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Operating Instructions

Rxn-40 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 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
EXC	Excitation
°F	Fahrenheit
IEC	International Electrotechnical Commission
INTLK	Interlock
IPA	Isopropyl Alcohol
IS	Intrinsically Safe
LED	Light Emitting Diode
mbar	Millibar pressure unit
mm	Millimeter
MPE	Maximum Permissible Exposure
NeSSI	New Sampling/Sensor Initiative
nm	Nanometer
PED	Pressure Equipment Directive
psi	Pounds per square inch
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-40 Raman spectroscopic probe is intended for liquid immersion sample analysis in a laboratory or process plant setting.

Recommended applications include:

- **Chemical:** Reaction monitoring, blending, catalyst monitoring, feed and final product monitoring
- **Polymer:** Polymerization reaction monitoring, extrusion monitoring, polymer blending
- **Pharmaceutical:** Active Pharmaceutical Ingredient (API) reaction monitoring, crystallization, polymorph, blending
- **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

Direct eye contact with the output beam from the laser will cause severe damage and possible blindness.

⚠ 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.

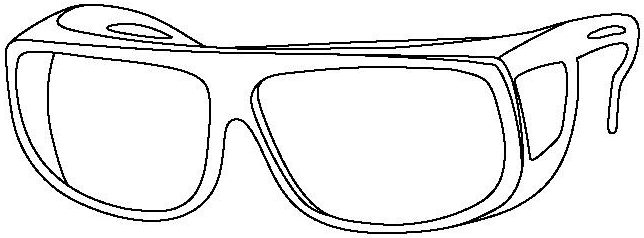

Figure 1. Laser safety glasses

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. Section 12 of this document provides 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-40 probe for anything other than its intended use.
- Do not look directly into the laser beam.
- Do not point laser at a mirrored/shiny surface or a diffuse surface. The reflections from these may be harmful.
- 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 I, 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-40 probe, as installed, forms part of the interlock circuit. If the fiber cable is severed, the laser will turn off within 20 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 6 inches (152.4 mm).

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

The interlock circuit is a low-current electrical loop. If the Rxn-40 probe is used in a hazardous classified area, the interlock circuit must pass through an Intrinsically Safe (IS) barrier.

The location of the LED laser indicator depends on the assembly type.

- Integrated stainless steel fiber connection shell option: The indicator is located on the fiber connection shell. When there is potential for the laser to be energized, the indicator light is illuminated.
- Non-removable right-angle fiber connector (EO style) assembly: The indicator is located on the assembly. When there is potential for the laser to be energized, the indicator light is illuminated.

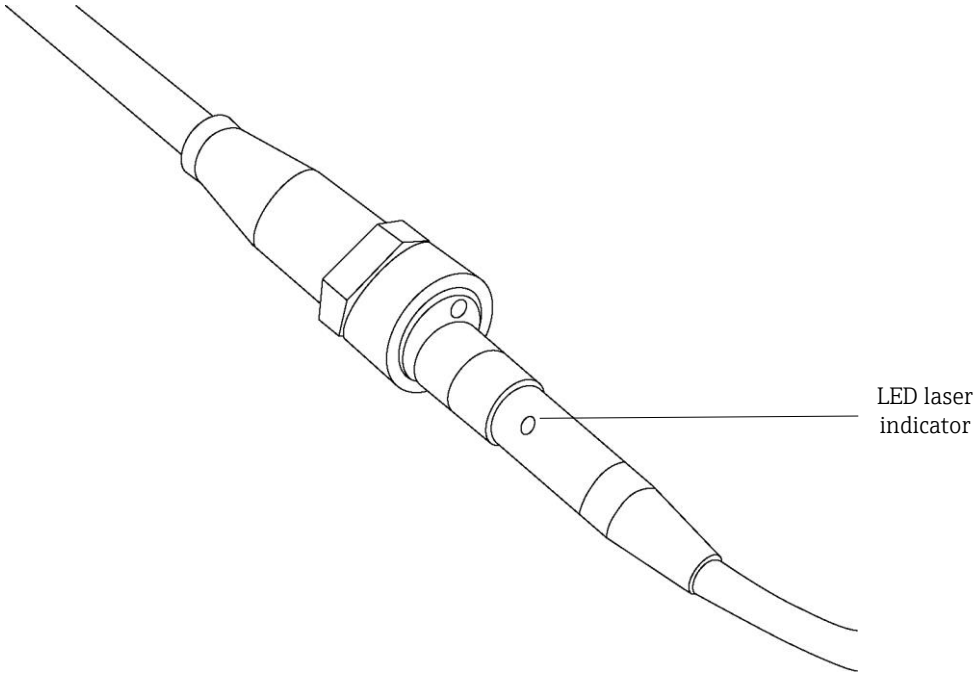

Figure 2. LED laser indicator on integrated stainless steel fiber connection shell

