TI01655C/66/EN/06.25
70231517

Technical Information

Rxn-40 Raman spectroscopic probe

System design and specifications

Application

The Raman Rxn-40 probe is a sealed immersion probe for *in situ* Raman spectroscopy of liquid-phase samples in a laboratory or process plant setting. The process connection for the Raman Rxn-40 can be swaged, compression-mounted, flange-mounted, or installed in an Endress+Hauser flow cell, and is NeSSI compatible. These versatile options allow for direct insertion in slip-streams, drain-valves, reactors, circulation loops, blend headers, and inlet or outlet pipework.

- **Chemical:** reaction monitoring, blending, catalysis, feed and final product monitoring
- **Polymer:** polymerization reaction monitoring, extrusion monitoring, polymer blending
- **Oil and gas:** any hydrocarbon analysis
- **Pharmaceutical:** Atmospheric pressure ionization (API) reaction monitoring, crystallization, polymorph, blending

Device properties

- C276 alloy, 316L stainless steel, or Grade 2 titanium
- High-purity sapphire

Your benefits

- Customizable to your process
- Robust design with a range of process connections
- *In situ*/no transfer lines or fast-loops required
- Faster, simpler installation
- Support for a range of chemical processes and corrosivity requirements
- Ensures safety and meets regulatory requirements
- Suitable for hazardous/classified environments

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Function and system design

Application

Using the device for any purpose other than that described may compromise personal safety, damage the measuring system, and invalidates any warranty.

Laser safety interlock

The Rxn-40 probe, as installed, forms part of the interlock circuit. If the fiber cable is severed, the laser will turn off within milliseconds of the breakage.

NOTICE

Permanent damage may result if cables are not routed appropriately.

- ▶ Handle probes and cables with care, ensuring they are not kinked.

Install fiber cables with a minimum bend radius according to the *Raman fiber-optic cables KFOC1 and KFOC1B Technical Information (TI01641C)*.

The interlock circuit is a low-current electrical loop. If the Rxn-40 probe is used in a classified area, the interlock circuit must be run through an intrinsically safe (IS) barrier.

Rxn-40 probe, non-flanged configuration

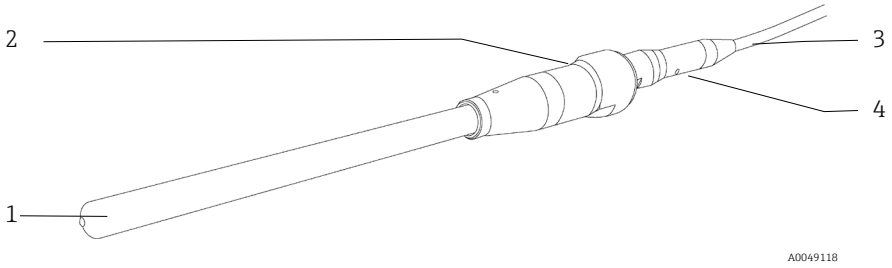


Figure 1. Non-flanged configuration with fiber channel cable

#	Name	Description
1	Tip	316L stainless steel, C276 alloy or Grade 2 titanium Immersible length of 152, 305, or 457 mm (6, 12, or 18 in)
2	Optic body	Materials matched to probe tip, but not wetted by process fluids
3	Fiber cable	Cable: PVC jacketed, proprietary construction Connections: proprietary electro-optic Connector body: 300-series stainless steel
4	LED laser indicator	Illuminated when the laser is energized

Laser emission indicator

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

- Straight configuration (Figure 1): The indicator is located on the assembly. When there is potential for the laser to be energized, the indicator light is illuminated.
- EO right-angle connector configurations (figures 2 to 4) The indicator is located on the fiber connection shell. When there is potential for the laser to be energized, the indicator light is illuminated.

