-1 as administered by the International Electrotechnical Commission.

2.8.1 CDRH and IEC compliance

Endress+Hauser Raman analyzers are certified by Endress+Hauser to meet CDRH and IEC 60825-1 design and manufacturing requirements.

Endress+Hauser Raman analyzers have been registered with the CDRH. Any unauthorized modifications to an existing Raman Rxn analyzer or accessory may result in hazardous radiation exposure. Such modifications may result in the system being no longer in conformance with Federal requirements as certified by Endress+Hauser.

2.8.2 Laser safety interlock

The Rxn-41 probe, as installed, forms part of the interlock circuit. If the fiber cable is severed, the laser will turn off within milliseconds of the breakage.

NOTICE

Handle probes and cables with care.

Fiber cables should NOT be kinked and should be routed to maintain the minimum bend radius of 152.4 mm (6 in.).

- ▶ Permanent damage may result if cables are not routed appropriately.

The interlock circuit is a low-current electrical loop. If the Rxn-41 probe is used in a hazardous classified area, the interlock circuit must pass through an intrinsically safe (IS) barrier.

The laser interlock indicator is located on the probe assembly. When there is potential for the laser to be energized, the indicator light is illuminated.

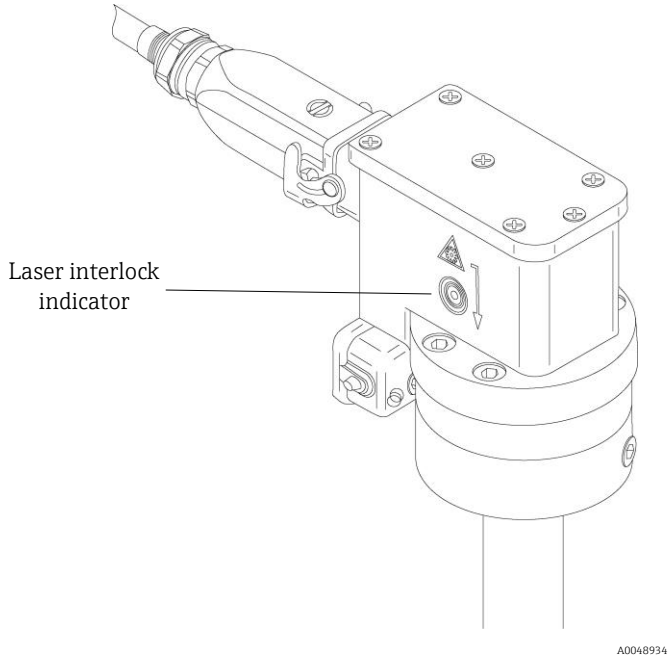

Figure 2. Location of laser interlock indicator light

2.8.3 Hazardous area approvals

The Rxn-41 probe has been third-party approved for use in hazardous areas in accordance with Article 17 of Directive 2014/34/EU of the European Parliament and of the Council dated 26 February 2014. The Rxn-41 probe has been certified to the ATEX Directive for use in Europe, as well as in other countries accepting ATEX-certified equipment.

Figure 3. ATEX label for use in hazardous areas

The Rxn-41 probe has also been approved for use in hazardous areas in the United States (US) and Canada by the Canadian Standards Association when installed in accordance with the Hazardous Area Installation Drawing (4002396).

The products are eligible to bear the CSA Mark shown with adjacent indicators 'C' and 'US' for Canada and US or with adjacent indicator 'US' for US only or without either indicator for Canada only.

Figure 4. CSA label for use in hazardous areas in the US and Canada

The Rxn-41 probe can also be marked for International Electrotechnical Commission Certification Systems for Explosive Atmospheres (IECEx) when installed in accordance with the Hazardous Area Installation Drawing (4002396).

3 Product description

3.1 The Rxn-41 probe

The Rxn-41 Raman spectroscopic probe, powered by Kaiser Raman technology, is intended for direct insertion in large reactors in a pilot or process environment. The probe is compatible with Endress+Hauser Raman Rxn analyzers operating at 532 nm, 785 nm, or 993 nm and is certified for use in hazardous areas.

The Rxn-41 probe is ideally suited for use in chemical plants and refineries to measure batch or continuous flow production. It is also highly effective for use in pharmaceutical manufacturing facilities for glasslined reactors as part of a quality-by-design (QbD) solution using process analytical technology (PAT) analyzers.

For direct measurements in cryogenic fluids, an optimized cryogenic version of the Rxn-41 probe is available.