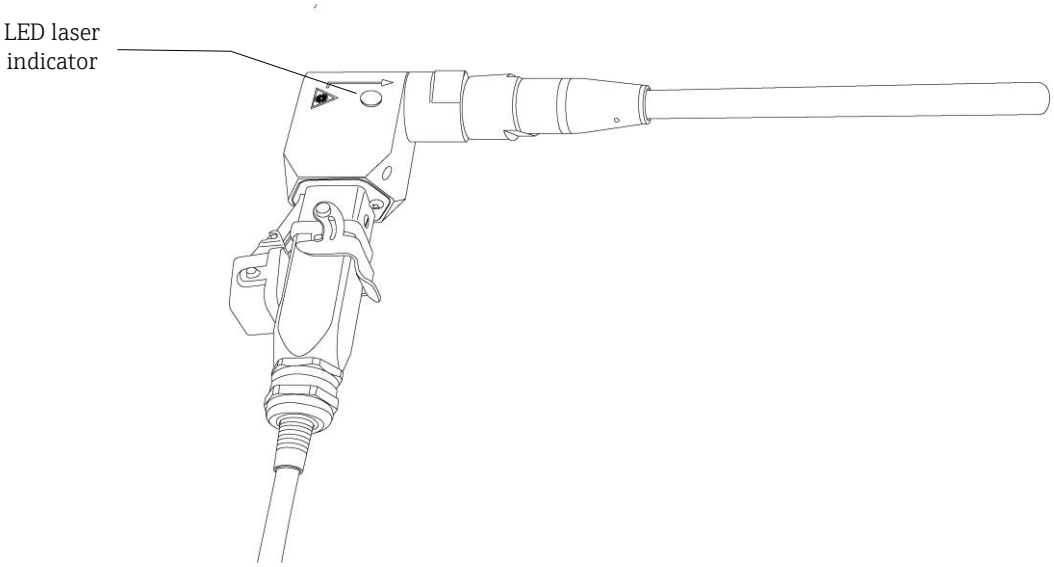

Figure 3. LED laser indicator on right-angle fiber connector (EO style) assembly

2.8.3 Hazardous area approvals

The Rxn-40 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-40 probe has been certified to the ATEX Directive for use in Europe, as well as in other countries accepting ATEX-certified equipment (Certificate # ITS10ATEX17085X).

Figure 4. ATEX label for use in hazardous areas

The Rxn-40 probe has also been approved for use in hazardous areas in the United States (US) and Canada by the Canadian Standards Association (Certificate # 2413954) 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 5. CSA label for use in hazardous areas in the US and Canada

The Rxn-40 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). The IECEx Certificate of Conformity has Certificate # IECEx ITS 14.0015X.

3 Product description

3.1 Rxn-40 probe

The Rxn-40 Raman spectroscopic probe is intended for liquid immersion sample analysis in a laboratory or process plant setting. The probes provide inline, real-time chemical measurements and are designed to be compatible with Endress+Hauser Raman Rxn analyzers operating at 532 nm, 785 nm, or 993 nm.

The Rxn-40 probe is extremely compact and offers several mounting options. The process connection for the Rxn-40 probe can be swaged, compression-mounted, flange-mounted, installed in a flow cell, and is NeSSI compatible. The probe is available in the following configurations to aid customization to the process and offer greater sampling flexibility:

- Rxn-40 probe, non-flanged or flanged configuration
- Rxn-40 probe, mini configuration

3.1.1 Rxn-40 probe, non-flanged configuration

The non-flanged configuration of the Rxn-40 probe has a standard immersible range of 6, 12, and 18 inches.

