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Operating Instructions

Accessory optics for the Rxn-10 probe

KIO1, KNCO1, KLBIO1, KRSU1

Endress+Hauser
People for Process Automation

Table of Contents

1 About this document

This manual provides information about the optics used with the Endress+Hauser Rxn-10 Raman spectroscopic probe. The types of interchangeable optics available include:

- Immersion optic
- Non-contact optic
- bIO-Optic
- Raman optic system for single use

Refer to the *Rxn-10 Raman spectroscopic probe Operating Instructions* for specific probe-related information.

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 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.

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
˚C	Celsius
cm	centimeter
˚F	Fahrenheit
HCA	Raman Calibration Accessory
in.	inches
IO	immersion optic
kg	kilogram
LED	light emitting diode
m	meter
µin	microinches
µm	micrometer
mm	millimeter
mW	milliwatt
NCO	non-contact optic
nm	nanometer
PD	process development
psi	pounds per square inch
WEEE	Waste Electrical and Electronic Equipment

Table 3. Glossary

2 Basic safety instructions

The safety information in this section is specific to the optics that are compatible with the Rxn-10 Raman spectroscopic probe. Refer to the *Rxn-10 Raman spectroscopic probe Operating Instructions* for additional information related to probe and laser safety.

2.1 Requirements for the personnel

- Installation, commissioning, operation, and maintenance of the probe/optics 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 authorized trained personnel. Repairs not described in this document must be carried out only directly at the manufacturer's site or by the service organization.

2.2 Designated use

The Rxn-10 Raman spectroscopic probe is designed for product and process development as well as manufacturing (when used with the Raman optic system for single use). The probe is compatible with a range of interchangeable, commercially available optics (immersion and non-contact) to meet the requirements of different applications.

Recommended applications for the optics include:

Optic	Fields of application
Immersion optic (IO)	▪ Development laboratory ▪ Pharmaceutical: drug substance unit operations, reaction analysis, crystallization, end-point detection, solvent swaps ▪ Chemical: material identification, reaction analysis, polymerization, cross-linking, blending ▪ Food and beverage: blending, purification, natural and synthetic components
Non-contact optic (NCO)	▪ Polymer solids (pellets, films, or powders) ▪ Pharmaceutical drug product manufacturing ▪ Raw material identification ▪ Meat or fish quality ▪ Formulation optimization
bIO-Optic	▪ Cell culture: glucose, lactate, glutamine, amino acids, cell density, titer ▪ Fermentation: glycerol, methanol, ethanol, sorbitol, biomass ▪ Downstream: aggregation, protein crystallization, formula stability, product CQA, protein concentration, buffer excipients
Raman optic system for single use	▪ Cell culture: glucose, lactate, amino acids, cell density, titer ▪ Fermentation: glycerol, methanol, ethanol, sorbitol, biomass

Table 4. Fields of application

The above table lists common applications for the Rxn-10 probe and optics. There are other possible fields of application; however, use of the device for any purpose well outside of the fields of application described here 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

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/optics 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 Service safety

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

2.6 Important safeguards

- Do not use the optics for anything other than their 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.
- When not in use, close the shutter on the Rxn-10 probe. If an optic cap is available, place it on the unused optic.
- Always use a laser beam block to avoid inadvertent scatter of laser radiation.

2.7 Product safety

The 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 comply with the applicable analyzer safety standards.

3 Product description

The variety of optics available for the Rxn-10 Raman spectroscopic probe, powered by Kaiser Raman technology, enables flexible sampling options in the laboratory, process development, or single use manufacturing environment. Endress+Hauser offers immersion, bioprocess, and non-contact optics for the analysis of liquids, slurries and solids. Optics are available in multiple lengths and sizes to meet the requirements of different applications. Refer to the sections below for descriptions of the optics types and their use.

- 3.1: Immersion optic
- 3.2: Non-contact optic
- 3.3: bIO-Optic
- 3.4: Raman optic system for single use

3.1 Immersion optic (KIO1)

The Endress+Hauser immersion optic is suited for use with the Rxn-10 probe in reaction vessels, laboratory reactors, or process streams. It has a fixed focus design and no movable parts, providing long-term measurement stability and superior signal performance. The sealed design is the standard for use with embedded Raman Rxn analyzers.

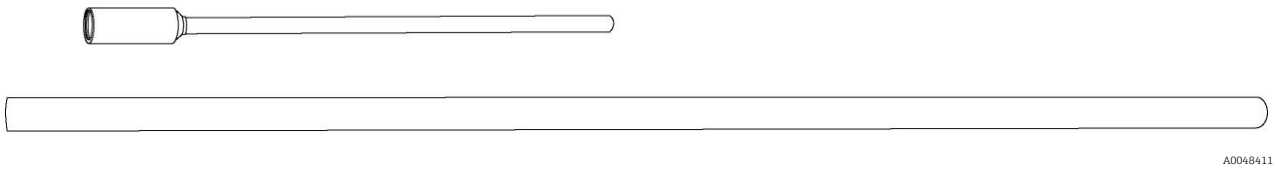

Figure 1. Immersion optics with varying shaft length and diameter

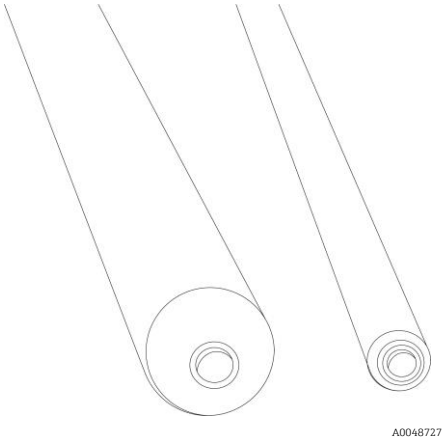

Figure 2. Tips of immersion optics with varying diameters

3.1.1 Benefits of the immersion optic

The immersion optic offers the following benefits for transferable, high-performance Raman measurements:

- Ideal for quick liquids, slurries and semisolids measurements in the laboratory
- Superior signal performance
- No user-adjustable parts
- Wettable components resist corrosion in harsh environments (including acidic solutions)

3.1.2 Immersion optic options

The immersion optic is available in 12.7 mm (0.5 in.) and 6.35 mm (0.25 in.) diameter configurations with two optical coating options:

- VIS: optimized for use in the visible (VIS) region (532 nm)
- NIR: optimized for use in the near infrared (NIR) region (785 nm and 993 nm)

3.1.3 Data collection zone: short vs. long

The immersion optic can have either a short (at the window) or long (3 mm or 0.12 in. from the window) data collection zone. The data collection zone selected is also indicated on the immersion optic.

Short or long data collection zones are used for different kinds of samples. Spectral data is collected most efficiently at the focal plane.

