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Operating Instructions

Accessory optics for the Rxn-10 probe

KIO1, KNCO1, KLBIO1, KRSU1, KRBMO, KRBSL

Endress+Hauser
People for Process Automation

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1 About this document

This manual provides information about the optics used with the Endress+Hauser Raman Rxn-10 probe. The following interchangeable optics are available:

- Immersion optic
- Non-contact optic
- bIO-Optic
- Bio multi optic and bio sleeve
- 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)** Consequences of non-compliance (if applicable) ▸ Corrective action	This symbol alerts you to a dangerous situation. Failure to avoid the dangerous situation can result in a fatal or serious injury.
⚠ CAUTION **Causes (/consequences)** Consequences of non-compliance (if applicable) ▸ Corrective action	This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or more serious injuries.
NOTICE **Cause/situation** Consequences of non-compliance (if applicable) ▸ Action/note	This symbol alerts you to situations which may result in damage to property.

Table 1. Warnings

1.2 U.S. export compliance

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

2 Basic safety instructions

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

2.1 Requirements for personnel

- Only specially trained technical personnel may install, commission, operate, or maintain the measuring system.
- Technical personnel must be authorized by the plant operator to carry out the specified activities.
- Technical personnel must read, understand, and follow the steps outlined in these Brief Operating Instructions.
- 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 may only be carried out at the manufacturer's site or by the service organization.

2.2 Designated use

The Rxn-10 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 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	▪ Benchtop bioreactors to measure glucose, lactate, amino acids, cell density, titer, and more ▪ Benchtop fermenters to measure glycerol, methanol, ethanol, sorbitol, biomass, and more ▪ Use with Flow assembly CYA680 for select downstream bioprocessing applications
Bio multi optic and bio sleeve	▪ Benchtop bioreactors to measure glucose, lactate, amino acids, cell density, titer, and more ▪ Benchtop fermenters to measure glycerol, methanol, ethanol, sorbitol, biomass, and more ▪ Use with Flow assembly CYA680 for select downstream bioprocessing applications
Raman optic system for single use	▪ Single-use bioreactors to measure glucose, lactate, amino acids, cell density, titer, and more ▪ Single-use fermenters to measure glycerol, methanol, ethanol, sorbitol, biomass, and more

Table 2. Fields of application

The above table lists common applications for the Rxn-10 probe and optics. Different applications are possible; however, use of the device outside of the specified fields of application may compromise the safety of personnel and the 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:

- Verify that all connections are correct.
- Ensure that electro-optical cables are undamaged.
- Ensure the fluid level is sufficient for immersing the probe/optics (if applicable).
- Do not operate damaged products. Protect them from unintentional operation.
- Label damaged products as defective.

During operation:

- If faults cannot be rectified, products must be taken out of service and steps taken to prevent unintentional operation.
- When working with laser devices, always follow all local laser safety protocols, which may include using personal protective equipment and limiting device access to authorized users.

Service ratings may include limitations for fittings, flanges, or seals. The installer must understand these limitations and use appropriate hardware and assembly procedures for a pressure-tight, safe joint.

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 scattering laser radiation inadvertently.

2.7 Product safety

This product is designed to meet local safety requirements for the intended application and has been tested accordingly, leaving the factory in safe operating condition. All applicable 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 probe, powered by Kaiser Raman technology, enables flexible sampling options in the laboratory, process development, or a 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 optic types and their uses.

- 3.1: Immersion optic
- 3.2: Non-contact optic
- 3.3: bIO-Optic
- 3.4: Bio multi optic and bio sleeve
- 3.5: 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.

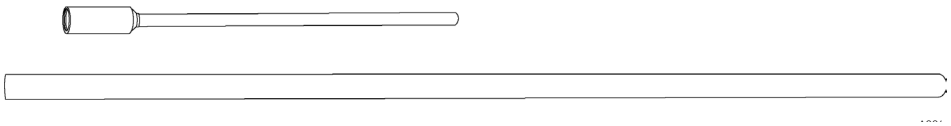

Figure 1. Immersion optics with different shaft lengths and diameters

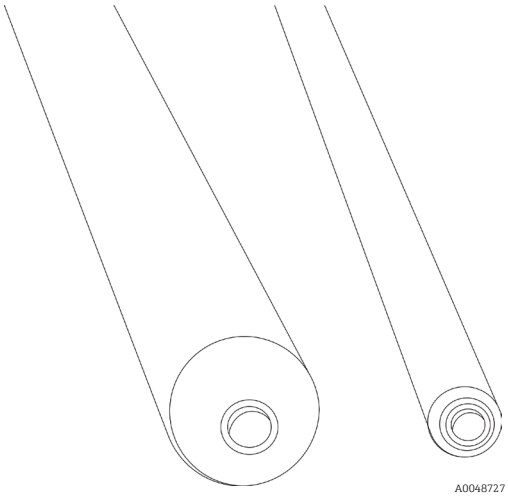

Figure 2. Tips of immersion optics with different diameters

3.1.1 Benefits of the immersion optic

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

- Ideal for measuring liquids, slurries, and semisolids in the laboratory quickly
- 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 Working distance: short vs. long

The immersion optic is available with either a short (at the window) or long (3 mm or 0.12 in. from the window) working distance. The selected working distance, which defines the zone in which spectral data are collected, is identified on the immersion optic.

Short or long working distances are used for different sample types. Spectral data are collected most efficiently at the focal plane.

A short working distance is typically used for opaque or turbid media samples. When an immersion optic with a long working distance is used for these materials, the incident radiation may be lost due to specular and diffuse reflection by material above the focal plane.

A long working distance is preferred for transparent samples because it maximizes the signal intensity by using the entire effective focal cylinder.

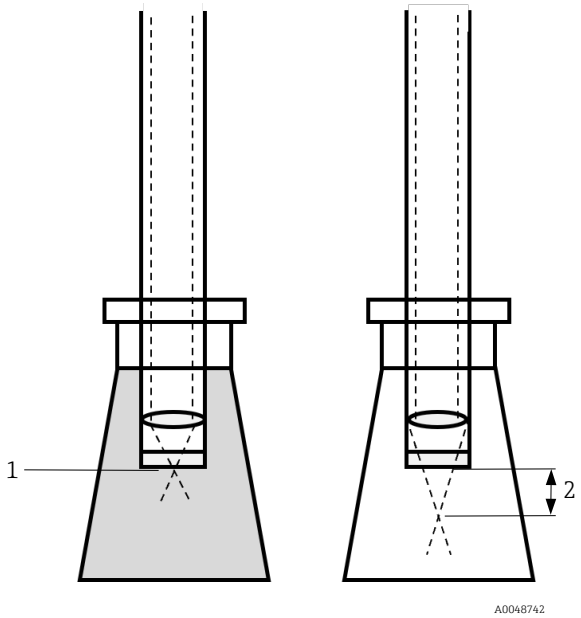

Figure 3. Short (1) vs. long (2) working distance (data collection zone)

3.2 Non-contact optic (KNCO1)

Paired with the Rxn-10 probe, the Endress+Hauser non-contact optic enables contactless Raman measurements directly, through sight glass, or through translucent sample packaging. These optics are ideal for applications involving solids or turbid media, or when avoiding sample contamination or damage to optical components is critical.