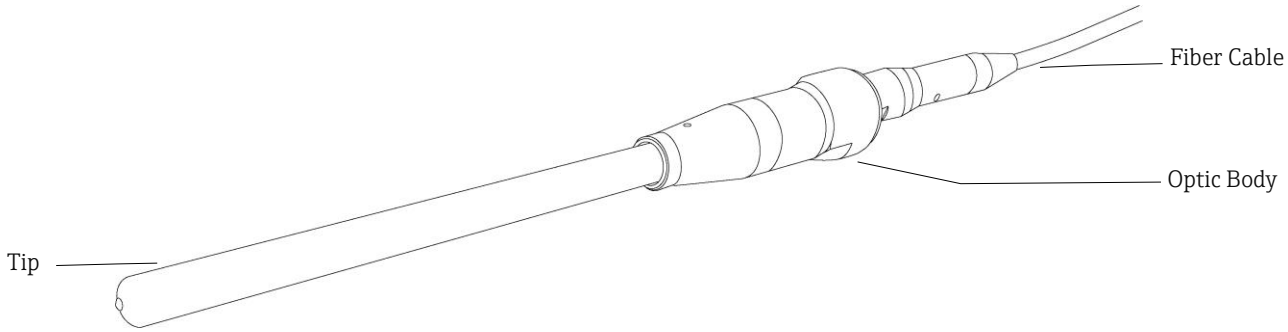

Figure 6. Non-flanged configuration of the Rxn-40 probe

3.1.2 Rxn-40 probe, flanged configuration

ANSI B16.5 and DIN EN1092 Type B flanges are available upon request for the Rxn-40 probe with the flanged configuration.

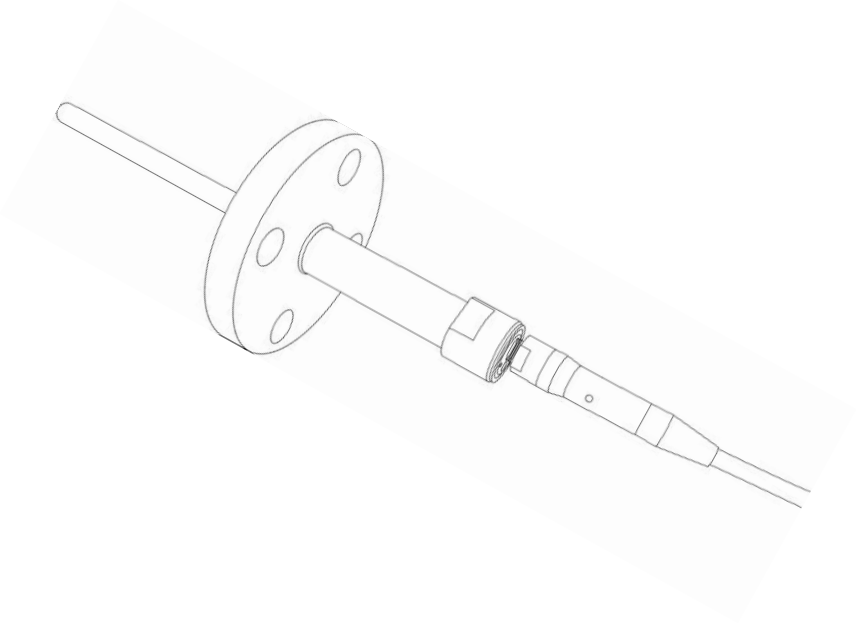

Figure 7. Flanged configuration of the Rxn-40 probe

3.1.3 Rxn-40 probe, mini configuration

The mini configuration of the Rxn-40 probe has an immersible length of 1.4 inches.