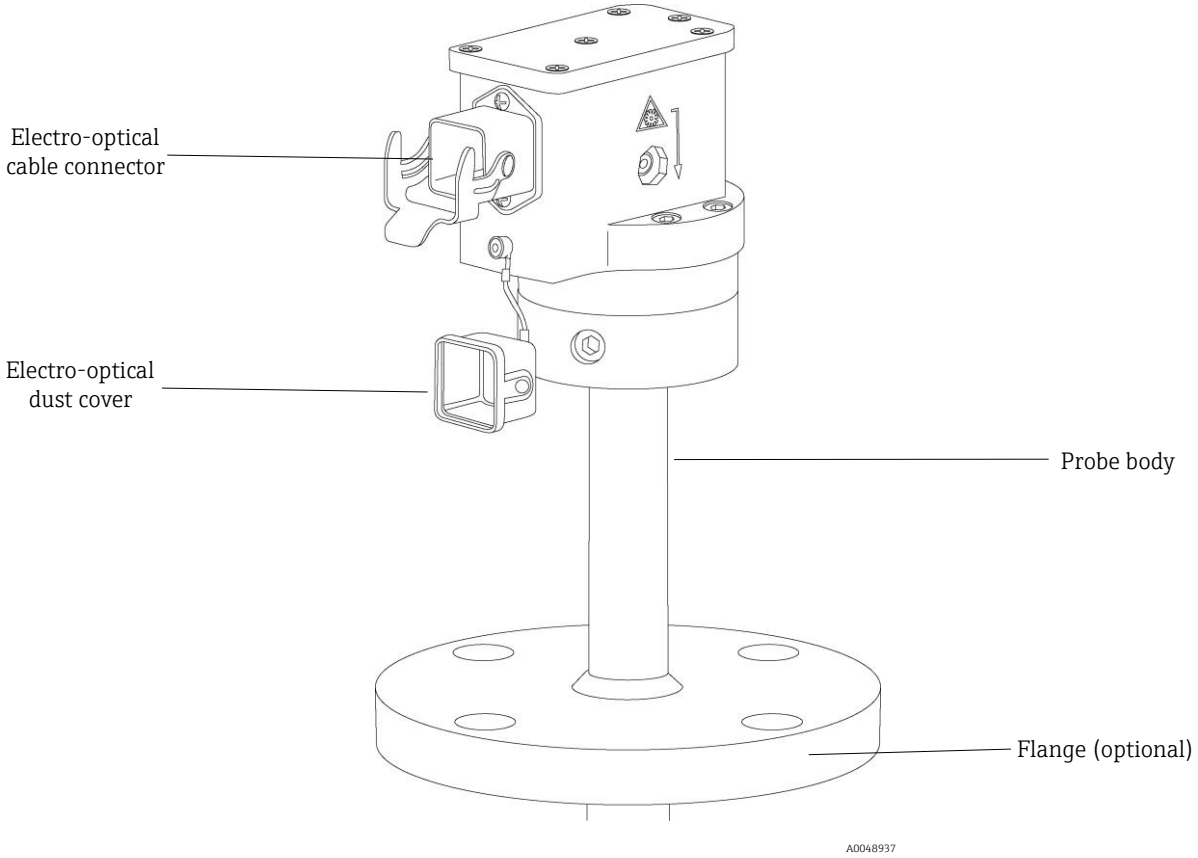

Figure 5. Rxn-41 probe

3.2 Benefits of the probe design

The Rxn-41 probe offers the following benefits compared to traditional probes:

- Sealed probe and optics design for direct liquid insertion compatibility
- Fixed-optic design for long-term measurement stability and superior signal-to-background measurements
- Integrated “laser on” indicator
- Resistant to extreme chemical, temperature and pressure environments
- Meets Category 1 pressure equipment safety standards
- Constructed to individual site requirements
- Certified for use in hazardous areas

4 Incoming product acceptance and product 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

Probe may be damaged during transport if packaged inadequately.

4.2 Product identification

4.2.1 Label

At a minimum, the probe/tag is labeled with the following information:

- Endress+Hauser branding
- Serial number

Where size allows, the following information is also included:

- Product identification (e.g., Rxn-41)
- Extended order code
- Manufacturer information
- Key functional aspects of the probe (e.g., material, wavelength, focal depth)
- Safety warnings and certification information, as applicable

Compare the information on the probe/tag with the order.

4.2.2 Manufacturer address

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

4.3 Scope of delivery

The scope of delivery comprises:

- Rxn-41 probe in the configuration ordered
- *Rxn-41 Raman spectroscopic probe Operating Instructions*
- Rxn-41 probe Certificate of Product Performance
- Local declarations of conformity, if applicable
- Certificates for hazardous zone use, if applicable
- Material certificates, if applicable
- Rxn-41 probe optional accessories, if applicable

If you have any queries, please contact your supplier or local sales center.

4.4 Certificates and approvals

Refer to the *Rxn-41 Raman spectroscopic probe Safety Instructions* manual for detailed certification and approval information.

5 Probe and fiber optic connection

The Rxn-41 probe connects to the Raman Rxn analyzer via one of the following:

- Electro-optical (EO) to EO fiber cable
- Fiber channel (FC) to EO fiber converter(s) for non-embedded systems

Refer to the applicable Raman Rxn analyzer operating instructions for analyzer connection details.