A short data collection zone is generally used for opaque or turbid media samples. If an immersion optic 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 because it maximizes the signal intensity by using the entire effective focal cylinder.

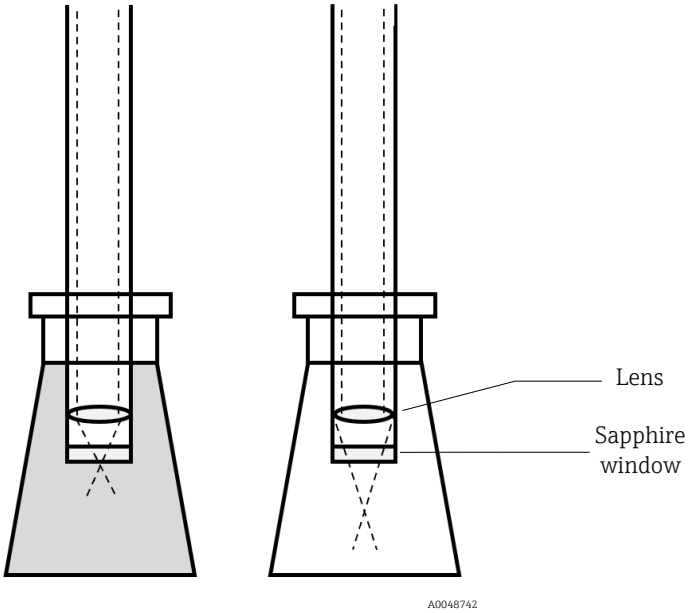

Figure 3. Short (left) vs. long (right) data collection zone

NOTICE

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

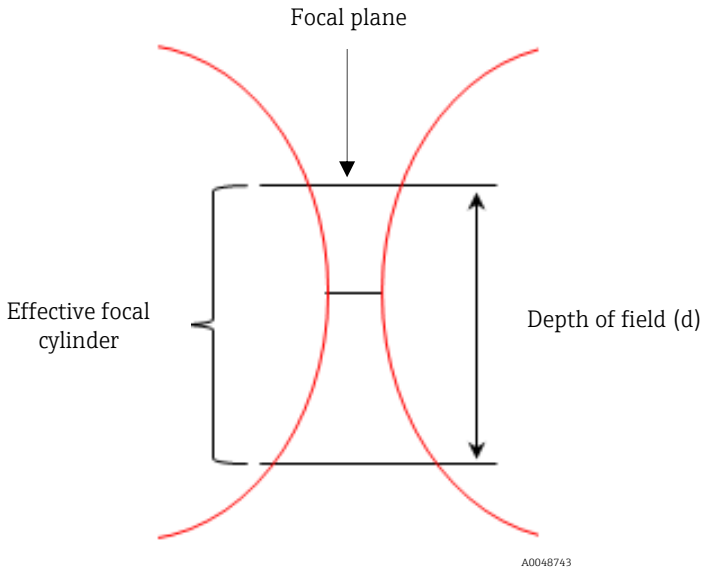

Figure 4. Effective focal cylinder

3.2 Non-contact optic (KNCO1)

Paired with the Rxn-10 probe, the Endress+Hauser non-contact optic provides contact-free Raman measurements of samples either directly or through sight glass or translucent packaging. These optics are ideal for use with solids or turbid media or when sample contamination or damage to optical components is a concern.

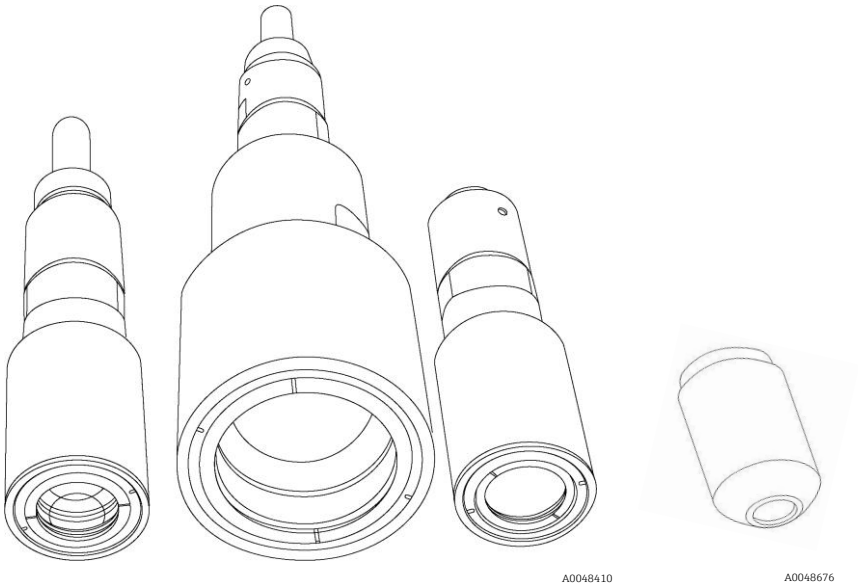

Figure 5. Non-contact optics in varying sizes

3.2.1 Benefits of the non-contact optic

The non-contact optic offers the following benefits for Raman measurements:

- Range of working distances for remote measurements either directly or through sight glass and translucent packaging
- Highly versatile, measuring films to pellets to powders
- Accurate measurement of static or moving samples
- Contact-free analysis of delicate or corrosive samples

3.2.2 Non-contact optic options

Non-contact optics are available in a variety of sizes with a working distance range of 10 to 140 mm (0.40 to 5.52 in.) depending on the option selected. The internal lens comes with one of two types of anti-reflective coatings:

- VIS: optimized for use in the visible (VIS) region
- NIR: optimized for use in the near infrared (NIR) region

Refer to the table below for available options.

Non-contact optic size	Anti-reflective coating	Working distance (mm)	Working distance (in.)
NCO-0.4	NIR	10	0.40
NCO-0.5	VIS	12.5	0.50
NCO-1.3	VIS	33	1.30
NCO-2.5	VIS	64	2.52
NCO-3.0	NIR	75	2.96
NCO-5.5	VIS	140	5.52
NCO-5.5	NIR	140	5.52

Table 5. Non-contact optics

3.3 bIO-Optic (KLBIO1)

The Endress+Hauser bIO-Optic is a versatile immersion optic used in conjunction with the Rxn-10 probe. It measures multiple, specific bioprocessing components in real-time and is compatible with standard PG13.5 bioreactor ports. The fixed focus design of the bIO-Optic provides long-term measurement stability along with superior signal performance, essential for transferable, high performance Raman-based bioprocess analysis. Available in various industry standard lengths, the bIO-Optic is ideally suited for benchtop bioreactor/fermentor applications requiring headplate entry.