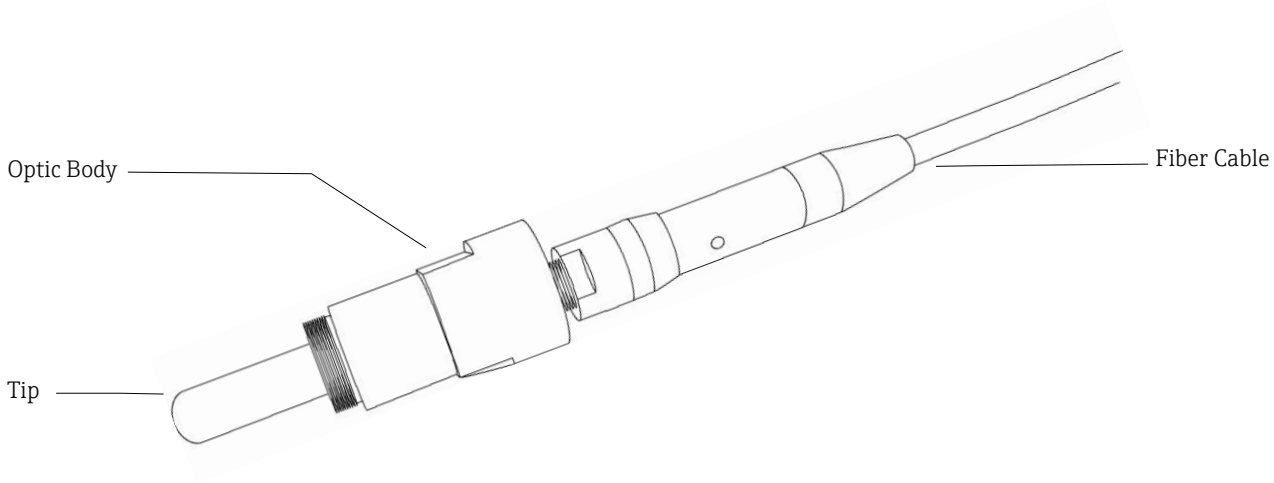

Figure 8. Mini configuration of the Rxn-40 probe

3.2 Hardware

3.2.1 Standard hardware

Standard hardware includes the Rxn-40 probe without a fiber cable. Fiber cable is sold separately.

For all new installations, one of the two following accessories is required:

1. Integrated stainless steel fiber connection shell - contains excitation/collection optic fibers, laser safety interlock connectors and interlock indicator LED.
   - There are two connector styles available. Select the connector appropriate for the analyzer in use.
   - Standard cable length is five (5) meters. Custom lengths are available in ten (10) meter increments, starting at ten (10) meters.
2. Non-removable right-angle fiber connector (EO style) assembly - contains excitation/collection and laser safety interlock connectors and interlock indicator LED.

3.2.2 Suggested adapter

A non-crimping adapter is available from Conax Technologies. For example, Conax part number SPA/PG5(S316L)-500-A-T/X fits the standard 1/2 inch diameter Rxn-40 probe.

The adapter allows the immersion depth of the Rxn-40 probe to be adjusted when necessary.

3.3 Data collection zone: short vs. long

The Rxn-40 probe comes with either a short (S) or a long (L) data collection zone depending on the version selected. A short data collection zone is generally used for opaque samples such as powders, gels, slurries, and paint. If an Rxn-40 probe with a long data collection zone were used to analyze these materials, most or all of the incident radiation would be lost to specular and diffuse reflection by material above the focal plane.

A long data collection zone is better for transparent samples, such as hydrocarbons and solvents, because it maximizes the signal intensity by using the entire effective focal cylinder.

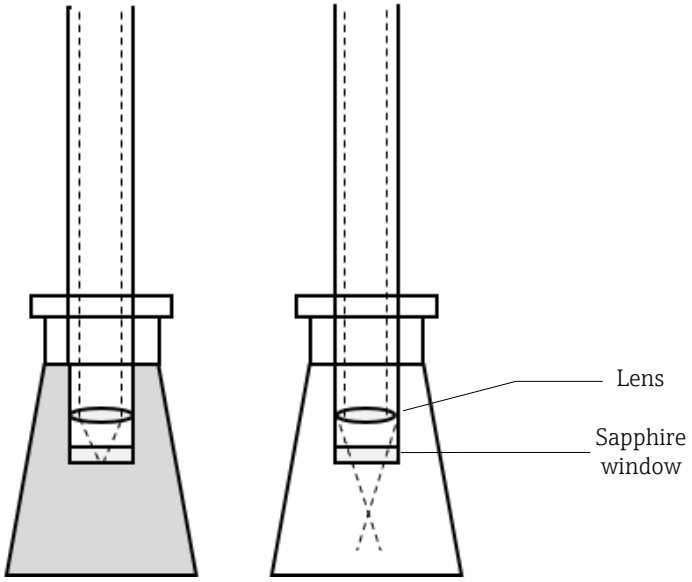

Figure 9. Use of Rxn-40 probe with short (left) vs. long (right) data collection zone

Spectral data is collected most efficiently at the focal plane.

NOTICE

The focus is set at the factory and cannot be adjusted by the user.