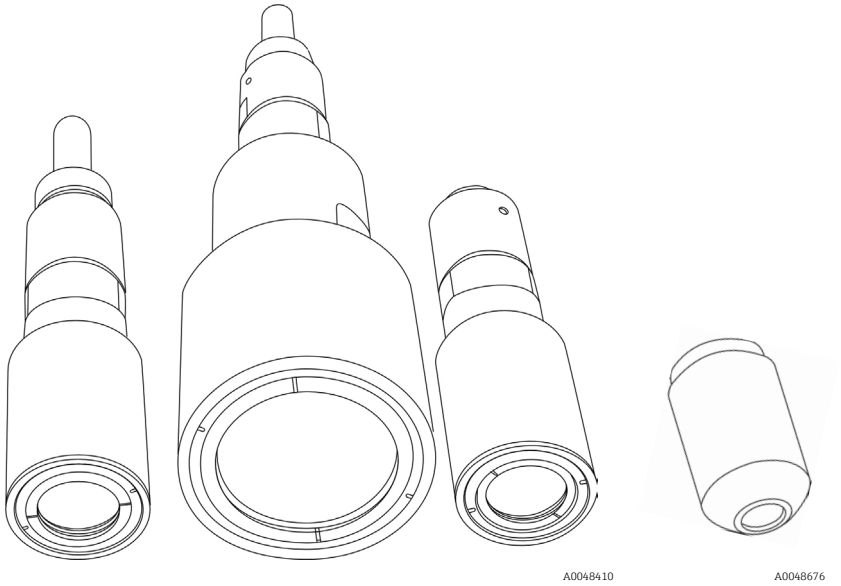

Figure 4. Non-contact optic in varying sizes

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 or translucent packaging
- Highly versatile for measuring films, pellets, powders, and more
- 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 range of sizes, with working distances from 10 to 75 mm (0.40 to 3 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

Table 3. Non-contact optics

3.3 bIO-Optic (KLBIO1)

The Endress+Hauser bIO-Optic is a versatile immersion optic designed for use with the Rxn-10 probe. It enables real-time measurement of key bioprocessing components and is compatible with standard PG13.5 bioreactor ports.

The fixed focus design of the bIO-Optic provides long-term measurement stability and superior signal performance, supporting reliable and transferable Raman-based bioprocess analysis.

Available in a range of industry standard lengths, the bIO-Optic is suitable for benchtop bioreactor or fermenter applications requiring headplate entry.

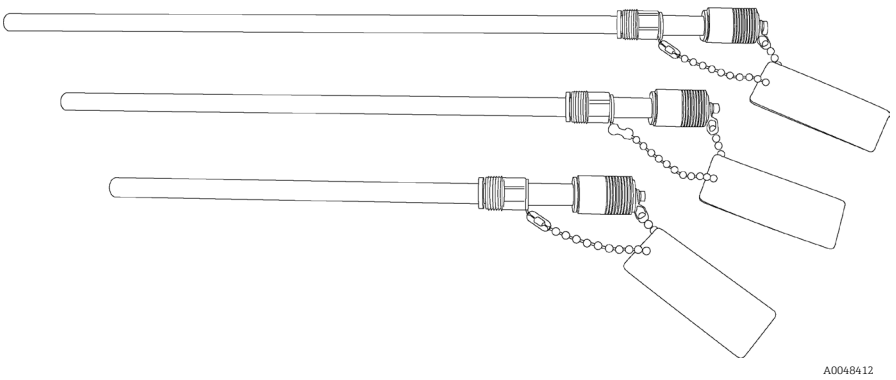

Figure 5. bIO-Optics in varying lengths

NOTICE

Do not use the bIO-Optic 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, with punch card included for tracking
- 120 mm version compatible with Endress+Hauser flow assembly CYA680

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 the PG13.5 threaded connector is suitable for headplate entry into the bioreactor or fermenter.

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

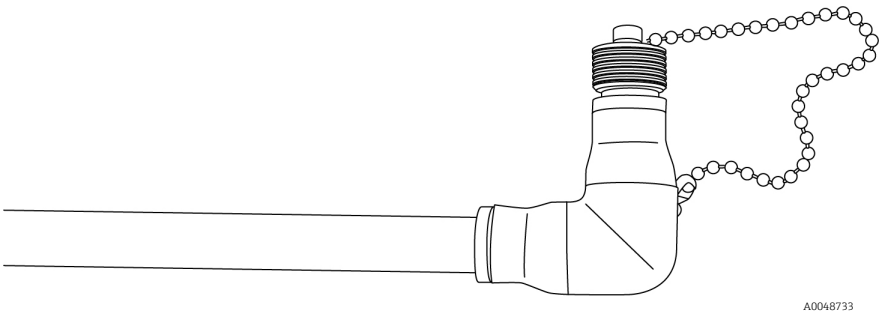

Figure 6. bIO-Optic with the bIO-Sample chamber

3.4 Bio multi optic (KRBMO) and bio sleeve (KRBSL)

The Endress+Hauser bio multi optic and bio sleeve make up a versatile, two-part immersion optic system for use with the Rxn-10 probe. This system enables real-time measurement of multiple key bioprocessing components and is compatible with standard PG13.5 bioreactor ports.

The system consists of the following parts:

- Reusable bioprocessing multi optic with no product contact
- Bioprocessing sleeve with product contact that interfaces with the bio multi optic. The sleeve supports up to 50 autoclave cycles when used with the bio sleeve desiccator.

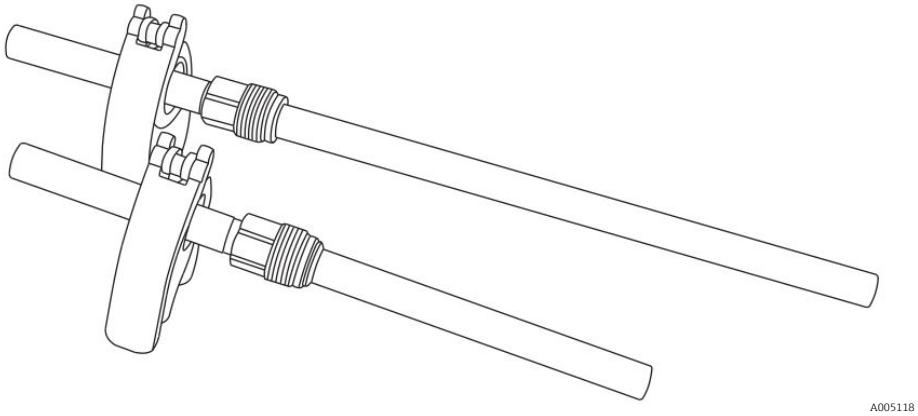

Figure 7. Bio multi optic and bio sleeve system in different lengths

NOTICE

Do not use this system with hydrocarbon solvents (including ketones and aromatics).

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

3.4.1 Benefits of the bio multi optic and bio sleeve

The bio multi optic and bio sleeve system offer the following benefits:

- Modular design allows operators to calibrate the optic without removing the bio sleeve from the bioreactor/wetted area.
- Simplified wetted/sterilized portion reduces probe service and maintenance.
- Fixed focus design provides long-term measurement stability and superior signal performance, essential for transferable, high-performance Raman-based bioprocess analysis.
- 120 mm version is compatible with Endress+Hauser flow assembly CYA680.

3.4.2 Bio multi optic and bio sleeve options

The bio multi optic and bio sleeve are available in 120 mm and 220 mm (4.73 in. and 8.67 in.) standard lengths.

The sample system is suitable for benchtop bioreactor or fermenter applications requiring headplate entry.

A multi optic verification accessory is an available option that can be used for the probe verification procedure.

3.5 Raman optic system for single use (KRSU1)

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

- Reusable optic with no product contact
- Disposable fitting supplied, installed, and tested by the single-use vessel vendor.

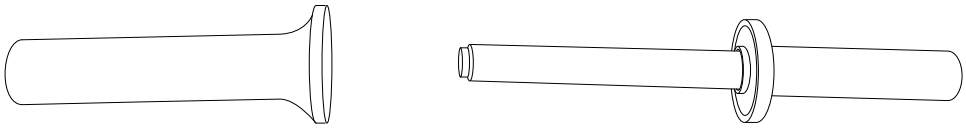

Figure 8. Disposable fitting (left) and reusable optic (right) A0048734

NOTICE

Do not use this system with hydrocarbon solvents (including ketones and aromatics).

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

3.5.1 Benefits of the Raman optic system for single use

When used with the Rxn-10 probe, the Raman optic system for single use has been shown to deliver the same quality data as reusable Raman probes. This allows customers to develop products and processes without limitations regarding 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.

3.5.2 Optic and fitting

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

Customers can purchase the disposable fitting from the vendor of the single-use vessel. This vendor will then deliver the system as an Endress+Hauser Raman-ready, single-use vessel. In other words, the vessel is manufactured to the customer's specifications with the fitting installed. The customer receives a sterile, single-use product that has been tested by the manufacturer. 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

- 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.
- 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.
- Check that the delivery is complete and nothing is missing. Compare the shipping documents with your order.
- Pack the product for storage and transportation in such a way that protects it from 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

The optic labels contain the following minimum information:

- Manufacturer data
- 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 questions, 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 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.