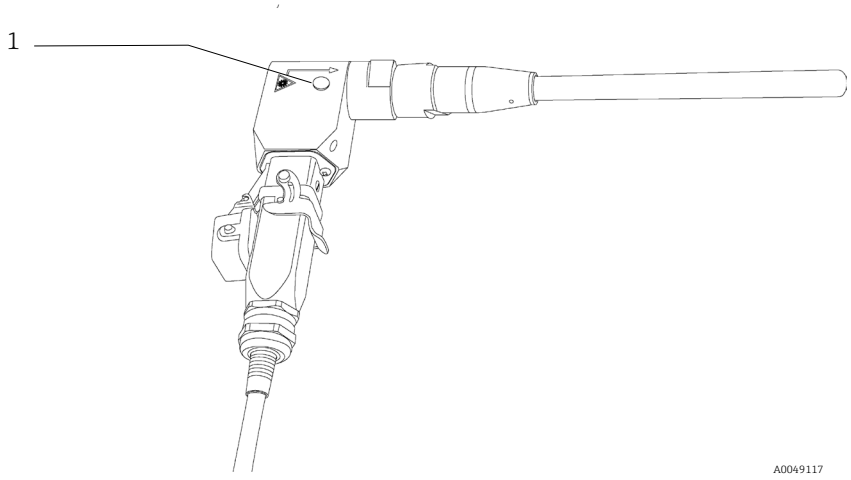


Figure 2. LED laser indicator (1) on right-angle EO fiber connector

Rxn-40 probe, flanged configuration

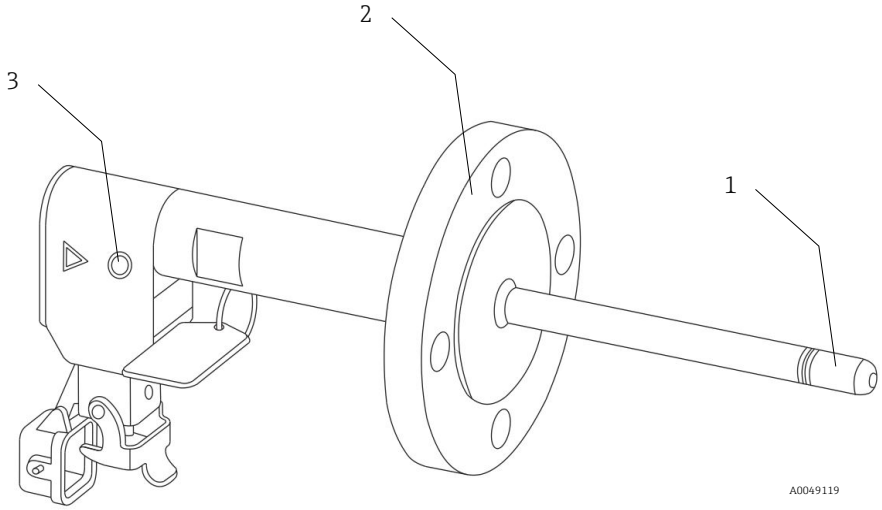


Figure 3. Flanged configuration of the Rxn-40 probe

#	Name	Description
1	Tip	316L stainless steel, C276 alloy or Grade 2 titanium Immersible length of 36 mm (1.42 in)
2	Flange	Flange for process connection (e.g. 316L, C276, Grade 2 titanium)
3	LED laser indicator	Illuminated when the laser is energized

Rxn-40 probe, mini configuration

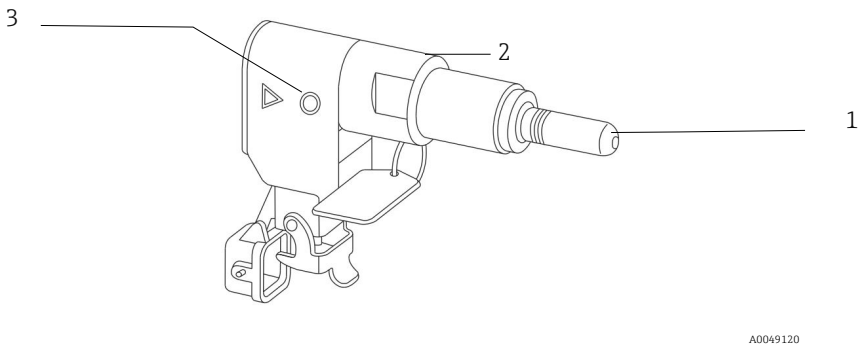


Figure 4. Mini configuration of the Rxn-40 probe

#	Name	Description
1	Tip	316L stainless steel, C276 alloy or Grade 2 titanium Immersible length of 36.07 mm (1.42 in)
2	Optic body	Materials matched to probe tip, but not wetted by process fluids
3	LED laser indicator	Illuminated when the laser is energized

Process and probe compatibility

Before installation, verify that the probe's pressure and temperature ratings, as well as its materials, are compatible with the process conditions.

The probes should be installed using sealing techniques (e.g., flanges, compression fittings) appropriate and typical for the vessel or piping.

WARNING

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

- A blow out protection device is highly recommended in accordance with local safety standards.
- It is the responsibility of the user to determine if any blow out protection devices are required and ensure they are attached to the probes during installation.