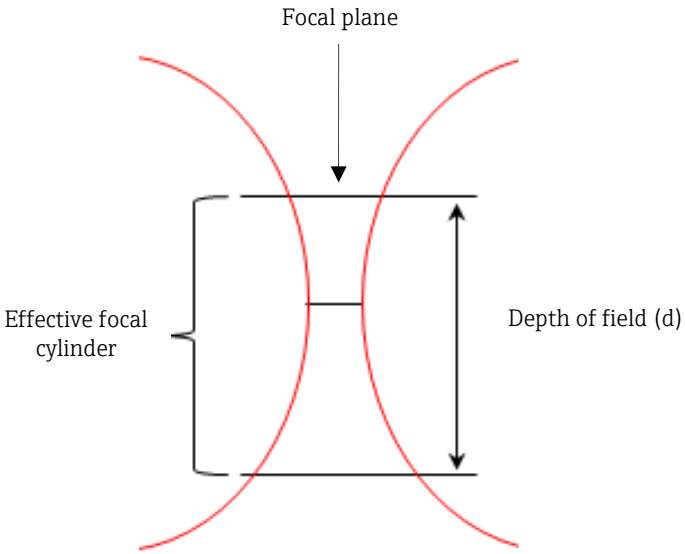

Figure 10. Effective focal cylinder

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:

- Manufacturer Information
- Laser Radiation Notice
- Serial Number
- Patent Information
- 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-40 probe in the configuration ordered
- Rxn-40 Raman spectroscopic probe Operating Instructions
- Rxn-40 probe Certificate of Product Performance
- Local declarations of conformity, if applicable
- Certificates for hazardous zone use, if applicable
- Material certificates, if applicable
- Rxn-40 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-40 Raman spectroscopic probe Safety Instructions* manual for detailed certification and approval information.

5 Probe and fiber optic connection

The Rxn-40 probe connects to the Raman Rxn analyzer via one of the following:

- Fiber Channel (FC) cable assembly
- Electro-Optical (EO) fiber cable

An optional EO extension fiber cable is also available.

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

NOTICE

Connection of the probe to the FC cable assembly or the EO fiber 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.

5.1 FC cable assembly

The FC cable assembly connects the Rxn-40 probe to the analyzer via the following:

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

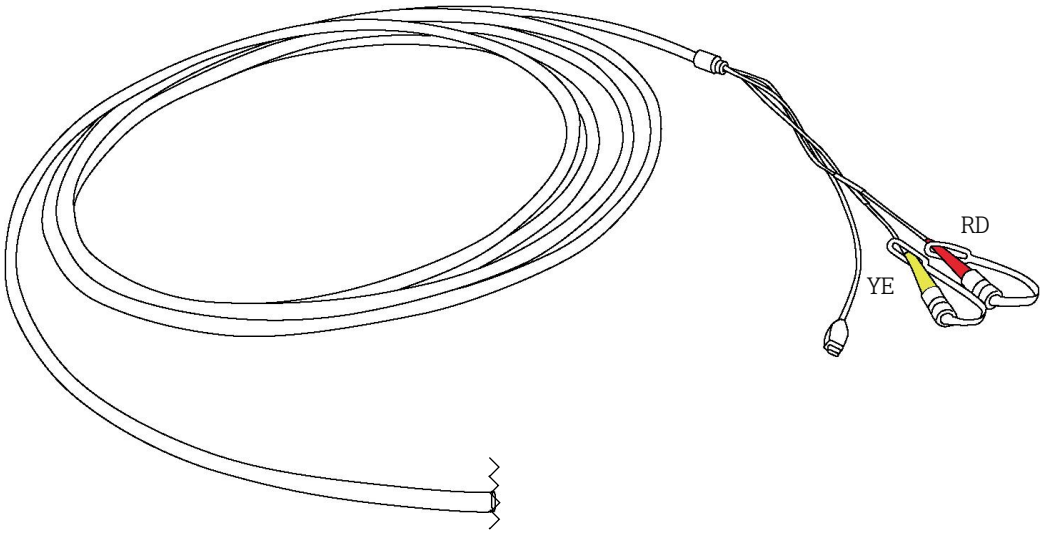

Figure 11. FC cable assembly showing connector for analyzer

5.2 EO fiber cable

The EO fiber cable connects the Rxn-40 probe to the analyzer with a single, robust connector that contains the excitation and collection fiber-optics as well as an electrical laser interlock.