NOTICE

Connection of the probe to the fiber optic cable must be conducted by a qualified Endress+Hauser engineer or specially trained technical personnel.

- ▶ Unless trained by qualified personnel, customer attempts to connect the probe to the fiber optic cable can result in damage and may void the warranty.
- ▶ Contact your local Endress+Hauser service representative for additional support regarding the probe and fiber cable connection.

The fiber connection for the Rxn-41 probe is a right-angle/direct fiber connection.

An EO extension cable is available for longer cable runs or installation in conduit.

5.1 EO fiber cable

The EO fiber cable connects the Rxn-41 probe to the analyzer with a single, robust connector that contains the excitation and collection fiber-optics as well as an electrical laser interlock.

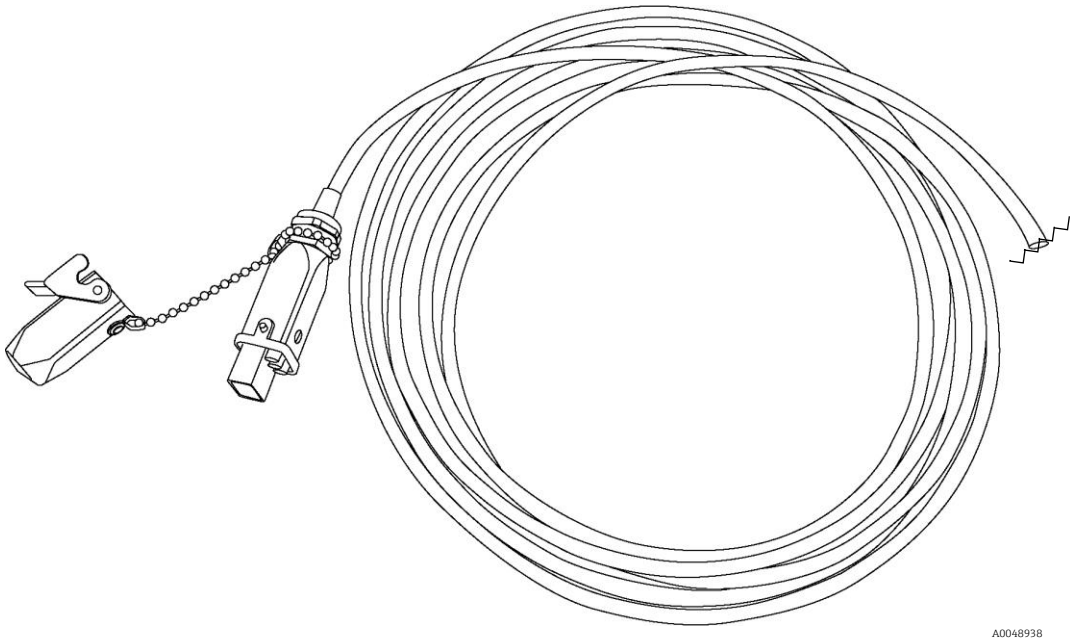

Figure 6. EO fiber cable showing connector for analyzer

5.2 FC cable assembly

The FC cable assembly connects to the analyzer via the following:

- Electrical interlock connector
- Yellow (YE) excitation fiber for laser output
- Red (RD) collection fiber for spectrograph input

An FC to EO fiber converter is then used to connect the FC cable to the Rxn-41 probe.

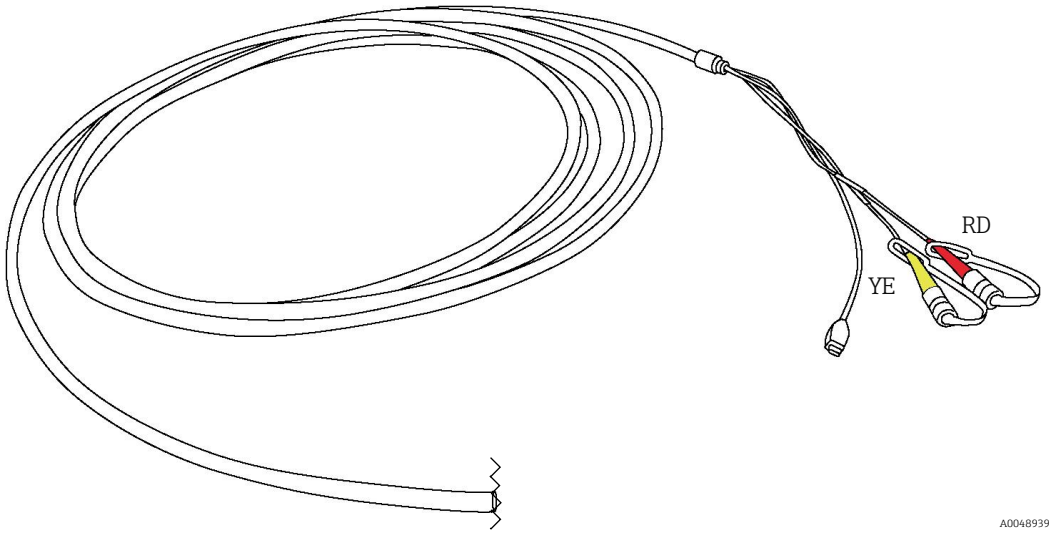

Figure 7. FC cable assembly showing connector for analyzer

6 Installation

Prior to installation in the process, verify that the amount of laser power out of each probe is no more than the amount specified in the Hazardous Area Equipment Assessment (4002266) or equivalent.