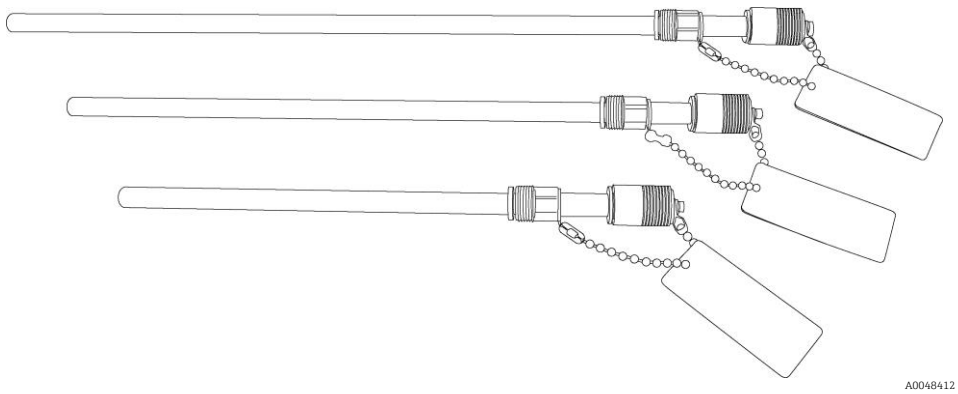

Figure 6. bIO-Optics in varying lengths

NOTICE

The bIO-Optic should NOT be used with hydrocarbon solvents (including ketones and aromatics).

▶ These solvents can degrade probe performance and invalidate the warranty.

3.3.1 Benefits of the bIO-Optic

The bIO-Optic offers the following benefits for *in situ* monitoring of bioprocess applications in process development (PD):

- Immersion optic for multi-component bioprocess measurement
- Compatible with standard PG13.5 bioreactor ports
- Fixed-focus design
- Available in various industry standard lengths
- Autoclavable; punch card included for tracking

3.3.2 bIO-Optic options

The bIO-Optic is available in 120, 220, 320, or 420 mm (4.73, 8.67, 12.60, or 16.54 in.) lengths. The 12 mm (0.48 in.) diameter with PG13.5 threaded connector is ideally suited for headplate entry into the bioreactor/fermentor.

A bIO-Sample chamber is an available option that can be used for the probe verification procedure.

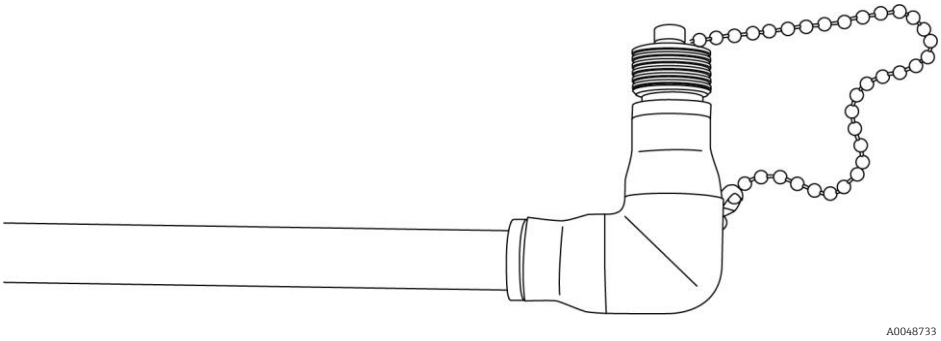

Figure 7. bIO-Optic with the bIO-Sample chamber

3.4 Raman optic system for single use (KRSU1)

The Endress+Hauser Raman optic system for single use was developed according to industry standards for single use sensors and is designed for single use bioprocess applications. The system is used in conjunction with the Rxn-10 probe and is comprised of the following parts:

- The reusable optic, which is never in contact with the end product, and
- A disposable fitting, which is installed, tested, and supplied ready to use from the single use vessel vendor.

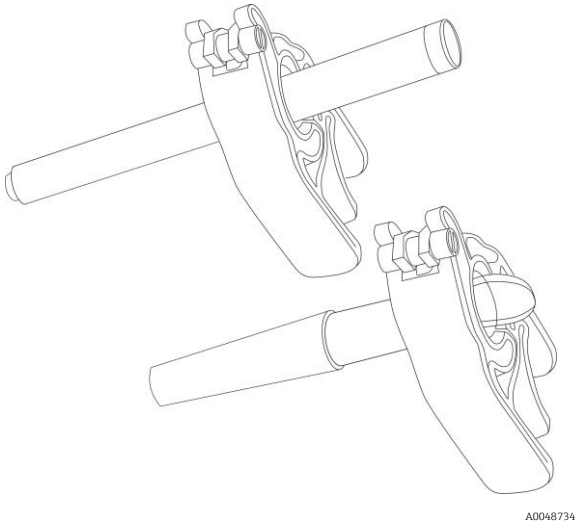

Figure 8. Reusable optic (top) and disposable fitting (bottom)

NOTICE

The Raman optic system for single use should NOT be used with hydrocarbon solvents (including ketones and aromatics).

▶ These solvents can degrade probe performance and invalidate the warranty.

3.4.1 Benefits of the Raman optic system for single use

The Raman optic system for single use, in conjunction with the Rxn-10 probe, has been shown to offer the same quality data as reusable Raman probes. This ability allows customers to develop products and processes without limitations of the final production reactor type.

Additional benefits include:

- Disposable fitting plus a reusable non-contact optic
- Developed to industry standards for single use sensors
- cGMP qualified
- Gamma sterilizable
- Tested and supplied by multiple single use vessel vendors

Biopharmaceutical customers depend on its sterility and reliability for single use development and manufacturing.

3.4.2 Optic and fitting

The reusable optic is supplied by Endress+Hauser and does not break the sterile barrier.

The disposable fitting is purchased through the single use vessel vendor as an Endress+Hauser Raman-ready, single use vessel. The vessel is manufactured to the customer's specification with the fitting installed. The manufacturer tests and supplies a sterile single use product to the customer. The disposable fitting is intended to be used for a single batch cycle only.

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

Incorrect transportation can damage the optics.

4.2 Product identification

4.2.1 Label

At a minimum, the optics are labeled with the following information:

- Manufacturer information
- Serial number

Compare the information on the label/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:

- Selected optic(s)
- *Accessory optics for the Rxn-10 probe Operating Instructions* manual

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

5 Installation

The installation information in this section is specific to the optics that are compatible with the Rxn-10 Raman spectroscopic probe. Refer to the *Rxn-10 Raman spectroscopic probe Operating Instructions* for additional information related to probe installation.

The Rxn-10 probe is compatible with both immersion optics and non-contact optics. The probe has a torque limiting clamp that secures the immersion optics. The clamp also holds the adapter for non-contact optics.

When replacing an optic on a probe, use the Raman Calibration Accessory (or HCA) to perform an intensity calibration for that probe with the new optic.

5.1 Installing immersion optics and bIO-Optics

Endress+Hauser immersion optics and bIO-Optics are not threaded. They slip into the Rxn-10 probe and are secured by a thumb screw-based clamp.