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

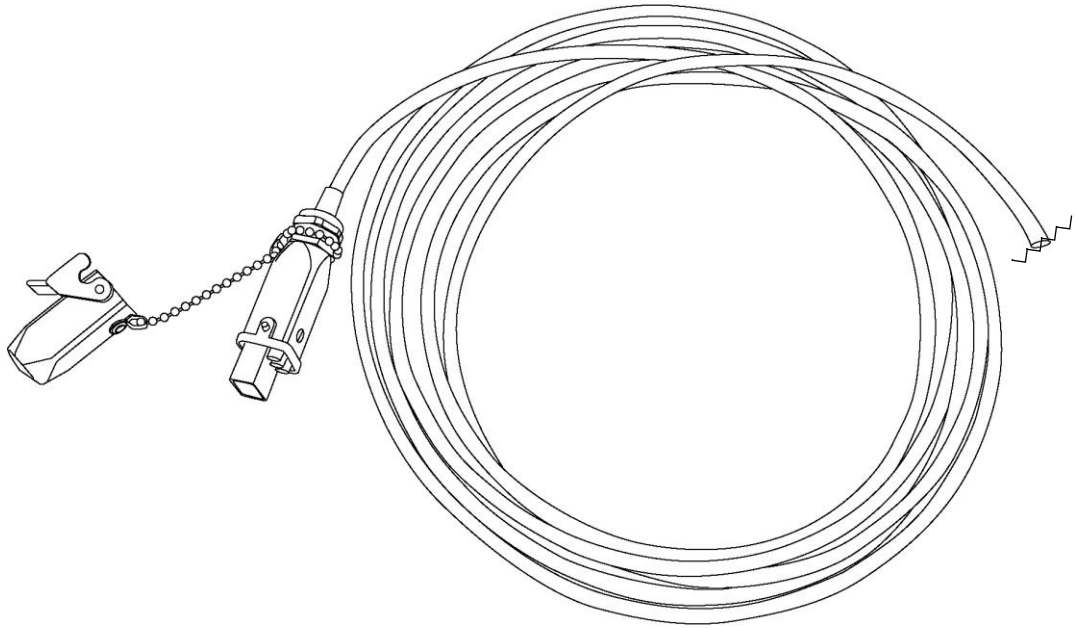

Figure 12. EO fiber cable showing connector for analyzer

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 Rxn-40 probe with integrated stainless steel fiber connection shell

When installing an Rxn-40 probe equipped with the integrated stainless steel fiber connection shell into the sample interface, rotate the entire cable with the probe as the Rxn-40 probe is threaded into a fixed fitting. If the fitting is not fixed it is preferable to thread the fitting onto the stationary Rxn-40. Excessive twisting of the cable within the connector may break a fiber connection, rendering the Rxn-40 probe inoperable.

6.2 Rxn-40 probe with right-angle fiber connector (EO style)

When installing an Rxn-40 probe equipped with the non-removable right-angle fiber connector (EO style) assembly it is recommended that the fiber optic cable assembly be disconnected from the probe during installation.

6.3 Rxn-40 probe with custom flange adapter

The Rxn-40 probe may accommodate installation in a sample stream or vessel using a range of custom ANSI and DIN flanges available upon receipt of specifications.

6.4 Hazardous area installation

The probe has been designed to be installed directly into slip-streams, drain-valves, reactors, circulation loops, blend headers, and inlet or outlet pipework. The probe must be installed according to the Hazardous Area Installation Drawing (4002396 version X4).