Standard eye and skin safety precautions for Class 3B laser products (as per EN-60825/IEC 60825-14) should be observed as described below.

⚠ WARNING	**Probes are designed with specific sealing boundaries.** ▶ The probe pressure specifications are only valid if sealing is accomplished on the intended sealing feature (shaft, flange, etc.). **Standard precautions for laser products should be observed.** ▶ Probes should always be capped and/or pointed away from people toward a diffuse target if not installed in a sample chamber.
⚠ CAUTION	**If stray light is allowed to enter an unused probe, it will interfere with data collected from a used probe and may cause calibration failure or measurement errors.** ▶ Unused probes should ALWAYS be capped to prevent stray light from entering the probe.
NOTICE	**Take care to install the probe such that it measures the flowing sample or sample region of interest.**

6.1 Installation guidelines

The Rxn-41 probe is designed for installation directly into process streams and reactor vessels according to the installation guidelines below:

- When installing a probe equipped with the non-removable right-angle fiber connector (EO style) assembly, it is recommended that the fiber cable assembly be disconnected from the probe during installation.
- Ensure that the laser interlock is connected to the safety indicator light and to any other safety systems, such as liquid level sensors or purges appropriate to the installation.
- The Rxn-41 probes have no active electrical devices requiring earthing. The user should determine if the probe requires earthing for other reasons associated with its installation.

6.2 Hazardous area installation

For hazardous areas, the probe must be installed according to the Hazardous Area Installation Drawing (4002396).