⚠ WARNING

When installing or removing immersion optics, ensure the laser and emission shutter are in the closed position.

To install an immersion optic:

1. Loosen the metal thumb screw on the Rxn-10 probe by turning the screw approximately one turn (do not remove). Then find the probe end of the optic, which is the end that includes the product markings.
2. Insert the probe end of the optic through the end optic clamp.
3. Push the optic back until it stops.
4. Tighten the thumb screw until you hear a clicking sound to ensure the optic is held in place. Failure to tighten the screw will result in the optic coming loose, potentially damaging the optic.
5. After installing an optic on a probe, use the Raman Calibration Accessory to perform an intensity calibration for the probe with the new optic.

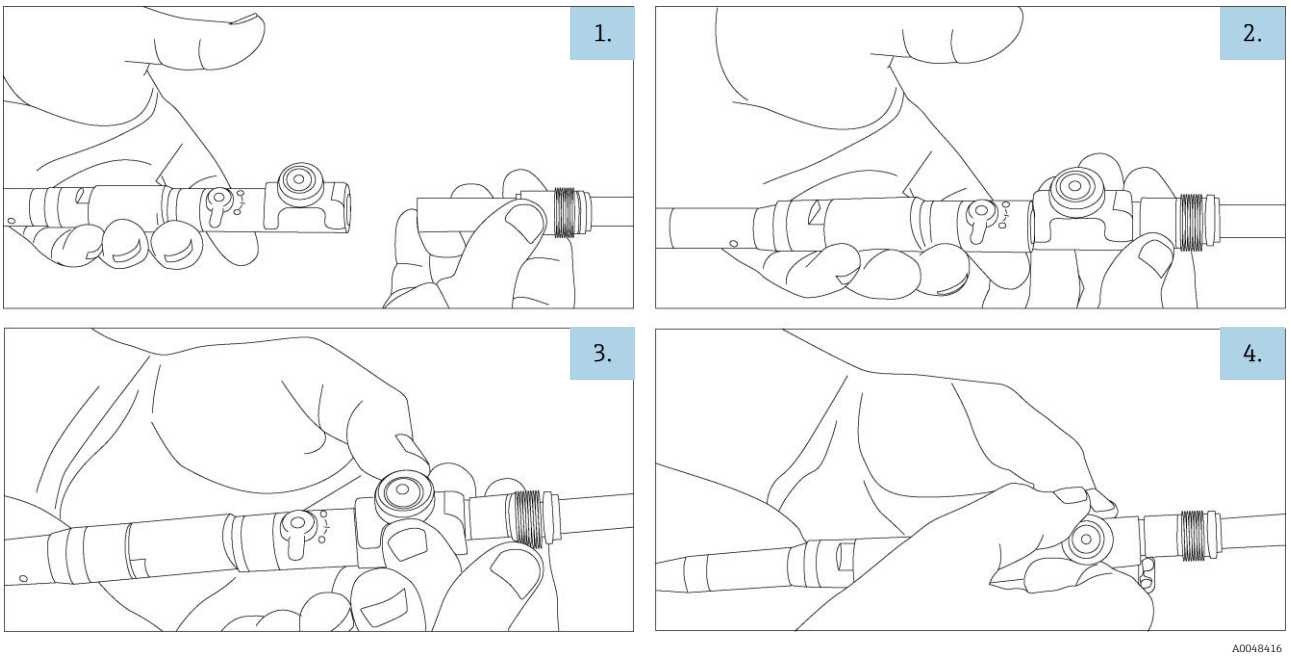

Figure 9. Installing an immersion optic (IO) on an Rxn-10 probe

To remove an immersion optic:

1. Loosen the torque limiting thumb screw by turning it approximately one turn so that the immersion optic is released from its clamp. Do not remove the screw.
2. Slide the immersion optic out.

5.2 Installing non-contact optics

The non-contact optics offered with the Rxn-10 probe are threaded, so a threaded adapter is required to attach the optic to the Rxn-10 probe.

⚠ WARNING

When installing or removing non-contact optics, ensure the laser and emission shutter are in the closed position.

To install a non-contact optic:

1. Loosen the torque limiting thumb screw on the Rxn-10 probe by turning the screw approximately one turn (do not remove). Then find the narrow, non-threaded end of the adapter.
2. Insert the narrow end of the adapter through the clamp. Push the adapter back until it stops.
3. Tighten the torque limiting thumb screw to hold the adapter in place.
4. Find the male threaded end of the non-contact optic.
5. Screw a non-contact optic onto the threaded end of the adapter.
6. After installing an optic on a probe, use the Raman Calibration Accessory to perform an intensity calibration for the probe with the new optic.