NOTICE

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

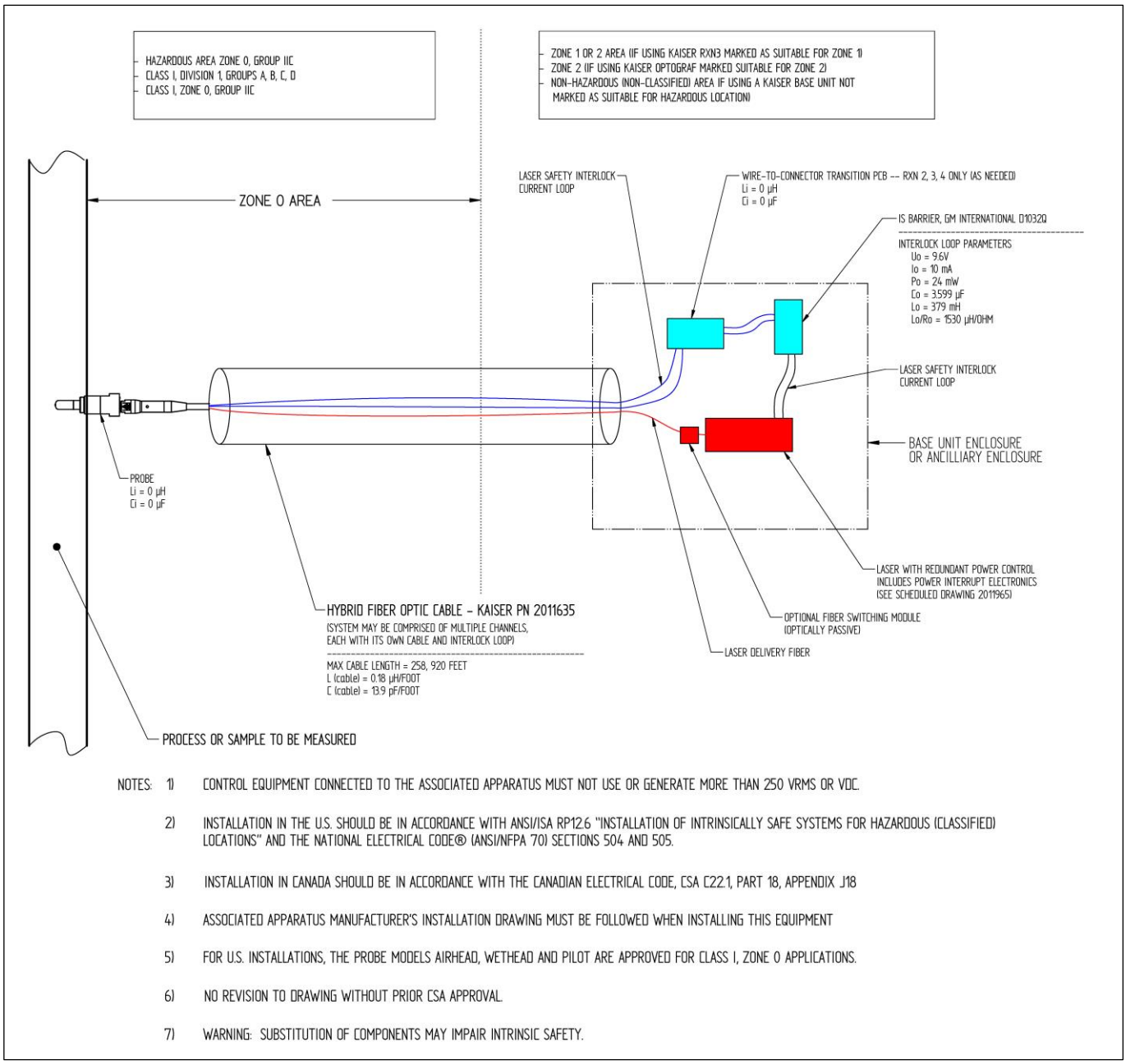

Figure 13. Hazardous Area Installation Drawing (4002396 version X4)

6.5 Process and probe compatibility

Prior to installation, the user must verify 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.

6.6 Certifications and markings

Endress+Hauser offers certifications for the Rxn-40 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-40 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-40 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-40 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-40 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 (Certificate # ITS10ATEX17085X), CSA (Certificate # 2413954), or IECEx (IECEx ITS 14.0015X) 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 or is pressed into the probe body beyond the 45-degree bevel, 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 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 Rxn2 or Raman Rxn4 analyzer operating instructions are available by searching the Downloads area of the Endress+Hauser web site: www.endress.com → Downloads

8 Operation

The Endress+Hauser Raman Rxn-40 probe is a compact, sealed immersion probe for *in situ* Raman spectroscopy of liquid-phase samples in a laboratory or process plant setting. The Rxn-40 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: www.endress.com → Downloads

9 Diagnostics and troubleshooting

Refer to the table below when troubleshooting issues with the Rxn-40 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 as described in Section 10.1 before returning it to service.
		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 LED laser indicator is lit	Broken fiber without interlock wire breakage	Ensure all fiber connections are secure.
3	LED laser 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 Cleaning the probe window

If the Rxn-40 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-40 probe is serviced at the manufacturer's site.

To clean the Rxn-40 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.

10.2 Inspecting and cleaning the optical fibers

The optical fiber connectors (FC or EO) 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.

11 Repair

Repairs not described in this document must be carried out only directly at the manufacturer's site or by the service organization. Contact your local Endress+Hauser service provider for additional repair information.

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-40 probe vary depending on the materials of construction. 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 Bar (full vacuum). However, unless specified, they are not rated for low outgassing at high vacuum service.
- The temperature ramp is up to 30°C/min (86°F/min).

