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Technical Information

Accessory optics for the Rxn-10 probe

KIO1, KNCO1, KLBIO1, KRSU1

Endress+Hauser
People for Process Automation

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Function and system design

Fields of application

The Rxn-10 Raman spectroscopic probe, powered by Kaiser Raman technology, 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 wide range of interchangeable, commercially available optics (immersion and non-contact) to meet the requirements of different applications.

Table 1 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.

Recommended applications for the optics include:

Optic	Fields of application
Immersion optic (KIO1)	• 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 (KNCO1)	• Polymer solids (pellets, films, or powders) • Pharmaceutical drug product manufacturing • Raw material identification • Meat or fish quality • Formulation optimization
bIO-Optic (KLBIO1)	• 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 (KRSU1)	• Cell culture: glucose, lactate, amino acids, cell density, titer • Fermentation: glycerol, methanol, ethanol, sorbitol, biomass

Table 1. Fields of application

Immersion optics: 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)

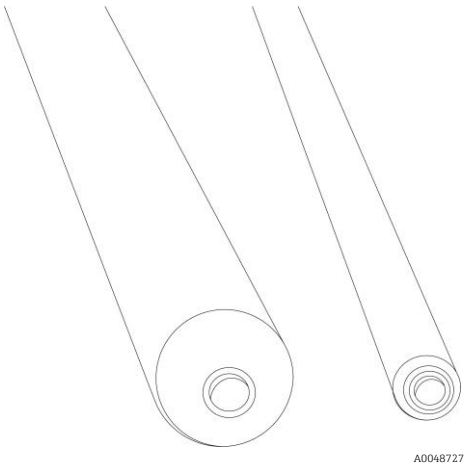

Figure 1. Tips of immersion optics with varying diameters

Immersion optics: data collection zone

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.

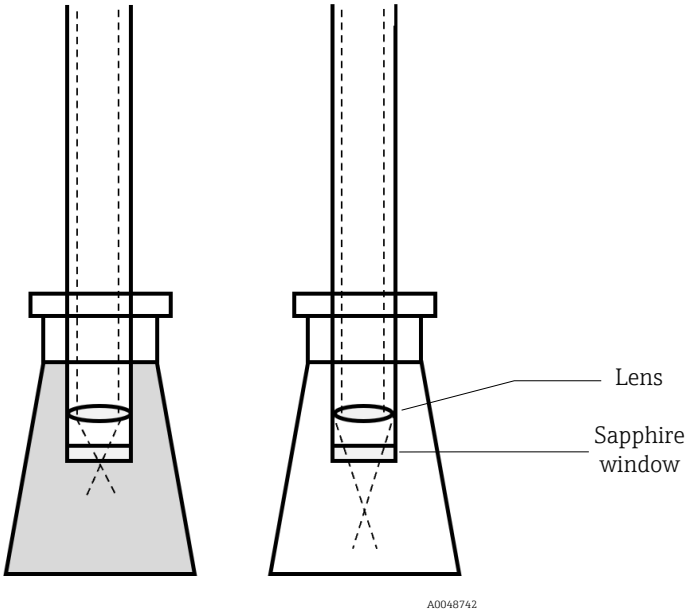

Figure 2. Short (left) vs. long (right) data collection zone

NOTICE

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

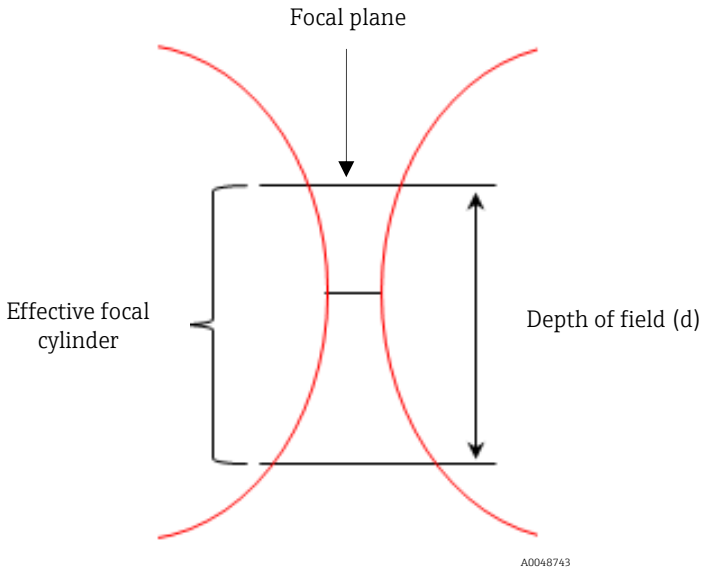

Figure 3. Effective focal cylinder

Non-contact optics

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.