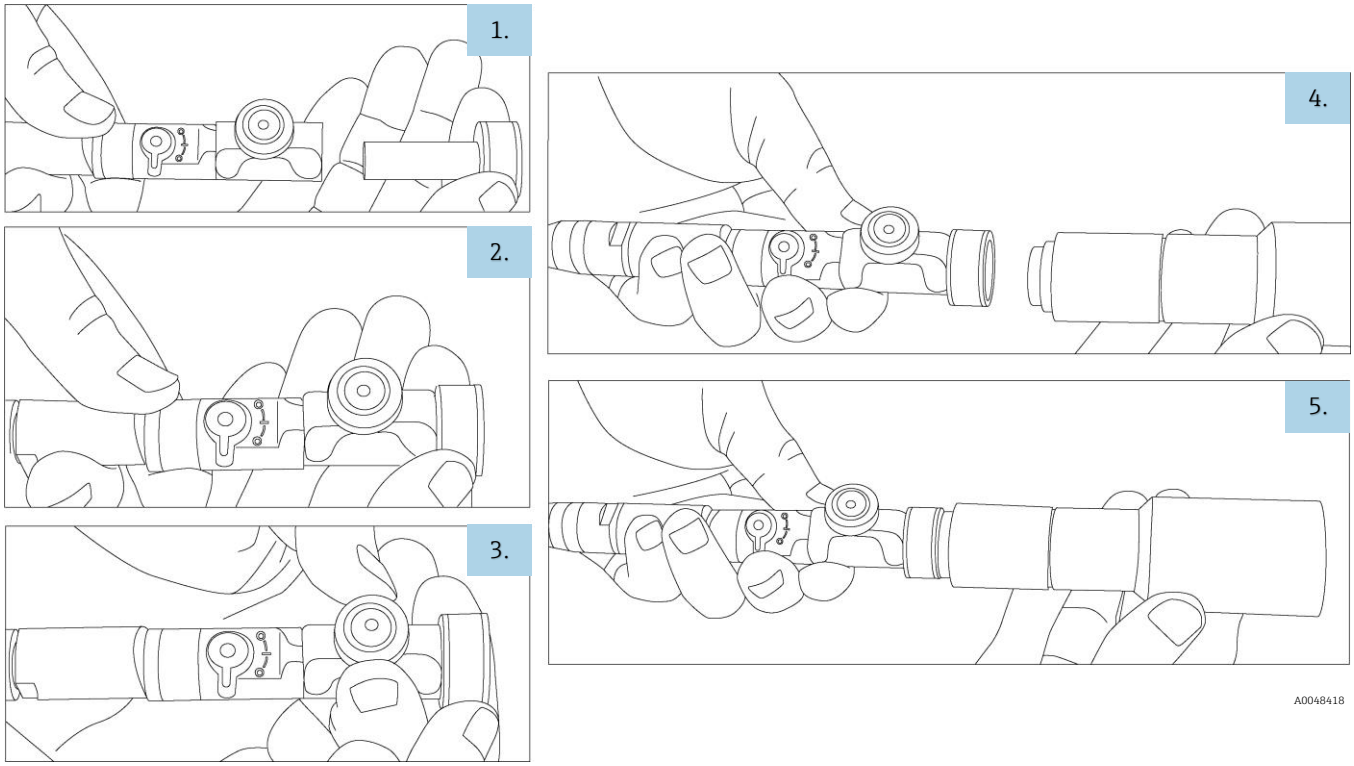

Figure 10. Installing an adapter and non-contact optic on an Rxn-10 probe

To remove a non-contact optic:

1. Unscrew the non-contact optic from the adapter.
2. If an immersion optic will be used, remove the adapter by turning the torque limiting thumb screw approximately one turn until the adapter is released from the clamp. Slide the adapter out.

5.3 Installing the Raman optic system for single use

NOTICE

Prior to insertion in the disposable fitting, the Rxn-10 probe with the reusable optic should be calibrated and verified.

▶ See Section 6.2 → 🖹 for calibration and verification instructions.

5.3.1 Preparing the disposable fitting

The port shown below is specific to one type of single use bioreactor. The port, fitting, and cap/clamp (if present) may vary depending on the type of single use bioreactor. However, the optic insertion instructions are the same for all types of single use bioreactors.

To prepare the disposable fitting for optic insertion:

1. Depress the release lever on the sanitary clamp and remove the clamp.
2. Remove the sanitary cap from the fitting.
3. Ensure the sanitary o-ring seal is in place on the fitting.

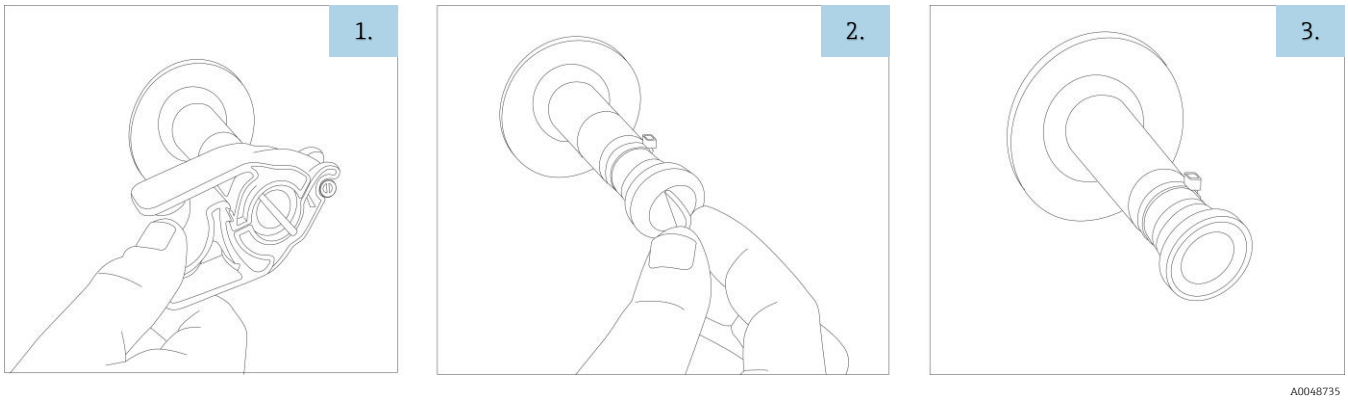

Figure 11. Preparing the disposable fitting

5.3.2 Preparing the reusable optic for insertion into the fitting

To prepare the optic for insertion into the fitting:

1. Depress the release lever on the sanitary clamp and remove the clamp.
2. Remove the cap and seal. Store these components in a secure location.

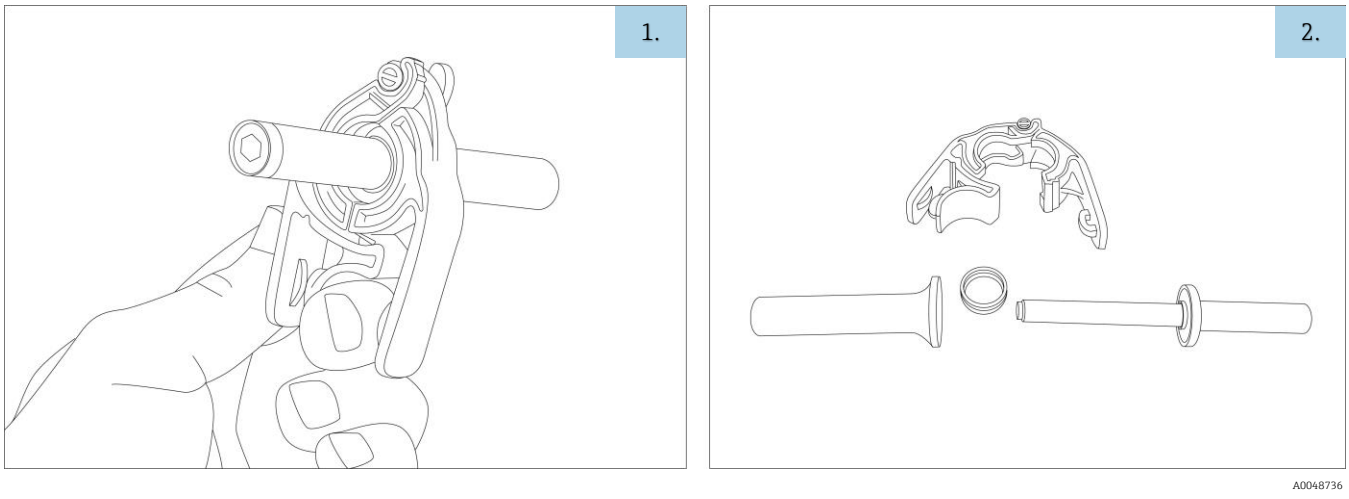

Figure 12. Preparing the reusable optic

5.3.3 Inserting the optic in the fitting

To insert the optic in the disposable fitting:

1. Verify the sanitary o-ring seal on the fitting is still in place.

   If not present, place a sanitary o-ring seal over the optic such that it is located in the sealing gland area.
2. Insert the optic into the disposable fitting.
3. Install the sanitary clamp, making sure it is clamped tightly.