WARNING

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

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

Installation

Before installation in the process, the maximum amount of laser power output should be verified to ensure it is no more than the amount specified in the Hazardous Area Equipment Assessment (4002266) or equivalent.

Standard eye and skin safety precautions for Class 3B laser products (per EN 60825/IEC 60825-14) should be observed during installation. Additionally, observe the following:

WARNING	**Probes are designed with specific sealing boundaries.** ▶ The probe pressure specifications are only valid if sealing is accomplished on the intended sealing feature (shaft, flange, etc.). ▶ Service ratings may include limitations for fittings, flanges, bolts, and seals. The installer must understand these limitations and use appropriate hardware and assembly procedures for a pressure-tight and safe joint. **Standard precautions for laser products should be observed.** ▶ Probes should always be capped or pointed away from people toward a diffuse target if not installed in a sample chamber.
CAUTION	**If stray light enters an unused probe, it will interfere with data collected from a probe in-use and may cause calibration failure or measurement errors.** ▶ Unused probes should ALWAYS be capped to prevent stray light from entering the probe.
NOTICE	**Excessive twisting of the cable within the connector may break a fiber connection, rendering the Rxn-40 probe inoperable.** ▶ Take care to install the probe so that it measures the flowing sample or sample region of interest.

Data collection zone: short vs. long

The Rxn-40 probe comes with either a short (S) or a long (L) data collection zone depending on the version selected.

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

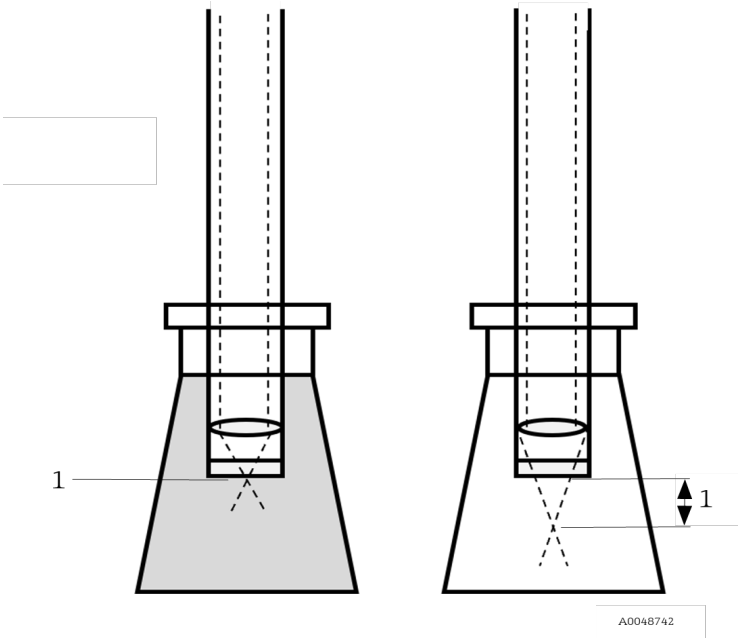


Figure 5. Short (left) vs. long (right) data collection zone (1)

Specifications

Temperature and pressure

The temperature and pressure specifications for the Rxn-40 probe vary depending on the materials of construction. In addition:

- Max pressure is calculated per ASME B31.3 2020 edition for material and probe geometry at the maximum rated temperature.
- Max service pressure ratings do not include the ratings of any fittings or flanges used to mount the probe into the process system. These items need to be independently evaluated and may lower the maximum service pressure of the probe.
- Minimum pressure rating: All probes have a minimum pressure rating of 0 bara (full vacuum). However, unless specified, they are not rated for low outgassing at high vacuum service.
- The temperature ramp is ≤ 30 °C/min (≤ 54 °F/min).