NOTICE

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

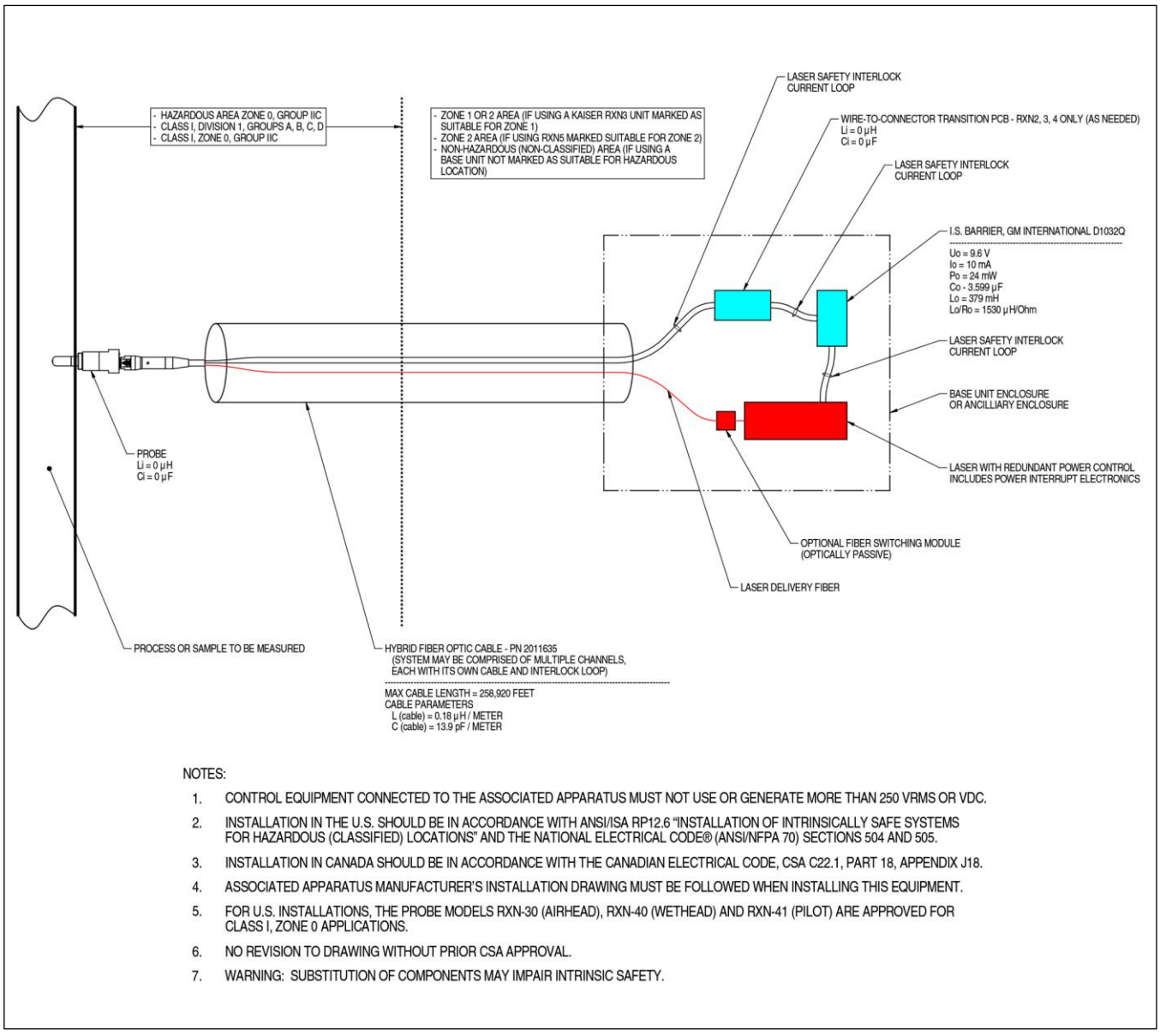

Figure 8. Hazardous Area Installation Drawing (4002396 version X5)

6.3 Process and probe compatibility

Prior to installation, the user must check that the probe pressure and temperature ratings, as well as the materials from which the probe is made, are compatible with the process into which it is being inserted.

The probes should be installed using sealing techniques (e.g., flanges, compression fittings) appropriate and typical for the vessel or piping and in accordance with any local construction codes.

⚠ WARNING

If the probe will be installed in a high temperature or pressure process, additional safety precautions must be taken to avoid equipment damage or safety hazards.

A blow-out protection device is highly recommended in accordance with local safety standards.

- It is the responsibility of the user to determine if any blow-out protection devices are required and ensure they are attached to the probes during installation.

⚠ WARNING

If the probe being installed is constructed of titanium, the user should be aware that impacts or excessive process friction could cause a spark or otherwise cause ignition.

- The user must ensure that precautions are taken when installing and using a titanium probe to avoid such an occurrence.

6.4 Certifications and markings

Endress+Hauser offers certifications for the Rxn-41 probe according to the standards below. Based on the desired certification(s) below, the probe or probe tag will be constructed and marked accordingly.

Type	Description
ATEX marking and installations	▪ ATEX marking is available as an option at the time of purchase. Available markings: II 2/1 G Ex ia op is IIA or IIB or IIB+H2 or IIC T3 or T4 or T6 Ga ▪ Prior to the order, the marking for the particular probe/application must be determined. The customer must do one of the following: o Work with purchasing to identify the required marking OR o Provide Endress+Hauser with a completed copy of the Hazardous Area Equipment Assessment (4002266). ▪ Endress+Hauser will mark the Rxn-41 probes according to the customer's provided information. Endress+Hauser is not responsible for the customer's inaccuracies. **⚠ WARNING** **In an ATEX-governed environment, only ATEX-marked probes may be used.**
North American hazardous area marking and installations	▪ CSA marking is available as an option at the time of purchase. Available markings: Ex ia op is IIA or IIB or IIB + H2 or IIC T3 or T4 or T6 Ga Class I, Zone 0 AEx ia op is IIA or IIB or IIB + H2 or IIC T3 or T4 or T6 Ga Class I, Division 1, Groups A, B, C, D T3/T4/T6 ▪ Prior to the order, the marking for the particular probe/application must be determined. The customer must do one of the following: o Work with purchasing to identify the required marking OR o Provide Endress+Hauser with a completed copy of the Hazardous Area Equipment Assessment (4002266). ▪ Endress+Hauser will mark the Rxn-41 probes according to the customer's provided information. Endress+Hauser is not responsible for the customer's inaccuracies. ▪ For North American applications into classified environments, the probe set will have the CSA mark and can be considered intrinsically safe when installed according to the Hazardous Area Installation Drawing (4002396). **⚠ WARNING** **In a CSA-governed environment, only CSA-marked probes may be used.**
IECEx hazardous area marking and installations	▪ IECEx marking is available as an option at the time of purchase. Available markings: Ex ia op is IIA or IIB or IIB + H2 or IIC T3 or T4 or T6 Ga IECEx ITS 14.0015X ▪ Prior to the order, the marking for the particular probe/application must be determined. The customer must do one of the following: o Work with purchasing to identify the required marking OR o Provide Endress+Hauser with a completed copy of the Hazardous Area Equipment Assessment (4002266). ▪ Endress+Hauser will mark the Rxn-41 probes according to the customer's provided information. Endress+Hauser is not responsible for the customer's inaccuracies. ▪ For IECEx applications into classified environments, the probe set will have the IECEx mark and can be considered intrinsically safe when installed according to the Hazardous Area Installation Drawing (4002396). **⚠ WARNING** **In an IECEx-governed environment, only IECEx-marked probes may be used.**

Table 4. Certifications and markings

7 Commissioning

The Rxn-41 probe is delivered ready to connect to the Raman Rxn analyzer. No additional alignment or adjustment to the probe itself is required. Follow the instructions below to commission the probe for use.