   There should be two distinct clicks indicating it is clamped correctly.

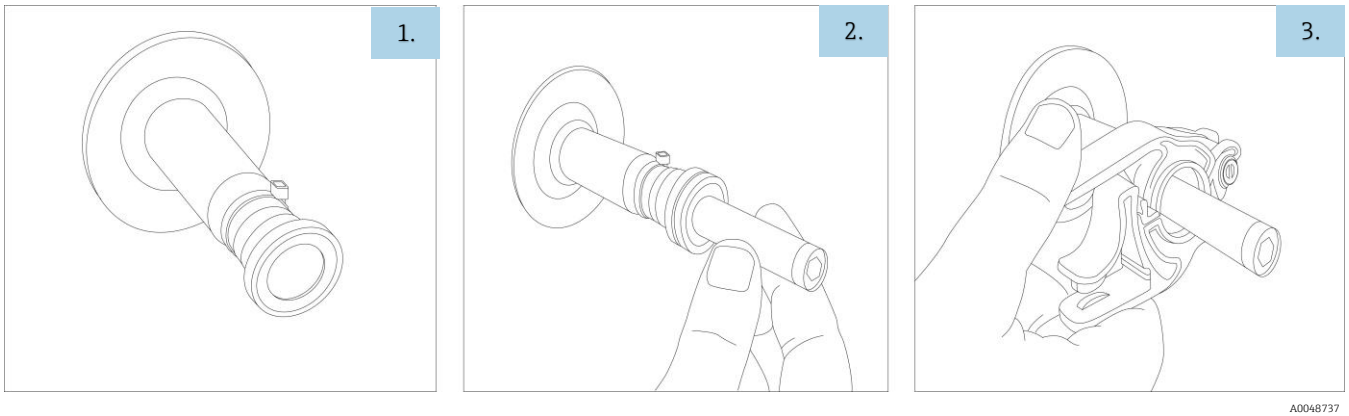

Figure 13. Inserting the optic in the fitting

5.3.4 Installing the optic on the Rxn-10 probe

The Endress+Hauser reusable optic is not threaded. It slips into the Rxn-10 probe and is secured by a torque limiting thumb screw-based clamp.

⚠ WARNING

When installing or removing optics, ensure the laser and emission shutter are in the closed position.

To install the optic onto the probe:

1. Loosen the torque limiting thumb screw on the Rxn-10 probe by turning the screw approximately one turn (do not remove). Then insert the optic through the end optic clamp.
2. Push the optic back until it stops.
3. Tighten the torque limiting thumb screw to hold the optic in place. Failure to tighten the screw will result in the optic coming loose, potentially damaging the optic.
4. After installing an optic on a probe, and before it is connected to the fitting, use the Raman Calibration Accessory to perform an intensity calibration for the probe with the new optic and single use calibration adapter.

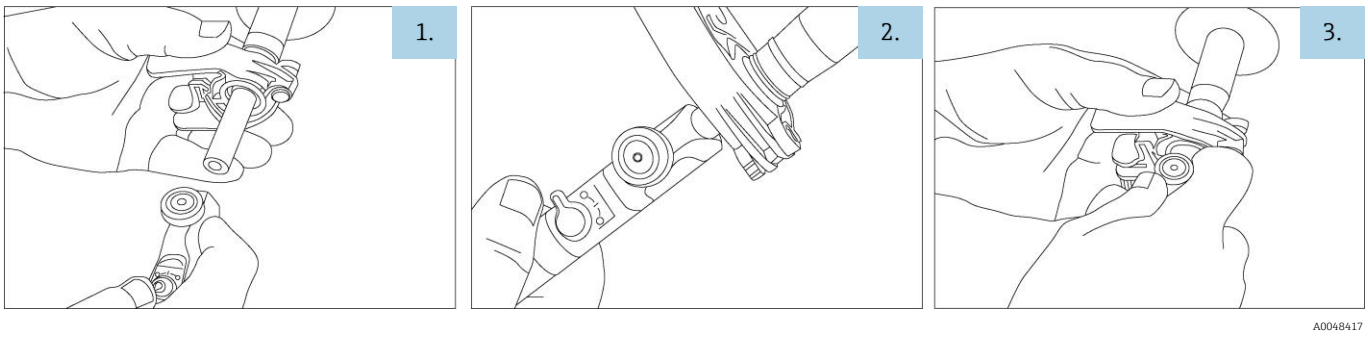

Figure 14. Installing the reusable optic on the Rxn-10 probe

To remove the optic:

1. Loosen the torque limiting thumb screw by turning it approximately one turn so that the optic is released from its clamp. Do not remove the screw.
2. Slide the optic out.

6 Commissioning

The optics for the Rxn-10 probe are delivered ready to connect to the probe. No additional alignment or adjustment to the probehead is required. Follow the instructions below to commission the optics for use in conjunction with the probe.

6.1 Receipt of optics

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

6.2 Calibration and verification

The probe and the analyzer must be calibrated before use.

6.2.1 Raman Calibration Accessory

After installing an optic on the probehead, use the Raman Calibration Accessory (HCA) to perform an intensity calibration for the probehead with the new optic.

For the Raman optic system for single use, an additional single use calibration adapter is installed onto the optic following the same process as connecting the optic to the fitting (see Section 5.3 → 📄). The optic/calibration adapter combination is then inserted into an HCA adapter attached to the HCA head.

Refer to the *Raman Calibration Accessory Operating Instructions* for additional information about the HCA and adapters.

6.2.2 Performing calibration and verification

Refer to the applicable Raman Rxn analyzer operating instructions 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 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 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

7 Operation

This manual provides information about the optics used with the Endress+Hauser Rxn-10 Raman spectroscopic probe. The Rxn-10 probe is a versatile probe designed for product and process development and is compatible with Endress+Hauser Raman Rxn analyzers operating at 532 nm, 785 nm, or 993 nm. The Rxn-10 probe accepts a variety of interchangeable optics including:

- Immersion optic
- Non-contact optic
- bIO-Optic
- Raman optic system for single use

The optics are installed on the probe following the instructions in Section 5 → 📄.

Refer to the *Rxn-10 Raman spectroscopic probe Operating Instructions* for operation of the probe with the optics. Standard precautions for laser products should be observed.

Additional use and storage instructions for some optics are provided below.

7.1 bIO-Optic and Raman optic system for single use

The bIO-Optic and Raman optic system for single use should NOT be used with hydrocarbon solvents (including ketones and aromatics. Doing so can degrade probe performance and invalidate the warranty.