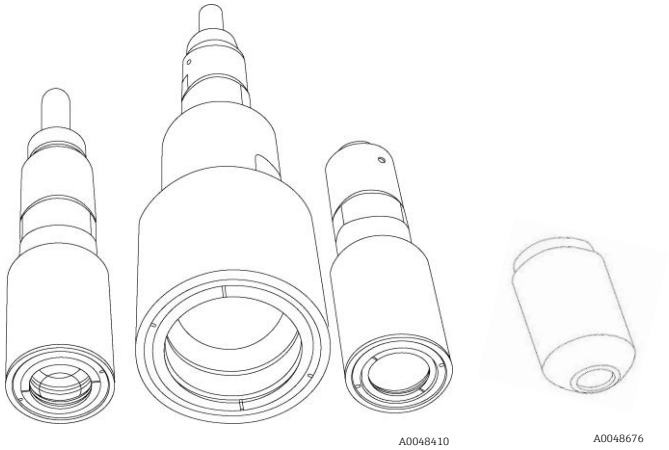

Figure 4. Non-contact optics in varying sizes

Non-contact-optics: 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 2. Non-contact optics

bIO-Optics

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.

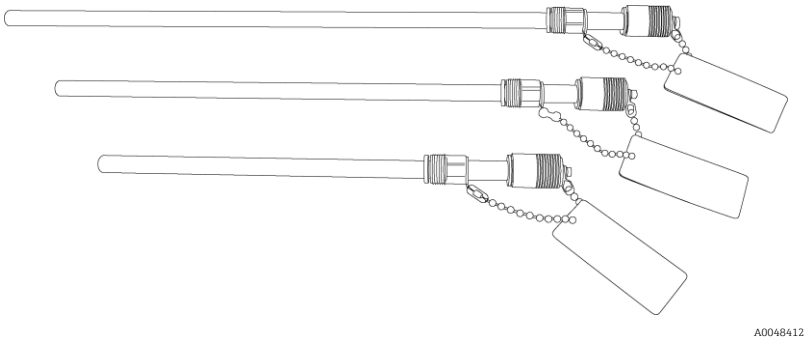

Figure 5. bIO-Optics in varying lengths

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.

bIO-Optics: 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.

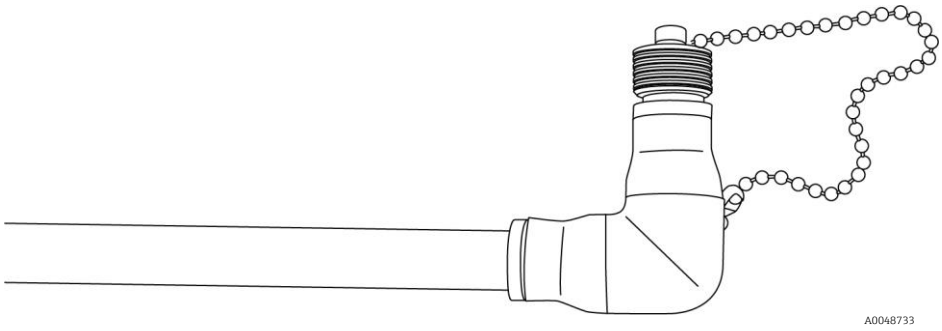

Figure 6. bIO-Optic with the bIO-Sample chamber

Raman optic system for single use

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 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.

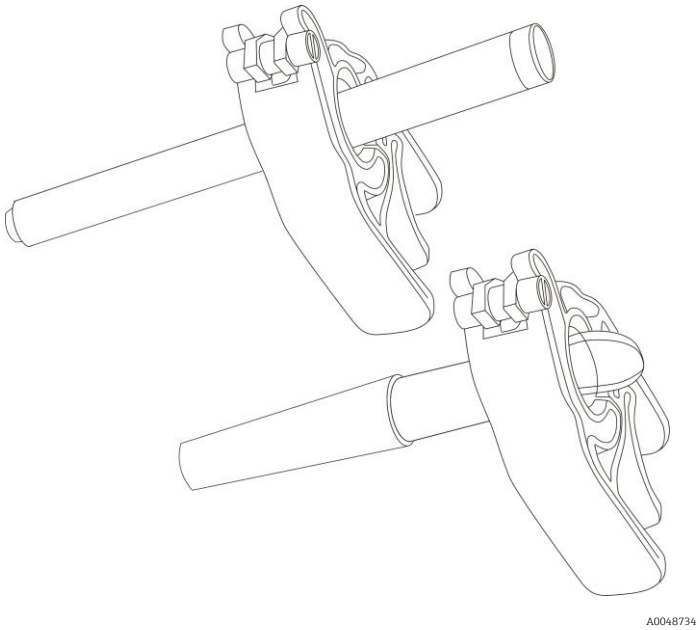

Figure 7. Reusable optic (top) and disposable fitting (bottom)

NOTICE

This system should NOT be used with hydrocarbon solvents (including ketones and aromatics).

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

NOTICE

The optic is NOT intended to be submerged into any liquid without being attached to the disposable fitting.

Specifications

Rxn-10 probe with accessory optics

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.

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 3. Immersion optic specifications

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 Table 2 →

Table 4. Non-contact optic specifications

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 5. bIO-Optic specifications

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 6. Raman optic system for single use specifications

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