Before installation, ensure any protective covers are removed from the optics.

When replacing a probe optic, use the multi optic calibration accessory or the Raman Calibration Accessory (HCA) to perform an intensity calibration for that probe with the new optic. See Section 11 → 🖹 to determine the appropriate calibration method for each optic.

5.1 Installing immersion optics and bIO-Optics

Endress+Hauser immersion optics and bIO-Optics slip into the Rxn-10 probe and are secured by a torque-limiting clamp and thumb screw. The thumb screw on the Rxn-10 probe should never be fully removed.

⚠ WARNING

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

To install an immersion optic:

1. If necessary, loosen the metal thumb screw on the Rxn-10 probe by turning the screw counterclockwise approximately one turn (do not remove). Next, 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 by gently turning it clockwise until there is an audible “click” sound. This indicates the thumb screw has reached the desired torque. Failure to tighten the screw will allow the optic to come loose, potentially damaging the optic.
5. After inserting an optic into a probe, use the Raman Calibration Accessory to perform an intensity calibration for the probe with the new optic.

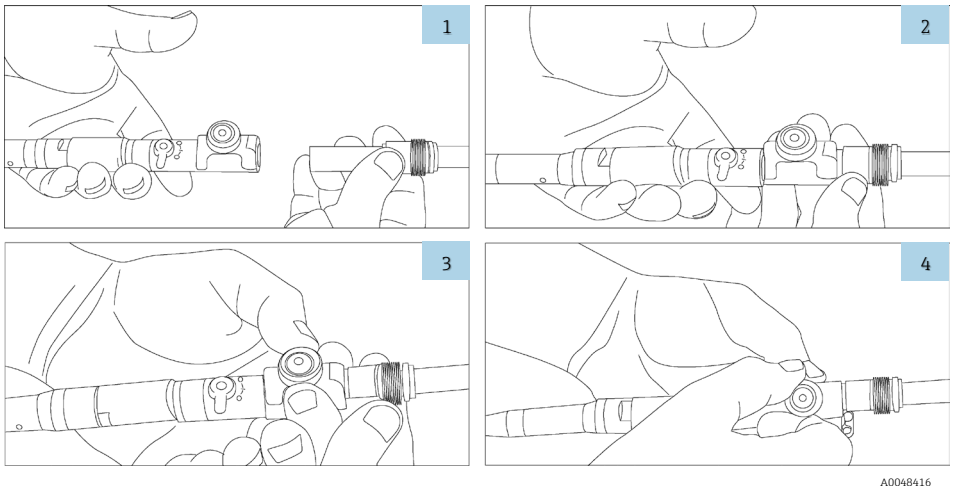

Figure 9. Installing an immersion optic (IO) on an Rxn-10 probe

To remove an immersion optic:

Loosen the torque-limiting thumb screw by turning it counterclockwise approximately one turn to release the immersion optic from its clamp. Do not remove the screw. Slide the immersion optic out.

5.2 Installing the bio multi optic and bio sleeve system

Proceed as follows to insert the bio multi optic and bio sleeve system into a bioreactor for data acquisition:

- Insert the bio multi optic into the Rxn-10 probe
- Slide the bio sleeve into the bioreactor
- Sterilize the bio sleeve/bioreactor combination (typically)
- Insert the Rxn-10 probe with the bio multi optic into the bio sleeve/bioreactor

5.2.1 Inserting the bio multi optic into the Rxn-10 probe

The Endress+Hauser bio multi optic slips into the Rxn-10 probe and is secured by a torque-limiting clamp and thumb screw. The thumb screw on the Rxn-10 probe should never be fully removed.

⚠ WARNING

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

To insert the optic into the probe:

1. If necessary, loosen the metal thumb screw on the Rxn-10 probe by turning the screw counterclockwise approximately one turn (do not remove).
2. Insert the optic through the end optic clamp.

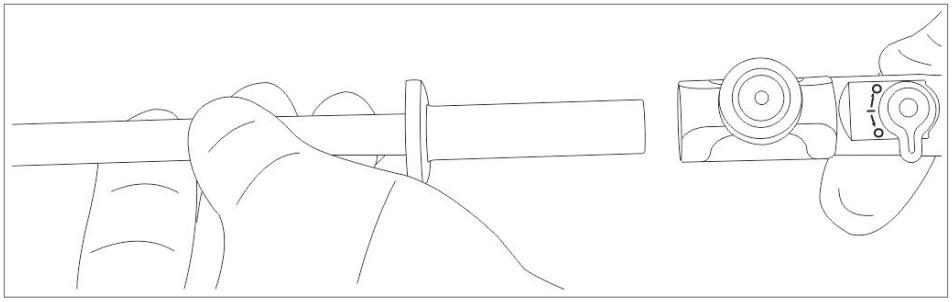

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Figure 10. Inserting the bio multi optic into the Rxn-10 probe

3. Push the optic back until it stops.

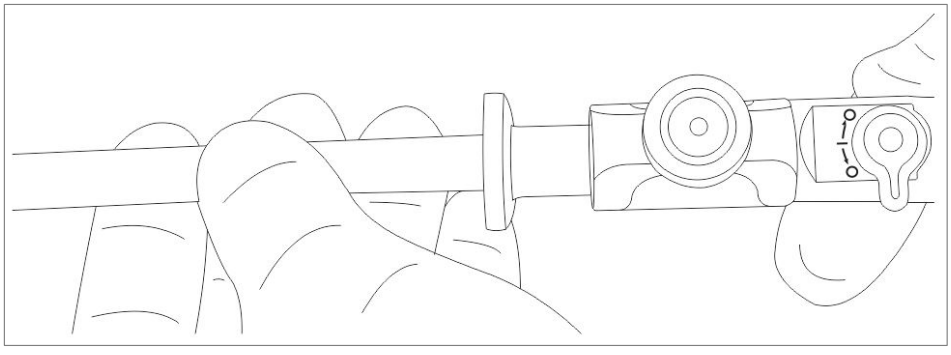

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Figure 11. Final position of bio multi optic in the Rxn-10 probe

4. Tighten the thumb screw by gently turning it clockwise until there is an audible “click” sound. This indicates the thumb screw has reached the desired torque. Failure to tighten the screw will allow the optic to come loose, potentially damaging the optic.

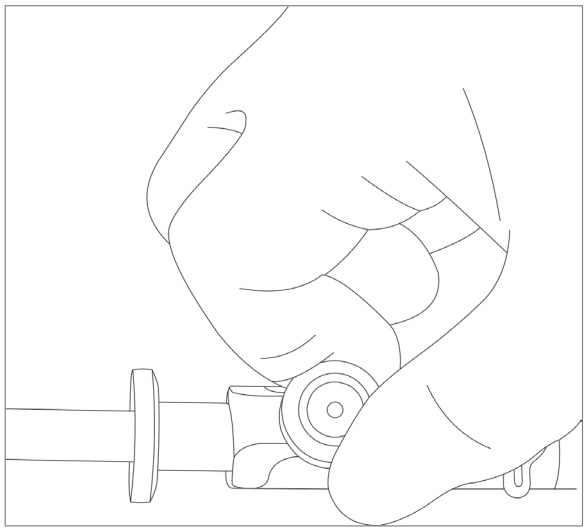

Figure 12. Tightening the thumb screw on the Rxn-10 probe

5. After inserting an optic into a probe, use the multi optic calibration accessory to perform an intensity calibration for the probe with the new optic. Alternately, the Raman Calibration Accessory (HCA) may be used, but a bio sleeve is required.

To remove the bio multi optic from the Rxn-10 probe:

Loosen the torque-limiting thumb screw by turning it counterclockwise approximately one turn to release the optic from its clamp. Do not remove the screw. Slide the optic out.

5.2.2 Inserting the bio sleeve into the bioreactor

The bio sleeve is designed to interface with a PG13.5 threaded port on the bioreactor.

To insert the bio sleeve into the bioreactor:

1. Align the bio sleeve with the available PG13.5 port.
2. Insert the bio sleeve into the PG13.5 port on the bioreactor.
3. Tighten the PG13.5 nut on the PG13.5 port of the bioreactor according to the bioreactor manufacturer’s guidelines.