The Raman optic system for single use is NOT intended to be submerged into any liquid without being attached to the disposable fitting.

7.2 Storing the reusable portion of the Raman optic system for single use

It is important to always keep the reusable optic protected via the fitting (when taking measurements) or with the cover provided during shipping (when storing). In either case, verify the o-ring seal is installed to ensure a clean and dry environment.

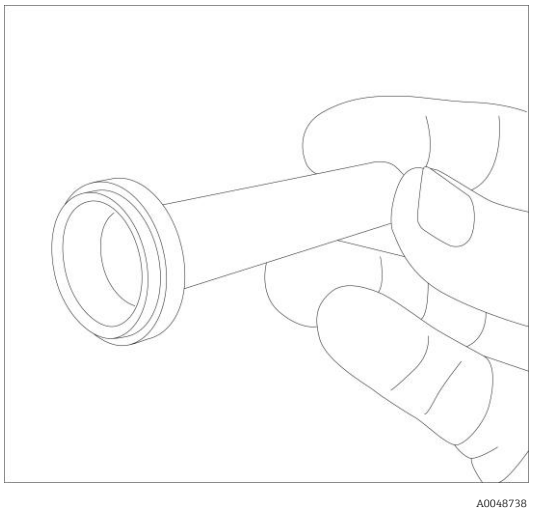

Figure 15. The cover for the reusable optic with o-ring present

⚠ WARNING

When installing or removing optics, ensure the laser and emission shutter are in the closed position.

To remove the optic and install the optic cover for storage:

1. Loosen, but do not remove, the torque limiting thumb screw on the Rxn-10 probe.
2. Slide the Rxn-10 probehead off the reusable optic.
3. Locate the quick release clamp, the optic cover, and the sanitary seal (see Figure 12).
4. Slide the optic into the cover.
5. Install the quick release clamp over the optic/cover flange and squeeze the clamp until you hear two distinct clicks to tighten.

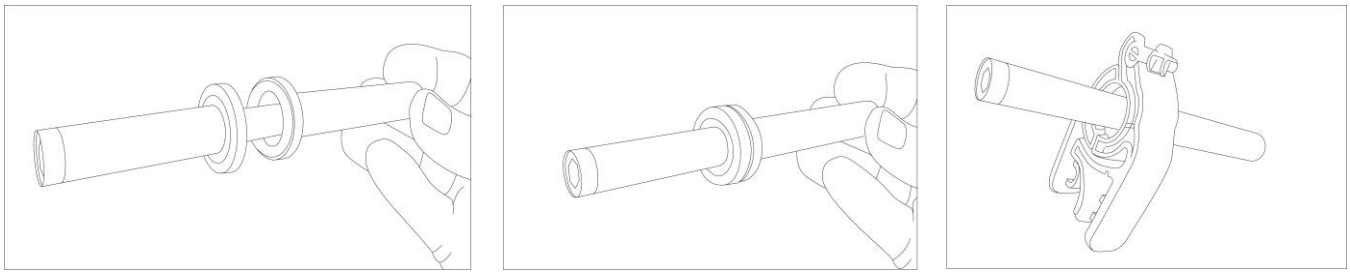

Figure 16. Installing the optic cover and clamp

8 Diagnostics and troubleshooting

Refer to the *Rxn-10 Raman spectroscopic probe Operating Instructions* to troubleshoot issues with the Rxn-10 probe and accessory optics.

9 Maintenance

If the optics have come in contact with a sample, dust or fingerprints, etc., they may need to be cleaned. Additionally, the bIO-Optic should be cleaned after immersion in phosphate buffer solutions to avoid particle deposit contamination.

The window on each of the optics can be cleaned following the steps below. For the bIO-Optic, sterilization via autoclaving is typically performed.

For all other maintenance, it is recommended that the optics are serviced at the manufacturer's site.

9.1 Cleaning the optics window

Extra care must be taken to ensure that the window surface is not further contaminated during the cleaning process.

NOTICE

Do NOT use hydrocarbon solvents (including ketones and aromatics) with the bIO-Optic or Raman optic system for single use.

- These solvents can degrade probe performance and invalidate the warranty.

To clean the optics 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 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.

9.2 Autoclaving the bIO-Optic

The bIO-Optic is rated for 25 autoclave cycles at 131 °C (268 °F) when used with the autoclave end cap. After that, the bIO-Optic must be replaced or returned for service. Contact your local Endress+Hauser service provider for additional information.

9.2.1 Preparing for autoclaving

To prepare the bIO-Optic for autoclaving:

1. Close the shutter on the Rxn-10 probe.
2. Use the key on the front of the Raman Rxn analyzer to turn OFF the laser power. Use a laser safety card to ensure the laser is not emitting from any probes during this step.
3. Loosen the thumb screw on the Rxn-10 probe and carefully disconnect the bIO-Optic from the probe.
4. Store the Rxn-10 probe in a safe location (away from traffic, heat, etc.).
5. Clean the bIO-Optic probe tip and window:
   - Spray with reagent alcohol/70 % IPA.
   - Wipe gently with a lint-free wipe.
   - Verify that no lint remains on the optic after cleaning.
   - Make sure that the optic is dry before proceeding.

6. Insert the bIO-Optic into a bioreactor and tighten the connection adaptor.
7. Attach the autoclave end cap to the rear of the bIO-Optic outside the bioreactor following the steps in Section 9.2.2 → 🖹.

9.2.2 Installing and removing the autoclave end cap

Each bIO-Optic includes an end cap that must be installed before the bIO-Optic can be autoclaved.

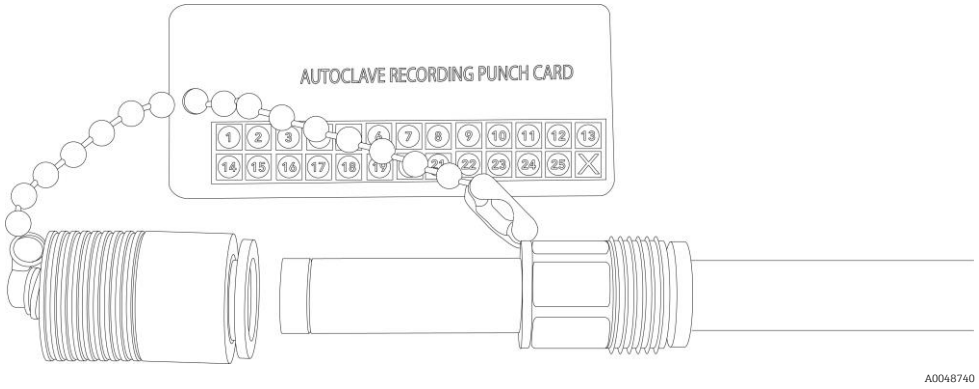

Figure 17. bIO-Optic with end cap and autoclave recording punch card

To install the autoclave end cap and track autoclave cycles:

1. Insert the autoclave end cap onto the rear end of the bIO-Optic. The rear end of the optic contains the product markings and is slightly larger in diameter.
2. Push the end cap all the way down onto the bIO-Optic until a faint snap is heard, indicating the end cap is securely fastened onto the bIO-Optic.
3. On the autoclave recording punch card, punch out the next number on the card and discard the scrap punch piece. Note:
   - It is advisable to punch out the next cycle count prior to autoclaving to avoid handling the card when it is hot.
   - The autoclave recording punch card can remain attached to the bIO-Optic during autoclaving.
   - If the punch card is not available, use an alternate method to track the number of autoclave cycles for the bIO-Optic.
   - The bIO-Optic is now ready for autoclaving.