NOTICE

The probe installation and usage parameters may have specific requirements governed by the associated application.

▶ Please refer to the appropriate certificate for ATEX, CSA, or IECEx for those specific requirements.

7.1 Receipt of probe

Perform the steps for incoming product acceptance described in Section 4.1 → 📄.

Additionally, upon receipt, remove the shipping container cover and inspect the sapphire window for any damage prior to installing into the process. If the window shows any visible cracks, please contact the supplier.

7.2 Probe calibration and verification

The probe and the analyzer must be calibrated before use.

Refer to the applicable Raman Rxn analyzer operating instructions manual for steps to:

- Perform internal analyzer calibration; may include alignment calibration, full wavelength calibration and/or full laser wavelength calibration depending on status of analyzer
- Perform probe calibration; requires a Raman Calibration Accessory (HCA) with an appropriate optic adapter
- Perform probe verification; verifies the calibration results using a standard reference sample
- View calibration and verification reports

The Raman RunTime software will not allow spectra to be collected without passing internal analyzer and probe calibrations. Passing the probe verification step is not required but highly recommended.

Raman Rxn analyzer operating instructions are available by searching the Downloads area of the Endress+Hauser web site: https://endress.com/downloads

8 Operation

The Endress+Hauser Raman Rxn-41 probe is a sealed immersion probe for *in situ* Raman spectroscopy of liquid-phase samples in a pilot or process plant setting. The Rxn-41 line of probes is designed to be compatible with Endress+Hauser Raman Rxn analyzers equipped with a laser operating at 532 nm, 785 nm, or 993 nm.

Refer to the applicable Raman Rxn analyzer operating instructions for additional instructions for use.

Raman Rxn analyzer operating instructions are available by searching the Downloads area of the Endress+Hauser web site: https://endress.com/downloads

9 Diagnostics and troubleshooting

Refer to the table below when troubleshooting issues with the Rxn-41 probe. If the probe is damaged, isolate the probe from the process stream and turn off the laser prior to evaluation. Contact your service representative as needed for assistance.

Symptom		Possible cause	Action
1	Substantial reduction in signal or signal-to-noise ratio	Window fouling	1. Carefully remove probe from the process, decontaminate, and inspect optical window at tip of probe. 2. If necessary, clean the window before returning it to service. See Section 10.2→ 🖹.
		Cracked but intact fiber	Verify condition of fiber and contact your service representative for replacement.
2	Complete loss of signal while laser is powered and laser interlock indicator is lit	Broken fiber without interlock wire breakage	Ensure all fiber connections are secure.
3	Laser interlock indicator on probe is not lit	Damaged fiber assembly	Look for signs of breakage in fiber. Contact your service representative for replacement.
		Fiber cable EO connector not secured/latched	Ensure EO connector is properly connected and latched at the probe (if applicable) and at the analyzer.
		Remote interlock connector disconnected	Ensure the twist-lock remote interlock connector at the rear of analyzer (next to fiber EO connector) is connected.
4	Unstable signal and contamination visible behind window	Window seal failure	1. Examine the area inside the window for moisture or condensation. 2. Examine the probe for fluid penetration or signs of sample fluid in the probe body (e.g., corrosion, residue). 3. Look for any sign of spectral deviation. 4. If any of the above are noted, contact your service representative to return the probe to the manufacturer.
5	Decreased laser power or collection efficiency	Contaminated fiber connection	Carefully clean the fiber ends at the probe. Refer to the applicable Raman Rxn analyzer operating instructions for cleaning instructions and steps for starting up a new probe.
6	Laser interlock on analyzer causes laser to shut down	Laser interlock activated	Check for fiber breakage on all connected fiber optic cable channels and ensure remote interlock connectors are in place on each channel.
7	Unrecognized bands or patterns in the spectra	Cracked but intact fiber	Verify possible causes and contact your service representative to return the damaged product.
		Contaminated probe tip	
		Contaminated internal optics of probe due to leakage	
8	Other unexplained negative performance of the probe	Physical damage to probe	Contact your service representative to return the damaged product.

Table 5. Troubleshooting

10 Maintenance

10.1 Probe inspection

It is the customer's responsibility to determine the corrosion rate of any process probes and set appropriate inspection intervals to verify probe integrity.

10.2 Cleaning the probe window

If the Rxn-41 probe window has come in contact with a sample, dust or fingerprints, etc., it may need to be cleaned. Extra care must be taken to ensure that the window surface is not further contaminated during the cleaning process.

For all other maintenance, it is recommended that the Rxn-41 probe is serviced at the manufacturer's site.

To clean the Rxn-41 probe window:

1. Ensure that the laser is turned **OFF** or the probe is disconnected from the analyzer.
2. Blow off the surface with clean compressed air to remove any loose particles.
3. Wipe the surface using a swab **lightly** dampened with a solvent appropriate for the substance to be cleaned. Solvents may include reagent grade acetone, 100 % isopropyl alcohol (IPA), deionized water, or others.