NOTICE

The bio sleeve must never interfere with the internal stirring device.

- Interference can damage the optic system and may cause cavitation.

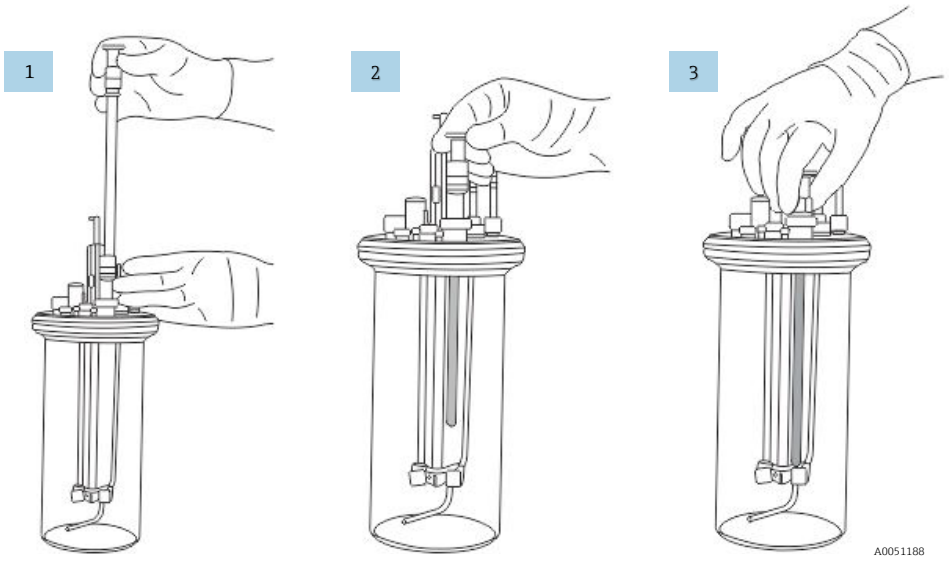

Figure 13. Installing the bio sleeve into the PG13.5 port of the bioreactor

NOTICE

The bioreactor/bio sleeve will typically need to be sterilized prior to use.

- The desiccator must be inserted into the bio sleeve prior to autoclave sterilization.

See Section 9.3 → for autoclaving instructions.

5.2.3 Inserting the Rxn-10 probe with bio multi optic into the bio sleeve

NOTICE

The Rxn-10 probe with the reusable optic should be calibrated and verified prior to insertion into the bio sleeve.

- See Section 6.2 → for calibration and verification instructions.

After calibrating the Rxn-10 and bio multi optic and sterilizing the bioreactor (including the installed bio sleeve), join the systems together to begin collecting data. Follow the steps below:

1. Obtain a sanitary flange seal.

   If a sanitary flange seal is already installed on the bio sleeve, go to step 3.

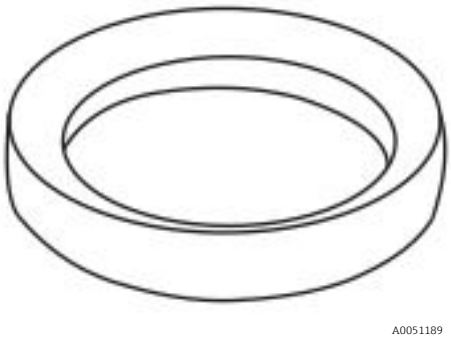

Figure 14. Sanitary flange seal

2. Place the sanitary flange seal on the seal gland.

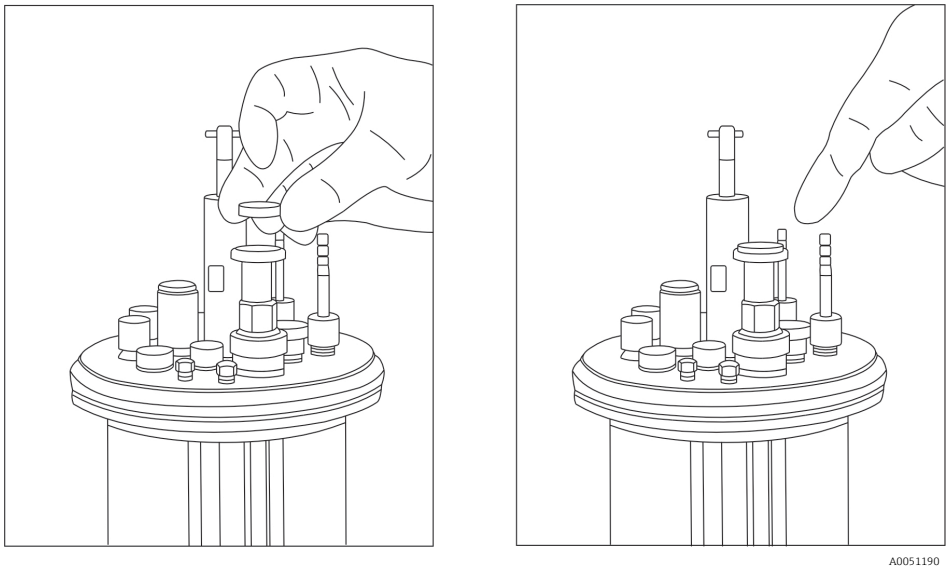

Figure 15. Installing the sanitary flange seal

3. Confirm that the immersion length is correct for the bio multi optic being used.
4. Insert the bio multi optic into the bio sleeve until the optic rests on the sanitary flange seal.

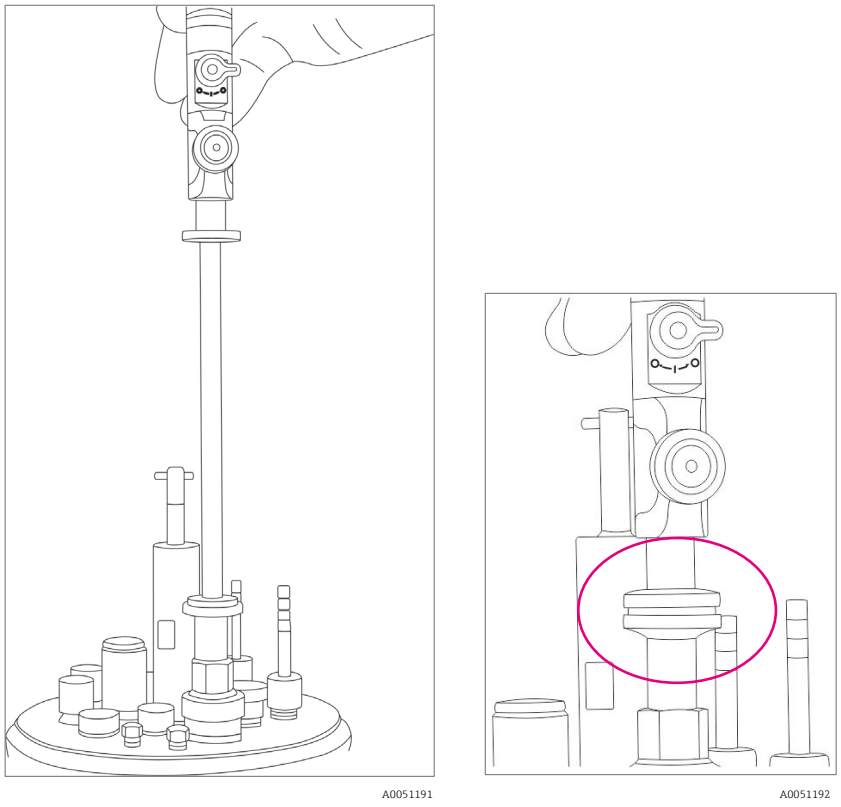

Figure 16. Inserting the bio multi optic into the bio sleeve (left) until the optic rests on the seal (right)

5. Confirm that the sanitary seal is properly seated between the optic and the sleeve.

6. Install the sanitary clamp, making sure it is clamped tightly. There should be two distinct clicks indicating it is clamped correctly.