Component	Materials of construction	Min temp	Max temp	Max service pressure
Rxn-40 probe, ½″ diameter	316L stainless steel	−30 °C (−22 °F)	120 °C (248 °F)	142.4 barg (2066 psig)
	C276 alloy	−30 °C (−22 °F)	280 °C (536 °F)	158.1 barg (2293 psig)
	Grade 2 titanium	−30 °C (−22 °F)	315 °C (599 °F)	65.2 barg (946 psig)
Rxn-40 probe, ¾″ diameter	316L stainless steel	−30 °C (−22 °F)	120 °C (248 °F)	169.5 barg (2458 psig)
	C276 alloy	−30 °C (−22 °F)	280 °C (536 °F)	182.8 barg (2651 psig)
	Grade 2 Titanium	−30 °C (−22 °F)	315 °C (599 °F)	72.2 barg (1047 psig)
Rxn-40 probe, 1″ diameter	316L stainless steel	−30 °C (−22 °F)	120 °C (248 °F)	169.5 barg (2458 psig)
	C276 alloy	−30 °C (−22 °F)	280 °C (536 °F)	182.8 barg (2651 psig)
	Grade 2 titanium	−30 °C (−22 °F)	315 °C (599 °F)	72.2 barg (1047 psig)
Rxn-40 probe, mini configuration	316L stainless steel	−30 °C (−22 °F)	120 °C (248 °F)	157.1 barg (2279 psig)
	C276 alloy	−30 °C (−22 °F)	150 °C (302 °F)	199.3 barg (2890 psig)
	Grade 2 titanium	−30 °C (−22 °F)	150 °C (302 °F)	153.6 barg (2228 psig)
Cable and connector	Cable: PVC jacketed, proprietary construction Connections: proprietary electro-optic	−40 °C (−40 °F)	70 °C (158 °F)	Not applicable

Flange temperature and pressure

The temperature specifications for probe flanges vary depending on the material of construction. The maximum pressure rating of a probe flange varies with the maximum rated temperature. Flanges with different materials of construction are covered under different standards, as indicated in the table below.

Flange ratings may be different than the probe ratings. The rating for any probe with a flange shall be the lower of the rating for the probe and the flange. Any hydrostatic or other testing shall be performed at the pressure rating of the limiting component.

The Rxn-40 probe, mini configuration, is not available with a process flange connection.

Materials of construction	Min temp	Max temp	Class	Max service pressure
ASME B16.5-2018 flange ratings				
316L stainless steel	−30 °C (−22 °F)	120 °C (248 °F)	150	12.8 barg (185 psig)
			300	33.4 barg (484 psig)
			600	66.9 barg (970 psig)
C276 alloy	−30 °C (−22 °F)	280 °C (536 °F)	150	10.9 barg (158 psig)
			300	44.2 barg (642 psig)
			600	88.5 barg (1283 psig)
ASME BPVC VIII.1-2021, Appendix 2 flange ratings				
Grade 2 titanium	−30 °C (−22 °F)	316 °C (600 °F)	150	6.2 barg (90 psig)
			300	16.2 barg (235 psig)
			600	32.3 barg (469 psig)
DIN EN 1092-1:2013-04 flange ratings				
316L stainless steel	−30 °C (−22 °F)	120 °C (250 °F)	10	9.0 barg (130 psig)
			16	14.5 barg (210 psig)
			25	22.7 barg (329 psig)
			40	36.4 barg (527 psig)

General specifications

General specifications for the Rxn-40 probe are listed below.

Item		Description
Laser wavelength		532 nm, 785 nm, or 993 nm
Spectral coverage		probe spectral coverage is limited by the coverage of the analyzer being used
Maximum laser power into probe		< 499 mW
Ambient temperature		Nonexplosive environments: -30 to 150 °C / -22 to 302 °F Explosive environments: T4: –20 to 70 °C / –4 to 158 °F T6: –20 to 65 °C / –4 to 149 °F Limited to normal ambient temperature IEC 60079-0 for Korea
Operating humidity		up to 95 % relative humidity, non-condensing
Probe body purge		helium
Probe body hermeticity		purge helium leak rate < 1×10^{-7} mbar·L/s
Chemical resistance		limited by materials of construction
Window material		high-purity sapphire
Working distance from probe exit		short: 0 mm (0 in) long: 3 mm (0.12 in)
IEC 60529 for (EO) right angle connector		IP65
IEC 60529 for (EO) straight stainless steel connector		IP65
North American TYPE rating for (EO) right angle connector		TYPE 13[1]
Probe immersible length	Rxn-40 non-flanged configuration	Standard lengths: 152, 305, or 457 mm (6, 12, or 18 in) Grade 2 titanium: 150 to 350 mm (5.9 to 13.8 in)
	Rxn-40 flanged configuration	150 to 380 mm (5.9 to 15.0 in)
	Rxn-40 mini configuration	36 mm (1.42 in)
Immersion shaft outer diameter	Rxn-40 non-flanged configuration	12.7 mm (0.5 in) standard; custom diameters may be available
	Rxn-40 flanged configuration	12.7, 19.05, or 25.4 mm (0.5, 0.75, or 1 in) standard; custom diameters may be available
	Rxn-40 mini configuration	12.7 mm (0.5 in) standard; custom diameters may be available

[1] This is a self-declaration of conformance to UL 50E TYPE 13 requirements. It does not constitute UL certification or authorization to use the UL mark.