   Do not allow the solvent to drip behind the retaining components.
4. Wipe the surface dry with a dry swab.
5. Repeat the cleaning with an additional solvent, if needed, and wipe the surface dry with a dry swab.
6. Blow with clean compressed air to remove any swab remnants.
7. Inspect the surface to verify the effectiveness of the cleaning.

   Verification with an inspection microscope in the cleaning process is highly recommended to look for smeared contaminants, swab remnants, etc., that may cause increased spectrum background.
8. Repeat the previous steps as necessary.

10.3 Inspecting and cleaning the optical fibers

The EO fiber connectors must be clean and free of debris and oil to achieve optimal performance. If cleaning is required, refer to the applicable Raman Rxn analyzer operating instructions.

10.4 Purging and pressurizing interior volumes

Approximately every 5 years, any probes that have been located in hazardous areas should have their interior volumes re-purged and re-pressurized. This can generally be done in the field with a few special tools. Contact your service representative for details.

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.

If a product must be returned for repair or replacement, follow all decontamination procedures indicated by your service provider.

⚠ WARNING

Failure to properly decontaminate wetted parts before return can result in a fatal or serious injury.

To ensure swift, safe and professional product returns, please contact your service organization.

For additional product return information, refer to the following site and select the applicable market/region: https://www.endress.com/en/instrumentation-services/instrumentation-repair

12 Technical data

12.1 Temperature and pressure specifications

The temperature and pressure specifications for the Rxn-41 probe vary depending on the probe size and materials of construction. A cryogenic compatible version is available for the 1-inch Rxn-41 probe upon request. Additionally:

- Max pressure is calculated per ASME BPVC VIII.1 UG-28(c) for material and probe geometry at the maximum rated temperature.
- Max service pressure ratings do not include the ratings of any fittings or flanges used to mount the probe into the process system. These items need to be independently evaluated and may lower the maximum service pressure of the probe.
- Minimum pressure rating: All probes have a minimum pressure rating of 0 bara (full vacuum). However, unless specified, they are not rated for low outgassing at high vacuum service.
- The probe withstands 0 to 100 °C (32 to 212 °F) water shock.
- The temperature ramp is ≤ 30 °C/min (≤ 54 °F/min).

Component	Materials of construction	Min temp	Max temp	Max service pressure
1-inch Rxn-41 probe	316L stainless steel	−30 °C (−22 °F)	120 °C (248 °F)	77.0 barg (1120 psig)
	C276 alloy	−30 °C (−22 °F)	150 °C (302 °F)	98.5 barg (1420 psig)
	Grade 2 titanium	−30 °C (−22 °F)	150 °C (302 °F)	76.0 barg (1100 psig)
2-inch (nominal) Rxn-41 probe	316L stainless steel	−30 °C (−22 °F)	120 °C (248 °F)	42.7 barg (620 psig)
	C276 alloy	−30 °C (−22 °F)	150 °C (302 °F)	66.1 barg (960 psig)
1-inch Cryogenic Rxn-41 probe	C276 alloy	−196 °C (−320.8 °F)	70 °C (158 °F)	111.0 barg (1610 psig)
	Hybrid metal combination (C276 tip/316L)	−196 °C (−320.8 °F)	70 °C (158 °F)	87.5 barg (1270 psig)
Cable and connector	Cable: PVC jacketed, proprietary construction Connections: proprietary electro-optic	−40 °C (−40 °F)	70 °C (158 °F)	not applicable

Table 6. Temperature and pressure specifications

12.2 General specifications

Item		Description
Laser wavelength		532 nm, 785 nm, or 993 nm
Spectral coverage		probe spectral coverage is limited by the coverage of the analyzer being used
Maximum laser power into probe		< 499 mW
Materials of construction Wetted, in contact with sample	probe body	• C276 alloy or 316L stainless steel • Grade 2 titanium available upon request • Hybrid metal combination (316L stainless steel, C276 alloy) available upon request
	window	high-purity sapphire
Probe immersible length	C276 alloy	• 1-inch Rxn-41: Up to 3040 mm (120 in.) • 2-inch Rxn-41: Up to 4550 mm (179.1 in.)
	316L stainless steel	• 1-inch Rxn-41: Up to 3040 mm (120 in.) • 2-inch Rxn-41: Up to 4550 mm (179.1 in.)
	Grade 2 titanium	1-inch Rxn-41: Up to 350 mm (13.78 in.)
Probe immersible diameter	C276 alloy	• 25.4 mm (1 in.) • 60.325 mm (2-inch nominal; actual OD 2.38 in.)
	316L stainless steel	• 25.4 mm (1 in.) • 60.325 mm (2-inch nominal; actual OD 2.38 in.)
	Grade 2 titanium	25.4 mm (1 in.)
pH range		0 to 14
Relative humidity		up to 95 %, non-condensing
Flanges	type	ASME B16.5 or DIN EN1092 Type B flanges available upon request
	diameter	up to 305 mm (12 in.)
Fiber cable (sold separately)	design	PVC jacketed, proprietary construction
	connections	proprietary electro-optic
	minimum bend radius	152.4 mm (6 in.)
	length	EO cable available from 5 m to 200 m in 5 m increments (16.4 ft. to 656.2 ft. in 16.4 ft. increments) limited by application
	pull strength	204 kg (450 lbs.)
	flame resistance	Certified: CSA-C/US AWM I/II, A/B, 80C, 30V, FT1, FT2, VW-1, FT4 Rated: AWM I/II A/B 80C 30V FT4