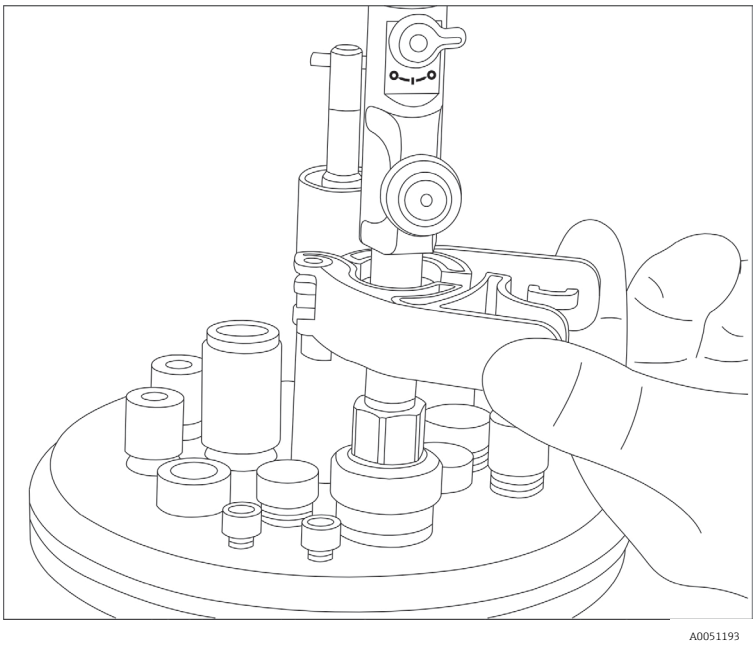

Figure 17. Installing the sanitary clamp

The Rxn-10 probe and bio multi optic / bio sleeve system are now ready to acquire data within the bioreactor.

5.3 Installing non-contact optics

The non-contact optics offered with the Rxn-10 probe are threaded. A threaded adapter is therefore required for attaching 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. If necessary, loosen the metal thumb screw on the Rxn-10 probe by turning the screw counterclockwise approximately one turn (do not remove). Next, 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 thumb screw by gently turning it clockwise until there is an audible “click” sound. This indicates the thumb screw has reached the desired torque. Failure to tighten the screw will allow the adapter to come loose.
4. Find the externally threaded end of the non-contact optic.
5. Screw the non-contact optic into the threaded end of the adapter.
6. After inserting an optic into a probe, use the Raman Calibration Accessory (HCA) to perform an intensity calibration for the probe with the new optic.

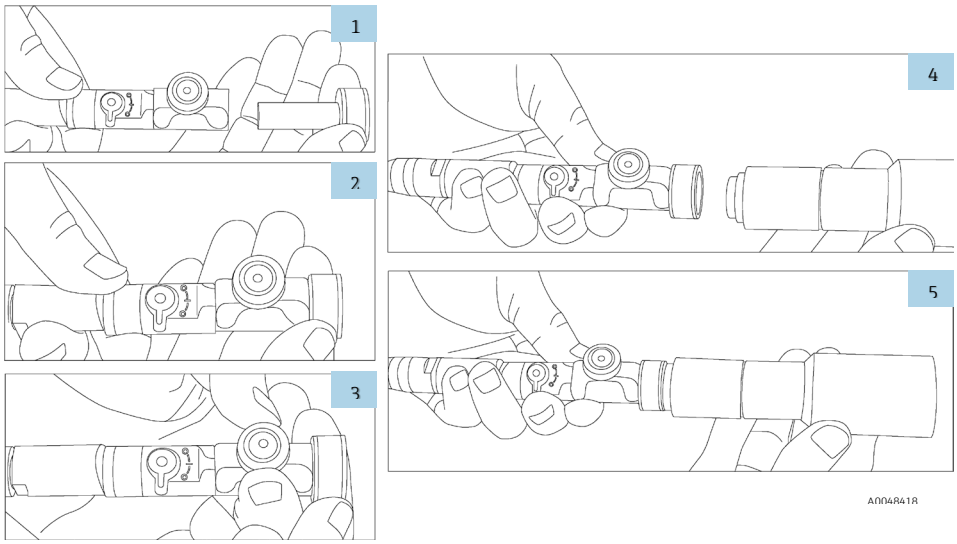

Figure 18. Installing an adapter and non-contact optic into the Rxn-10 probe

To remove a non-contact optic:

Unscrew the non-contact optic from the adapter. If planning to use an immersion optic, remove the adapter by turning the torque-limiting thumb screw counterclockwise approximately one turn to release the adapter from the clamp. Slide the adapter out.

5.4 Installing the Raman optic system for single use

NOTICE

Calibrate and verify the Rxn-10 probe with the reusable optic prior to inserting it into the disposable fitting.

▶ See Section 6.2 → for calibration and verification instructions.

5.4.1 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.

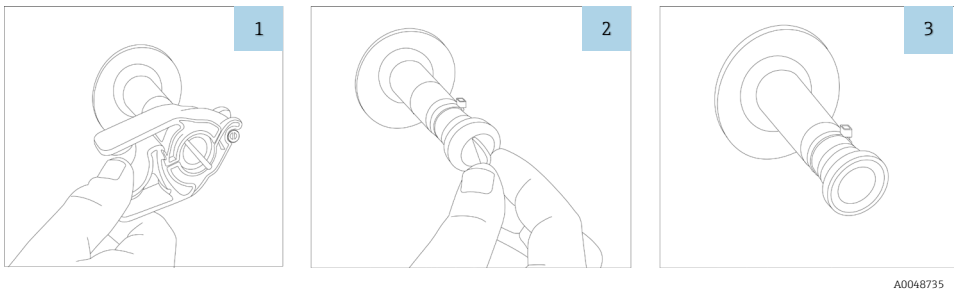

Figure 19. Preparing the disposable fitting

5.4.2 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.

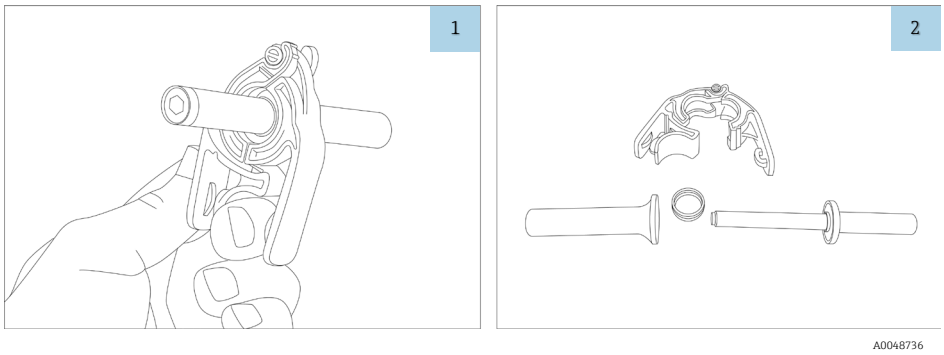

Figure 20. Preparing the reusable optic

5.4.3 Inserting the optic in the fitting

To insert the optic in the disposable fitting:

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

   If it is not, place a sanitary O-ring seal over the optic, ensuring that it is 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.

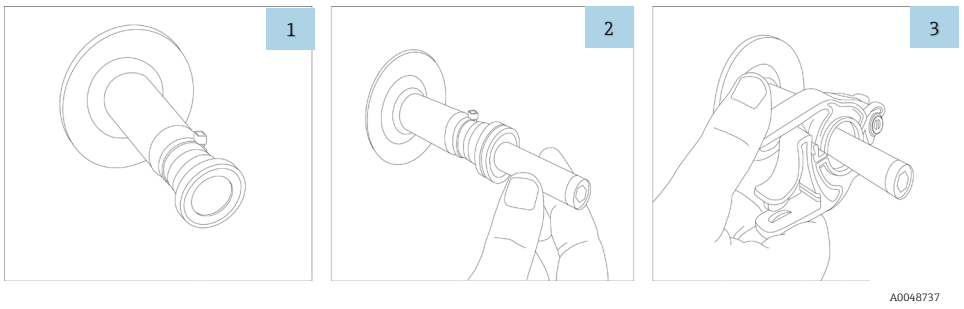

Figure 21. Inserting the optic in the fitting

5.4.4 Inserting the optic into the Rxn-10 probe

The Endress+Hauser reusable optic slips into the Rxn-10 probe and is secured by a torque-limiting clamp and thumb screw. The thumb screw on the Rxn-10 probe should never be fully removed.