All fiber-optic cable specifications can be found in the *Raman fiber-optic cables KFOC1 and KFOC1B Technical Information (TI01641C)*.

Maximum permissible exposure (MPE): ocular exposure

The ANSI Z136.1 standard provides means to perform MPE for ocular exposure. Please refer to the standard to calculate the relevant MPE levels for the case of laser exposure from the Rxn 40 probe and from the unlikely occurrence of laser exposure from a broken optical fiber.

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

MPE for point source ocular exposure to a laser beam				
Wavelength ***λ (nm)***	**Exposure duration** ***t (s)***	**MPE calculation**		***C_A***
		(J·cm^{-2})	***(W·cm^{-2})***	
785 and 993	10^{-13} to 10^{-11}	$1.5\ C_A \times 10^{-8}$	-	785: $C_A = 1.479$ 993: $C_A = 3.855$
	10^{-11} to 10^{-9}	$2.7\ C_A\ t^{0.75}$	-	
	10^{-9} to 18×10^{-6}	$5.0\ C_A \times 10^{-7}$	-	
	18×10^{-6} to 10	$1.8\ C_A\ t^{0.75} \times 10^{-3}$	-	
	10 to 3×10^{4}	-	$C_A \times 10^{-3}$	

MPE: skin exposure

Refer to the table below from the ANSI Z136.1 standard to calculate the MPE for skin exposure to a laser beam.

MPE for skin exposure to a laser beam				
Wavelength ***λ (nm)***	**Exposure Duration** ***t (s)***	**MPE Calculation**		***C_A***
		(J·cm^{-2})	***(W·cm^{-2})***	
532, 785, and 993	10^{-9} to 10^{-7}	$2\ C_A \times 10^{-2}$	-	532: $C_A = 1.000$ 785: $C_A = 1.479$ 993: $C_A = 3.855$
	10^{-7} to 10	$1.1\ C_A\ t^{0.25}$	-	
	10 to 3×10^{4}	-	$0.2\ C_A$	

Nominal hazard zone

Use the information below to calculate the nominal hazard zone at the tip of the probe. Refer to the applicable Raman Rxn2 or Raman Rxn4 analyzer operating instructions for analyzer-specific information regarding nominal hazard zone calculations.

Beam diameter (b_0)	Focal length (f_0)	Nominal ocular hazard distance (NOHD) equation
5 mm (0.20 in)	9 mm (0.35 in)	$r_{NOHD} = (f_0/b_0)(4\Phi/\pi MPE)^{1/2}$ Φ = Laser power output in Watts

Materials of construction

Materials of construction for the Rxn-40 probe are listed below.

Material	Version		
	C276 alloy [UNS N10276]	**316L [UNS S31603]**	**Titanium [UNS R50400]**
Wetted	C276 alloy	316L stainless steel	Grade 2 titanium
	high-purity sapphire	high-purity sapphire	high-purity sapphire
Non-wetted	C276 alloy	316L stainless steel	Grade 2 titanium
	316/316L stainless steel	316/316L stainless steel	316/316L stainless steel
	303/304 stainless steel	303/304 stainless steel	303/304 stainless steel
	oxygen-free copper	oxygen-free copper	oxygen-free copper
	high temperature epoxy	high temperature epoxy	high temperature epoxy