Table 7. General specifications

12.3 Maximum permissible exposure

The maximum permissible exposure (MPE) is the maximum level of laser radiation exposure that can occur before causing ocular or skin damage. The MPE is calculated using the laser wavelength (λ) in nanometers, the duration of the exposure in seconds (t), and the energy involved ($J \cdot cm^{-2}$ or $W \cdot cm^{-2}$).

A correction factor (C_A) may also be required and can be determined below.

Wavelength λ (nm)	**Correction Factor C_A**
400 to 700	1
700 to 1050	$10^{0.002(\lambda-700)}$
1050 to 1400	5

Table 8. Wavelength dependent correction factor C_A

12.3.1 MPE for ocular exposure

The ANSI Z136.1 standard provides means to perform MPE for ocular exposure. Please refer to the standard to calculate the relevant MPE levels for the case of laser exposure from the Rxn-41 probe and from the unlikely occurance of laser exposure from a broken optical fiber.

MPE for point source ocular exposure to a laser beam			
Wavelength *λ (nm)*	**Exposure duration *t (s)***	**MPE calculation**	
		(J·cm⁻²)	***(W·cm⁻²)***
532	10^{-13} to 10^{-11}	1.0×10^{-7}	-
	10^{-11} to 5×10^{-6}	2.0×10^{-7}	-
	5×10^{-6} to 10	$1.8\ t^{0.75} \times 10^{-3}$	-
	10 to 30,000	-	1×10^{-3}

Table 9. MPE for ocular exposure with 532 nm laser emission

MPE for point source ocular exposure to a laser beam				
Wavelength *λ (nm)*	**Exposure duration *t (s)***	**MPE calculation**		**MPE where C_A = 1.4791**
		(J·cm⁻²)	***(W·cm⁻²)***	
785 and 993	10^{-13} to 10^{-11}	$1.5\ C_A \times 10^{-8}$	-	2.2×10^{-8} ($J \cdot cm^{-2}$)
	10^{-11} to 10^{-9}	$2.7\ C_A\ t^{0.75}$	-	Insert time (*t*) and calculate
	10^{-9} to 18×10^{-6}	$5.0\ C_A \times 10^{-7}$	-	7.40×10^{-7} ($J \cdot cm^{-2}$)
	18 x 10^{-6} to 10	$1.8\ C_A\ t^{0.75} \times 10^{-3}$	-	Insert time (*t*) and calculate
	10 to 3×10^{4}	-	$C_A \times 10^{-3}$	1.4971×10^{-3} ($W \cdot cm^{-2}$)

Table 10. MPE for ocular exposure with 785 nm or 993 nm laser emission

12.3.2 MPE for skin exposure

The ANSI Z136.1 standard provides means to perform MPE for skin exposure. Please refer to the standard to calculate the relevant MPE levels for the case of laser exposure from the Rxn-41 probe and from the unlikely occurance of laser exposure from a broken optical fiber.

MPE for skin exposure to a laser beam				
Wavelength ***λ (nm)***	**Exposure Duration** ***t (s)***	**MPE Calculation**		**MPE where** C_A **= 1.4791**
		(J·cm⁻²)	***(W·cm⁻²)***	
532, 785 and 993	10^{-9} to 10^{-7}	2 $C_A \times 10^{-2}$	-	2.9582 × 10^{-2} (J·cm^{-2})
	10^{-7} to 10	1.1 $C_A\, t^{0.25}$	-	Insert time (t) and calculate
	10 to 3 x 10^4	-	0.2 C_A	2.9582 × 10^{-1} (W·cm^{-2})

Table 11. MPE for skin exposure with 532 nm, 785 nm, or 993 nm laser emission

13 Supplementary documentation

All documentation is available:

- On the Endress+Hauser Operations App for smartphone/tablet
- In the Downloads area of the Endress+Hauser web site: https://endress.com/downloads

Part number	Document type	Document title
KA01560C	Brief Operating Instructions	Rxn-41 Raman spectroscopic probe Brief Operating Instructions
XA02784C	Safety Instructions	Rxn-41 Raman spectroscopic probe Safety Instructions
TI01673C	Technical Information	Rxn-41 Raman spectroscopic probe Technical Information

Table 12. Supplementary documentation

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