⚠ WARNING

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

To insert the optic into the probe:

1. If necessary, loosen the metal thumb screw on the Rxn-10 probe by turning the screw counterclockwise approximately one turn (do not remove). Next, insert the optic through the end optic clamp.
2. Push the optic back until it stops.
3. Tighten the thumb screw by gently turning it clockwise until there is an audible “click” sound. This indicates the thumb screw has reached the desired torque. Failure to tighten the screw will allow the optic to come loose, potentially damaging the optic.

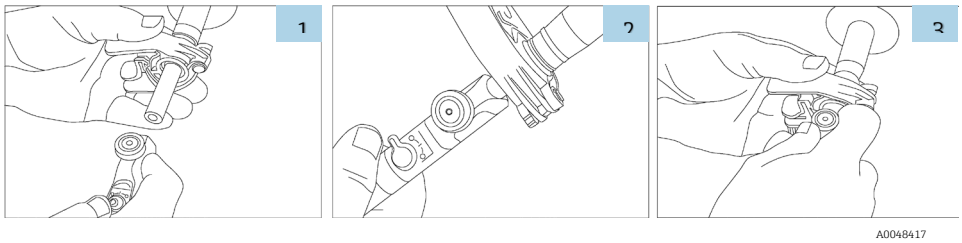

Figure 22. Installing the reusable optic into the Rxn-10 probe

4. After inserting an optic into a probe, and before connecting it to the fitting, use the multi optic calibration accessory to perform an intensity calibration for the probe with the new optic. Alternately, the Raman Calibration Accessory (HCA) and single-use calibration adapter may be used.

To remove the optic:

Loosen the torque-limiting thumb screw by turning it counterclockwise approximately one turn to release the optic from its clamp. Do not remove the screw. 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 probe head 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 Multi optic calibration accessory

After inserting the bio multi optic or the Raman optic system for single use into the Rxn-10 probe, use the multi optic calibration accessory to perform an intensity calibration for the probe head with the new optic.

Refer to the *Multi optic calibration kit Operating Instructions* for additional information about the multi optic calibration accessory.

If the multi optic calibration accessory is not available, a Raman Calibration Accessory (HCA) may be used for calibration as follows:

- Bio multi optic: with the bio sleeve and 12 mm HCA adapter
- Raman optic system for single use: with the single-use calibration adapter and 12 mm HCA adapter

6.2.2 Raman Calibration Accessory

After inserting the immersion optic, non-contact optic, or bIO-Optic into the probe head, use the Raman Calibration Accessory (HCA) to perform an intensity calibration for the probe head with the new optic.

If using the HCA with the Raman optic system for single use, install an additional single-use calibration adapter onto the optic following the process outlined in Section 5.3 → 🖹 for connecting the optic to the fitting. Next, insert the optic/calibration adapter combination into the HCA adapter attached to the HCA head.

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

6.2.3 Performing calibration and verification

Refer to the applicable Raman Rxn analyzer operating instructions for the following:

- Calibrating the internal analyzer. This may include alignment calibration, full wavelength calibration, and/or full laser wavelength calibration depending on the analyzer status.
- Calibrating the probe. This requires the multi optic calibration accessory or HCA with an appropriate optic adapter.
- Verifying the probe. This involves verifying the calibration results using a standard reference sample. A bIO-Sample Chamber or multi optic verification accessory may be used instead.
- Viewing calibration and verification reports

NOTICE

The multi optic verification accessory should be used for verifying the bio multi optic or Raman optic system for single use. Do NOT immerse the bio multi optic or optic system for single use directly in a sample.

▶ If the multi optic verification accessory is not available, the bio multi optic or Raman optic system for single use may be verified using a bIO-Sample Chamber and an additional bio sleeve (for bio multi optic) or a single-use calibration adapter (for single-use optic).

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 Raman Rxn-10 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 is compatible with a variety of interchangeable optics, including the following:

- Immersion optic
- Non-contact optic
- bIO-Optic
- Bio multi optic and bio sleeve
- Raman optic system for single use

Follow the instructions in Section 5 → 🖹 when inserting the optics into the probe.

Refer to the *Rxn-10 Raman spectroscopic probe Operating Instructions* for operating 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, bio multi optic and bio sleeve system, and Raman optic system for single use

Do not use the bIO-Optic, the bio multi optic and bio sleeve system, or the Raman optic system for single use 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. The bio multi optic is NOT intended to be submerged into any liquid without being attached to a bio sleeve.

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

When storing the bio multi optic or the reusable portion of the Raman optic system for single use, it is important to always protect the optic using the cover provided during shipping. Verify that the O-ring seal is installed to ensure a clean and dry environment.

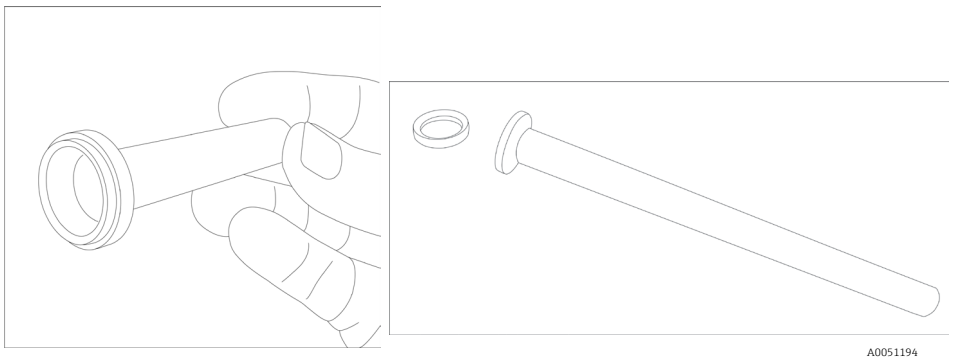

Figure 23. The cover for the reusable optic with O-ring (left) and O-ring and cover for the bio multi optic (right)

⚠ 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 the metal thumb screw on the Rxn-10 probe by turning the screw counterclockwise approximately one turn (do not remove).
2. Slide the Rxn-10 probe head off the bio multi optic or reusable optic.
3. Locate the quick release clamp, the optic cover, and the sanitary seal (O-ring).
4. Slide the optic into the cover, with the O-ring creating a seal between the two pieces.
5. Install the quick release clamp over the optic/cover flange and squeeze the clamp until you hear two distinct clicks indicating that it is secure.

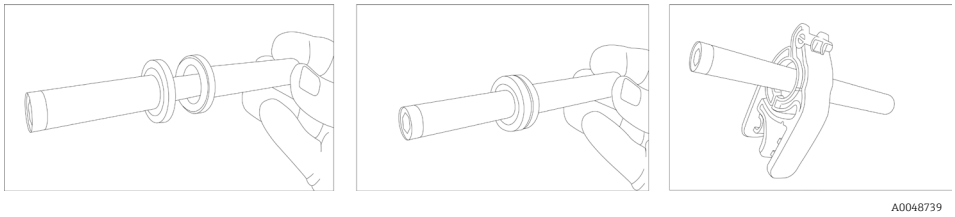

Figure 24. Installing an optic cover (left and center) and clamp (right)

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

Clean the optics if they come in contact with samples, dust, or fingerprints.

After immersion in phosphate buffer solutions, clean the bIO-Optic and bio sleeve to prevent particle deposits.

The window on each of the optics can be cleaned following the steps below. For the bIO-Optic and bio sleeve, this typically requires autoclave sterilization.

Service at the manufacturer's site is recommended for all other optic maintenance.

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, the bio multi optic and bio sleeve system, or the 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 that the probe is disconnected from the analyzer.
2. Dislodge loose particles from the surface using clean, compressed air.
3. Wipe the surface using a swab lightly dampened with an appropriate solvent. Solvents may include 100 % isopropyl alcohol (IPA), deionized water, or an equivalent solvent suitable for the contaminant.