Certificates and approvals

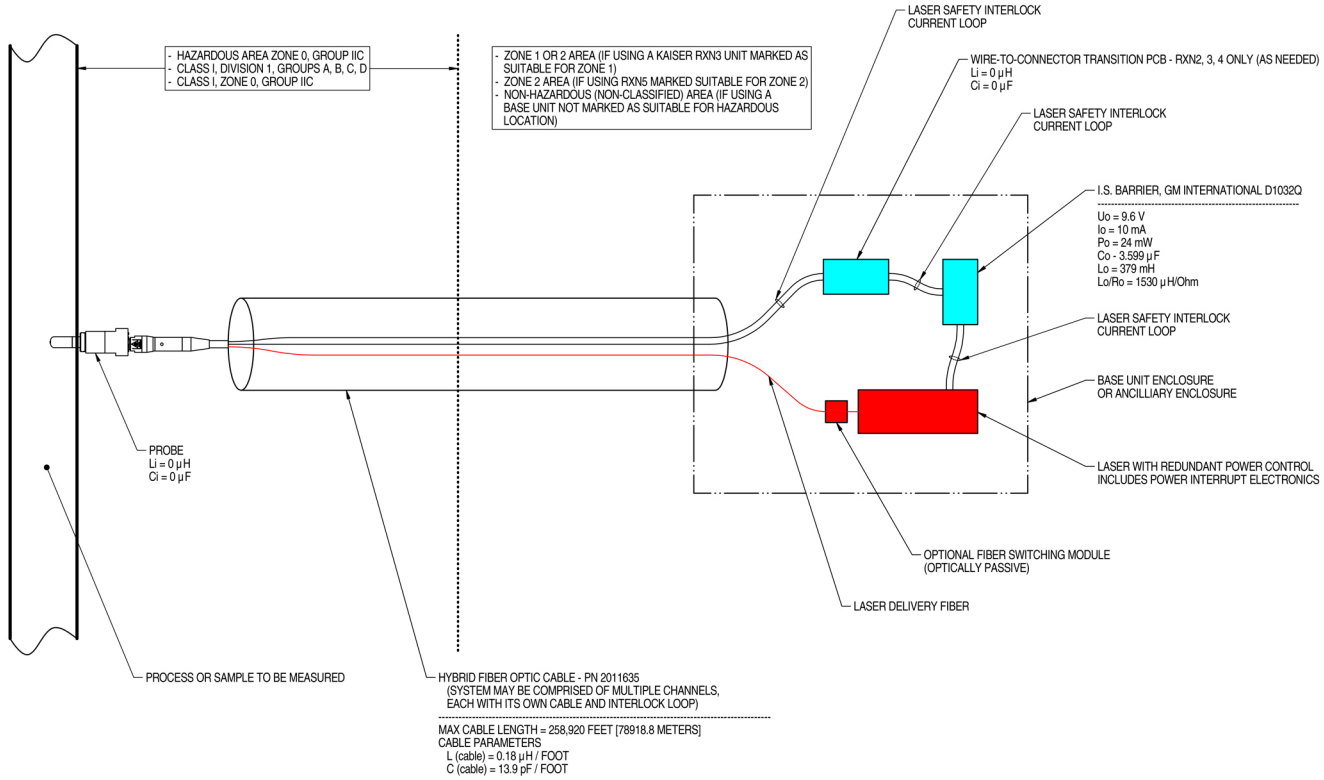
Hazardous area approvals

Refer to the *Rxn-40 Raman spectroscopic probe Safety Instructions (XA02749C)* manual for detailed certification and approval information.

Certifications and markings

Endress+Hauser offers certifications for the Rxn-40 probe to the standards. Upon purchase, ensure the desired certification(s) are selected to obtain appropriately marked probe tags. Select the desired certification(s) and the probe or probe tag is marked accordingly. Refer to *Rxn-40 Raman spectroscopic probe Safety Instructions (XA02749C)* documentation for more information about certifications.

Hazardous area drawing The Hazardous Area Installation Drawing (4002396) is shown below.



NOTES:

1. CONTROL EQUIPMENT CONNECTED TO THE ASSOCIATED APPARATUS MUST NOT USE OR GENERATE MORE THAN 250 VRMS OR VDC.
2. INSTALLATION IN THE U.S. SHOULD BE IN ACCORDANCE WITH ANSI/ISA RP12.6 "INSTALLATION OF INTRINSICALLY SAFE SYSTEMS FOR HAZARDOUS (CLASSIFIED) LOCATIONS" AND THE NATIONAL ELECTRICAL CODE® (ANSI/NFPA 70) SECTIONS 504 AND 505.
3. INSTALLATION IN CANADA SHOULD BE IN ACCORDANCE WITH THE CANADIAN ELECTRICAL CODE, CSA C22.1, PART 18, APPENDIX J18.
4. ASSOCIATED APPARATUS MANUFACTURER'S INSTALLATION DRAWING MUST BE FOLLOWED WHEN INSTALLING THIS EQUIPMENT.
5. FOR U.S. INSTALLATIONS, THE PROBE MODELS RXN-30 (AIRHEAD), RXN-40 (WETHEAD) AND RXN-41 (PILOT) ARE APPROVED FOR CLASS I, ZONE 0 APPLICATIONS.
6. NO REVISION TO DRAWING WITHOUT PRIOR CSA APPROVAL.
7. WARNING: SUBSTITUTION OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY.

A0049010

Figure 6. Hazardous Area Installation Drawing (4002396 version X6)

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