Component	Materials of Construction	Min Temp	Max Temp	Max Service Pressure Bar (psi)
Rxn-40 probe	Stainless Steel 316L	-30°C (-22°F)	120°C (248°F)	68.5 (990)
	Alloy C276	-30°C (-22°F)	280°C (536°F)	74.0 (1070)
	Titanium, Grade 2	-30°C (-22°F)	300°C (572°F)	29.0 (420)
Cable and connector	Cable: PVC jacketed, proprietary construction Connections: proprietary electro-optic	-40°C (-40°F)	70°C (158°F)	N/A

Table 6. Temperature and pressure specifications

12.2 General specifications

Item		Description
Operating humidity		Up to 95% relative humidity; non-condensing
Probe body purge		Helium
Probe body hermeticity		Purge helium leak rate < 1×10^{-7} mbar·L/s
Chemical resistance		Limited by Materials of Construction
Raman excitation wavelength (λ)		532 nm or 785 nm or 993 nm
Window material		High-purity sapphire
Working distance from probe exit		Short: 0 mm Long: 3 mm
Focal length (f_0)		9 mm
Beam diameter (b_0)		5 mm
Probe immersible length	Rxn-40 non-flanged configuration	Up to 18 inches (457 mm) Grade 2 Titanium: Up to 350 mm Standard lengths are 6, 12, and 18 inches.
	Rxn-40 flanged configuration	Up to 15 inches (381 mm)
	Rxn-40 mini configuration	1.4 inches (36 mm)
Immersion shaft outer diameter	Rxn-40 non-flanged configuration	1/2 inch (12.7 mm) standard; custom diameters may be available. For example: 3/4 inch (19.05 mm) or 1 inch (25.4 mm) for Rxn-40, non-flanged or flanged configuration
	Rxn-40 flanged configuration	
	Rxn-40 mini configuration	1/2 inch (12.7 mm) standard; custom diameters may be available.
Probe, spectral coverage, 532 nm		175 to 4325 cm^{-1}
Probe, spectral coverage, 785 nm		150 to 3425 cm^{-1}
Probe, spectral coverage, 993 nm		200 to 2400 cm^{-1}
Fiber optic cable 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·cm^{-2} or W·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-40 probe and from the unlikely occurance of laser exposure from a broken optical fiber.

Determining Maximum Permissible Exposure (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

Determining Maximum Permissible Exposure (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·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·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·cm^{-2})

Table 10. MPE for ocular exposure with 785 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-40 probe and from the unlikely occurance of laser exposure from a broken optical fiber.

Maximum Permissible Exposure (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 3×10^4	-	$0.2\ C_A$	2.9582×10^{-1} (W·cm^{-2})

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

12.4 Materials of construction

Probe Type	Version		
	Alloy C276 [UNS N10276; Hastelloy C276]	**316L [UNS S31603]**	**Titanium [UNS R50400]**
Rxn-40 flanged or non-flanged, Non-Wetted	Alloy C276	Stainless steel (316L)	Titanium (grade 2)
	Stainless steel (303)	Stainless steel (303)	Stainless steel (303)
	Oxygen-free copper	Oxygen-free copper	Oxygen-free copper
	High temperature epoxy	High temperature epoxy	High temperature epoxy
Rxn-40 mini configuration, Non-Wetted	Stainless steel (303)	Stainless steel (303)	Stainless steel (303)
	Oxygen-free copper	Oxygen-free copper	Oxygen-free copper
Rxn-40 flanged or non-flanged, Wetted - in Contact with Sample	Alloy C276	Stainless steel (316L)	Titanium (grade 2)
	High-purity sapphire	High-purity sapphire	High-purity sapphire
Rxn-40 mini configuration, Wetted - in Contact with Sample	Alloy C276	Stainless steel (316L)	Titanium (grade 2)
	High-purity sapphire	High-purity sapphire	High-purity sapphire

Table 12. Materials of construction

13 Supplementary documentation

All documentation is available:

- On the Endress+Hauser Operations App for smartphone/tablet
- In the Downloads area of the Endress+Hauser website: www.endress.com → Downloads

Document Type	Document Title
Brief Operating Instructions	Rxn-40 Raman spectroscopic probe Brief Operating Instructions
Safety Instructions	Rxn-40 Raman spectroscopic probe Safety Instructions
Technical Information	Rxn-40 Raman spectroscopic probe Technical Information

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