   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. Dislodge swab fibers from the surface using clean, compressed air.
7. Inspect the surface to verify that it is clean.
8. Use of an inspection microscope is strongly recommended to detect smeared contaminants, swab remnants, or other residues that may increase spectrum background.
9. 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 25 cycles, 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 metal thumb screw on the Rxn-10 probe by turning the screw counterclockwise approximately one turn (do not remove).
4. Carefully disconnect the bIO-Optic from the probe.
5. Store the Rxn-10 probe in a safe location (away from traffic, heat, etc.).

6. Clean the bIO-Optic probe tip and window:
   - Spray with reagent alcohol or 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.
7. Insert the bIO-Optic into a bioreactor and tighten the connection adaptor.
8. 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.

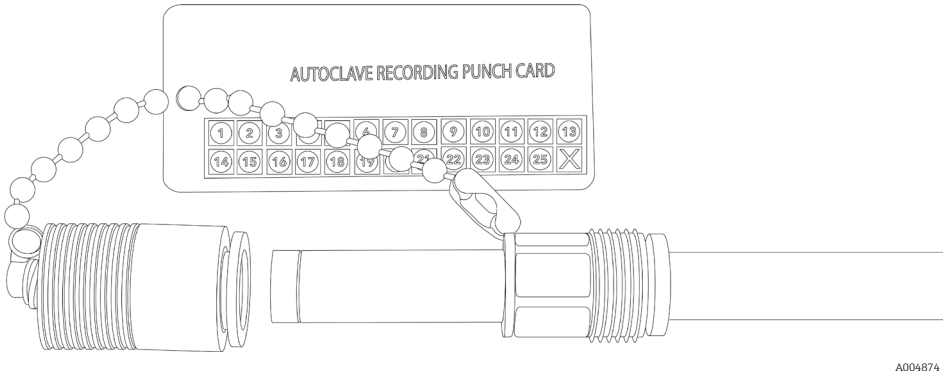

Figure 25. bIO-Optic with end cap and autoclave recording punch card

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 punched-out material. Note:
   - Punching out the next cycle count prior to autoclaving is advised in order 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.

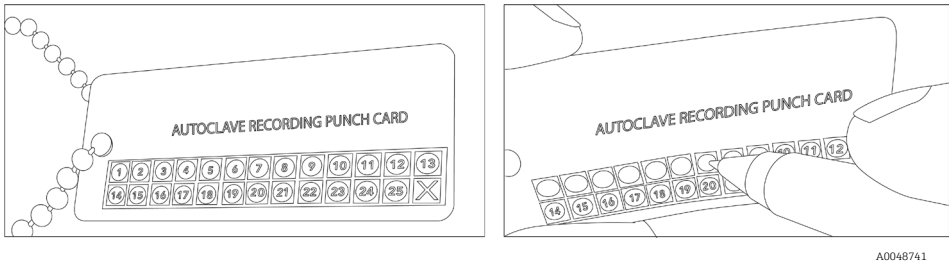

Figure 26. Using the autoclave recording punch card

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.

9.3 Autoclaving the bio sleeve

The bio sleeve is rated for 50 autoclave cycles at 131 °C (268 °F) with the use of the bio sleeve desiccator. After 50 autoclave cycles, the bio sleeve should be replaced.

9.3.1 Preparing the sleeve desiccator

The bio sleeve should be sterilized prior to use. A sleeve desiccator with new desiccant must be inserted into the bio sleeve for the sterilization process. Follow the steps below to replace the desiccant on the sleeve desiccator.

1. Confirm that the desiccator is the correct length.
2. Remove any existing desiccant (if present) by grasping the desiccant and pulling it toward the end of the desiccator shaft.

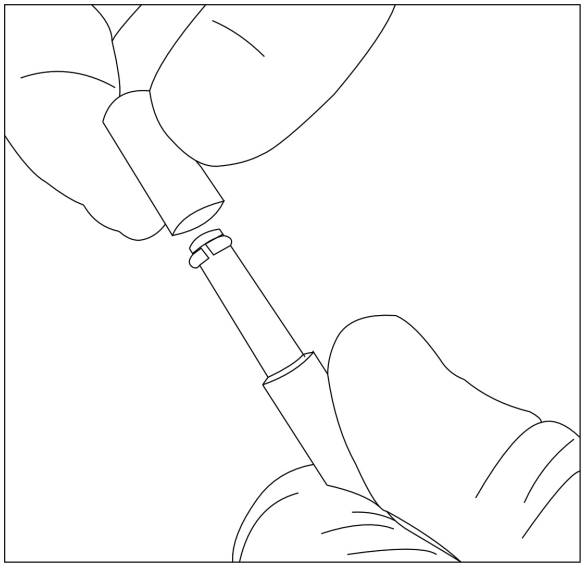

Figure 27. Removing desiccant from the sleeve desiccator

3. Discard the used desiccant and open the package containing the new desiccant. Only use desiccant from a freshly opened package.
4. Install the new desiccant by sliding it over the end of the desiccator until it reaches the shoulder. You should hear a faint click once it passes the retaining ring.

Figure 28. Installing desiccant on the sleeve desiccator

9.3.2 Installing the desiccator into the bio sleeve

The desiccator must be installed before autoclaving the bio sleeve.

1. Place the sanitary seal provided with the desiccator onto the gland on the bio sleeve.

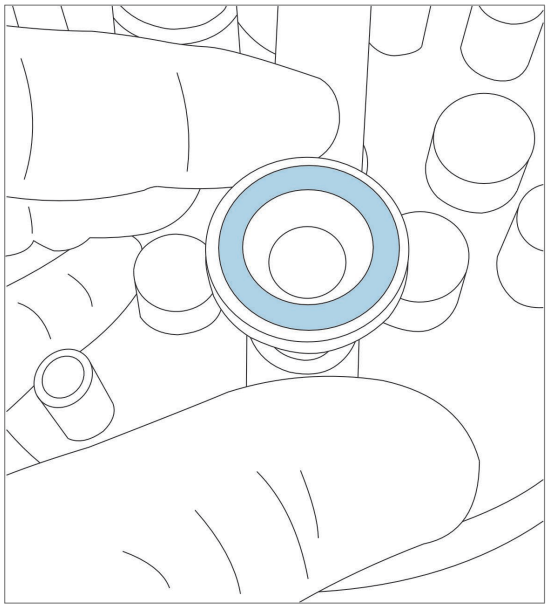

Figure 29. Placing the sanitary seal onto the bio sleeve gland

2. Slide the desiccator with new desiccant into the bio sleeve to be autoclaved, ensuring that the gland aligns with the seal.

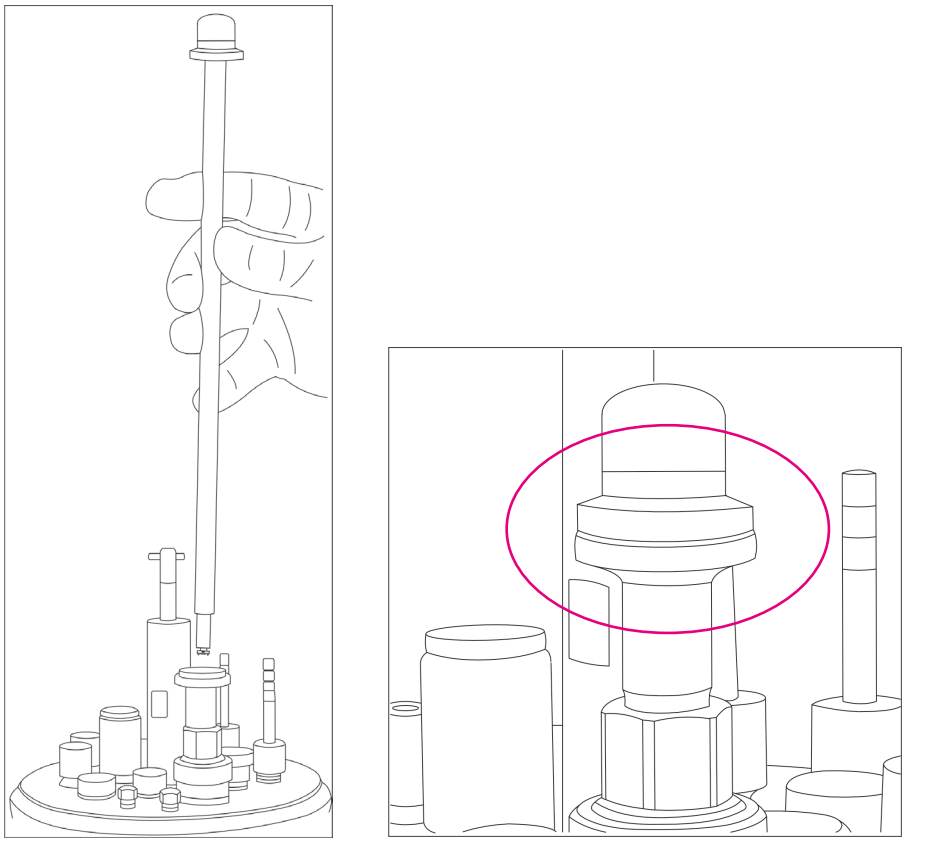

Figure 30. Inserting the desiccator with desiccant (left) until the desiccator is aligned with the bio sleeve (right)

3. Install the sanitary clamp, making sure it is clamped tightly. There should be two distinct clicks indicating it is clamped correctly.