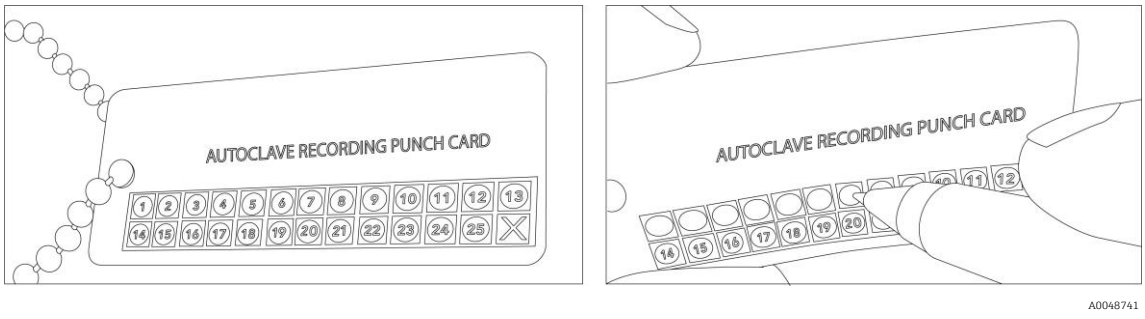

Figure 18. Using the autoclave recording punch card

To remove the autoclave end cap:

1. Push down on the top of the autoclave end cap.
2. Press in the release ring.
3. Remove the end cap. It should slide off easily.

10 Repair

10.1 Repairing optics for the Rxn-10 probe

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

10.2 User serviceable parts

There are no user serviceable parts for the following:

- Immersion optic
- Non-contact optic
- bIO-Optic

The replacement items below are available for the Raman optic system for single use. Contact your local Endress+Hauser service provider for purchasing information.

Item	Endress+Hauser part number	Description
Single use hardware kit	2017725	includes replacement quick release clamp, sanitary seal, and cover for reusable optic
¾ inch sanitary seal pack	6903122	pack of 25 seals

Table 6. Replacement items for Raman optic system for single use

11 Technical data

The specifications for the Rxn-10 probe in conjunction with each of the optics are listed in the tables below. Additionally:

- Maximum pressure is calculated per ASME BPVC VIII.1 UG-28(c) for material and probe geometry at the maximum rated temperature.
- Maximum 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.

11.1 Immersion optic

Item		Description		
Laser wavelength		532 nm, 785 nm, 993 nm		
Spectral coverage		limited by the coverage of the analyzer being used		
Maximum laser power into probehead		< 499 mW		
Sample interface	temperature	316L stainless steel:	−30 to 120 °C	(−22 to 248 °F)
		C276 alloy:	−30 to 280 °C	(−22 to 536 °F)
		Grade 2 titanium:	−30 to 300 °C	(−22 to 572 °F)
	relative humidity	sealed:	up to 95 %, non-condensing	
		non-sealed:	20 to 60 %, non-condensing	
	maximum pressure	316L stainless steel:	68.5 barg	(990 psig)
		C276 alloy:	74.0 barg	(1070 psig)
		Grade 2 titanium:	29.0 barg	(420 psig)
Wetted materials	metal	C276 alloy standard 316L stainless steel or Grade 2 titanium upon request		
	window	high-purity sapphire, proprietary compression fit non-brazed design		
Shaft length	12.7 mm (0.5 in.) diameter IO	152.4 mm	(6 in.)	
		304.8 mm	(12 in.)	
		457.2 mm	(18 in.)	
	6.35 mm (0.25 in.) diameter IO	152.4 mm	(6 in.)	
		203.2 mm	(8 in.)	
Working distance	short (S)	0 mm	(0 in.)	
	long (L)	3 mm	(0.12 in.)	

Table 7. Immersion optic specifications

11.2 Non-contact optic

Item		Description
Laser wavelength		532 nm, 785 nm, 993 nm
Spectral coverage		limited by the coverage of the analyzer being used
Maximum laser power into probehead		< 499 mW
Sample interface	temperature	ambient
	pressure	ambient
	relative humidity	ambient
Wetted materials		optic dependent
Length		varies based on model
Diameter		varies based on model
Working distance		10 to 140 mm (0.40 to 5.52 in.), depending on optic see Section 3.2.2 →

Table 8. Non-contact optic specifications

11.3 bIO-Optic

Item		Description	
Laser wavelength		785 nm, 993 nm	
Spectral coverage		limited by the coverage of the analyzer being used	
Maximum laser power into probehead		< 499 mW	
Sample interface	temperature	−30 to 150 °C	(−22 to 302 °F)
	maximum pressure	13.8 barg	(200 psig)
Wetted materials	body	316L stainless steel	
	window	proprietary material, optimized for bioprocesses	
	process connection	PG13.5	
	surface finish	Ra 0.38 µm (Ra 15 µin) with electropolish	
	adhesive	USP Class VI and ISO 10993 compatible	
Immersible length		120 mm 220 mm 320 mm 420 mm	(4.73 in.) (8.67 in.) (12.60 in.) (16.54 in.)
Immersible diameter		12 mm	(0.48 in.)
Sterilization method		autoclave rated for 25 autoclave cycles at 131 °C (268 °F)	

Table 9. bIO-Optic specifications

11.4 Raman optic system for single use

Item	Description
Laser wavelength	785 nm, 993 nm
Spectral coverage	limited by the coverage of the analyzer being used
Maximum laser power into probehead	< 499 mW
Sample interface temperature	0 to 100 ˚C (32 to 212 ˚F)
Immersible length	dimensions vary according to single use bioreactor vendor port and fitting type
Immersible diameter	dimensions vary according to single use bioreactor vendor port and fitting type

Table 10. Raman optic system for single use specifications

12 Supplementary documentation

All documentation is available:

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

Part number	Document type	Document title
KA01551C	Brief Operating Instructions	Accessory optics for the Rxn-10 probe Brief Operating Instructions
TI01635C	Technical Information	Accessory optics for the Rxn-10 probe Technical Information

Table 11. Supplementary documentation

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