   The bio sleeve is now ready for sterilization.

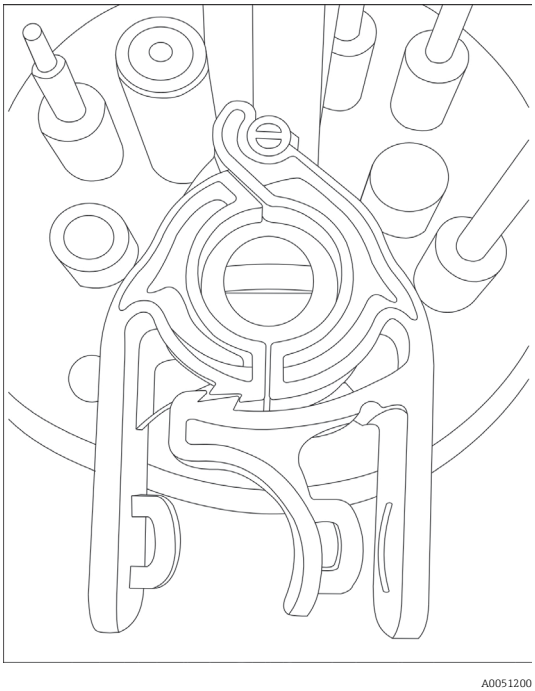

Figure 31. Sanitary clamp connecting desiccator and bio sleeve

9.3.3 Removing the desiccator from the bio sleeve

After sterilization, the desiccator must be removed from the bio sleeve before installing the bio multi optic.

To remove the desiccator:

1. Depress the release lever on the sanitary clamp and remove the clamp.
2. Slide the desiccator out of the bio sleeve.
3. Leave the sanitary flange seal in place for installing the Rxn-10 probe with the bio multi optic.
   See Section 5.2.3 → 🖹 for installation instructions.
4. Store the clamp and desiccator in a secure location.

10 Repair

10.1 Repairing optics for the Rxn-10 probe

Repairs not described in this document must only be carried out 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 returning them 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

For product and spare parts ordering information, please visit www.endress.com or contact your local sales center.

No user-serviceable parts are available for the following:

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

11 Technical data

The specifications for the Rxn-10 probe are listed in the tables below for each optic. The following conditions apply:

- Maximum pressure for the immersion optic and bIO-Optic is calculated in accordance with ASME B31.3 2020 Edition for material and probe geometry. Temperatures must not exceed the maximum listed.
- Minimum pressure rating: 0 bara (full vacuum). Unless otherwise specified, the probes are not rated for low outgassing in high-vacuum service.

11.1 Immersion optic

Item		Description	
Laser wavelength		532 nm, 785 nm, 993 nm	
Spectral coverage		Limited by the analyzer used	
Maximum laser power into probe head		< 499 mW	
Relative humidity		Sealed:	Up to 95 %, non-condensing
		Non-sealed:	20 to 60 %, non-condensing
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 315 °C (−22 to 599 °F)
	Maximum pressure[1], 12.7 mm (0.5 in.) diameter IO	316L stainless steel:	142.4 barg (2066 psig)
		C276 alloy:	158.1 barg (2293 psig)
		Grade 2 titanium:	65.2 barg (946 psig)
	Maximum pressure[1], 6.35 mm (0.25 in.) diameter IO	316L stainless steel:	168.5 barg (2444 psig)
		C276 alloy:	186.2 barg (2701 psig)
		Grade 2 titanium:	76.3 barg (1107 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 mm (6 in.) 305 mm (12 in.) 457 mm (18 in.)	
	6.35 mm (0.25 in.) diameter IO	152 mm (6 in.) 203 mm (8 in.)	
Working distance	Short (S)	0 mm (0 in.)	
	Long (L)	3 mm (0.12 in.)	
Calibration method	532 nm	HCA-532	
	785 nm	HCA-785	
	993 nm	HCA-1000	
Verification method	532 nm	Immerse in cyclohexane	
	785 nm, 993 nm	Immerse in cyclohexane or 70 % IPA	

Table 4. Immersion optic specifications

[1] Maximum service pressure ratings do not include the ratings of any fittings or flanges used to install the probe in the process system. These items need to be independently evaluated and may lower the maximum service pressure of the probe.

11.2 Non-contact optic

Item		Description
Laser wavelength		532 nm, 785 nm, 993 nm
Spectral coverage		Limited by the analyzer used
Maximum laser power into probe head		< 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 75 mm (0.40 to 3 in.), depending on optic see Section 3.2.2 → 🖹
Calibration method	532 nm	HCA-532
	785 nm	HCA-785
	993 nm	HCA-1000
Verification method	532 nm	Cyclohexane cuvette
	785 nm, 993 nm	Cyclohexane or 70 % IPA cuvette

Table 5. Non-contact optic specifications

11.3 bIO-Optic

Item		Description
Laser wavelength		785 nm, 993 nm
Spectral coverage		Limited by the analyzer used
Maximum laser power into probe head		< 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 (4.73 in.) 220 mm (8.67 in.) 320 mm (12.60 in.) 420 mm (16.54 in.)
Immersible diameter		12 mm (0.48 in.)
Sterilization method		Autoclave Rated for 25 autoclave cycles (30 minutes each) at 131 °C (268 °F)
Calibration method	785 nm	HCA-785
	993 nm	HCA-1000
Verification method	785 nm, 993 nm	bIO Sample Chamber with 70 % IPA

Table 6. bIO-Optic specifications

11.4 Bio multi optic and bio sleeve

Item		Description
Laser wavelength		785 nm
Spectral coverage		limited by the analyzer used
Maximum laser power into probe head		< 499 mW
Sample interface	Temperature	−30 to 150 °C (−22 to 302 °F)
	Maximum pressure	13.8 barg (200 psig)
Wetted materials (bio sleeve)	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 (bio sleeve)		120 mm (4.73 in.) 220 mm (8.67 in.)
Immersible diameter (bio sleeve)		12 mm (0.48 in.)
Sterilization method (bio sleeve)		Autoclave (with the use of the bio sleeve desiccator) rated for 50 autoclave cycles (30 minutes each) at 131 °C (268 °F)
Calibration method	785 nm	Multi optic calibration accessory (recommended) or HCA-785 with bio sleeve attached to bio multi optic
Verification method	785 nm	Multi optic verification accessory with 70 % IPA (recommended) or bIO Sample Chamber with 70 % IPA and bio sleeve attached to bio multi optic

Table 7. Bio multi optic and bio sleeve specifications

11.5 Raman optic system for single use

Item		Description
Laser wavelength		785 nm, 993 nm
Spectral coverage		Limited by the analyzer used
Maximum laser power into probe head		< 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
Calibration method	785 nm	Multi optic calibration accessory (recommended) or HCA-785 with single-use calibration adapter
	993 nm	HCA-1000 with single-use calibration adapter
Verification method	785 nm	Multi optic verification accessory with 70 % IPA (recommended) or bIO Sample Chamber with 70 % IPA and single-use calibration adapter
	993 nm	bIO Sample Chamber with 70 % IPA and single-use calibration adapter

Table 8. 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 9. Supplementary documentation

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