Technical Information

Fiber-optic cables

Innovative Raman fiber optics designed for maximum laser safety and easy installation

Endress+Hauser

People for Process Automation

Table of Contents

Function and system design

Introduction

Fiber-optic cables revolutionized Raman spectroscopy by allowing Raman sampling probes to be located remotely from a base unit. This enabled Raman spectra to be acquired in hazardous environments from samples that cannot be easily transported to a sampling chamber. Consequently, Raman spectroscopy entered several new arenas including the industrial process line, where the base unit is placed in a control room or other protected environment while the Raman probe is placed in the process line for real-time, *in situ* process monitoring and control.

In the majority of state-of-the-art remote dispersive Raman systems, the excitation radiation is delivered from the laser to the Raman probe through a single excitation fiber. The scattered radiation that is collected from the sample is delivered to the spectrograph through a single collection fiber.

Optical fibers are constructed of a low-hydroxyl silica core surrounded by a flourine-doped silica cladding and a protective acrylate buffer coating (this 3-layer fiber is typically formed in a single "draw" manufacturing operation). The outer packaging of the cable may vary depending on the application. Fibers intended for industrial and laboratory applications often place a tight polymer buffer on the fiber or run through a loose polymer tube. Such fiber subassemblies can then be packaged into a composite industrial grade cable with a robust polymer outer jacket containing other such optical fiber subassemblies, electrical wires, and a rigid strength member.

Raman cables

All Endress+Hauser Raman probes use standard cables comprised of an integrated fiber cable assembly containing an excitation fiber and a collection fiber packaged in a robust polyvinyl chloride (PVC) jacket to prevent breakage. Endress+Hauser Raman fiber-optic probes also have integrated the laser interlock into the probe termination for improved laser safety. If the cable is severed, the laser switches off within milliseconds, preventing laser light from being dispersed into the environment.

Endress+Hauser's standard fiber cables are indoor/outdoor, fiber-optic cables. These cables are also fully rated for flame/UV resistance and pull strength, maximizing their safety in the process environment. Endress+Hauser Raman fiber cables are suitable for use in a variety of environments including direct burial, underground ducts, aerial installations, steam tunnels, building risers, cable trays, and harsh industrial settings. Consult your local laws and regulations to ensure compliance with cable installation requirements for your specific environment.
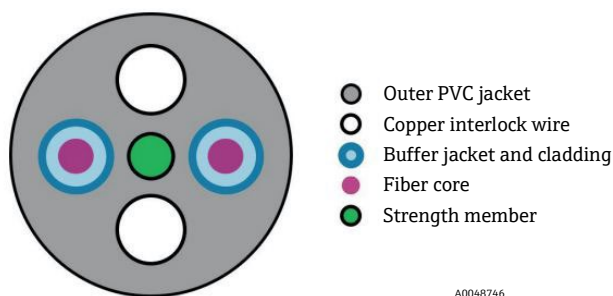

- Outer PVC jacket
- Copper interlock wire
- Buffer jacket and cladding
- Fiber core
- Strength member

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Figure 1. Cross section of a Raman fiber-optic cable

Specifications

General

The specifications for fiber-optic cables are listed below:

Item	Description
General features	Integrated copper conductor wire for interlock capability Aramid (Kevlar) internal strength members Flame retardant Fungus resistant
Cable rating (cable only)	Operating temperature: −40 °C to 70 °C (−40 °F to 158 °F) Storage temperature: −55 °C to 70 °C (−67 °F to 158 °F) Certified: CSA-C/US AWM I/II, A/B, 80C, 30V, FTI, FT2, VW-1, FT4 Rated: AWM I/II A/B 80C 30V FT4
Bend radius	152.4mm (6 in)
Termination	Electro-optic connectors

Cable types

Fiber-optic cables with different connectors are available to connect various Raman probes and Raman Rxn analyzers. A list of commonly used fiber cables is provided below.
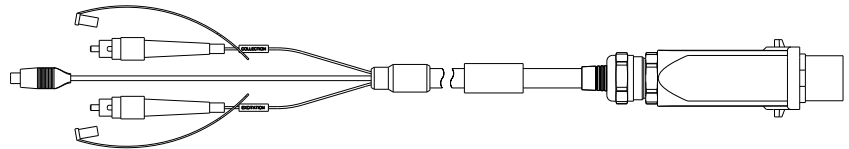
KFOC1-BD?
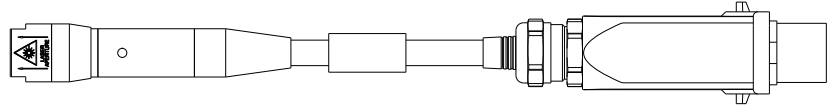
Figure 2. KFOC1-BD?

> **NOTICE**

▶ The question mark in KFOC1-BD**?** is either A, B, C, D, or Y depending on the length in m.

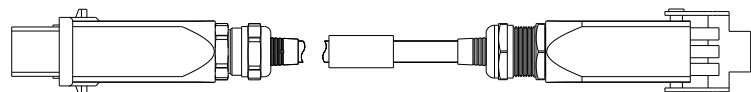| Analyzer	Probe	Description	Standard Length
Raman Rxn2 Raman Rxn4 Raman Rxn5	Raman Rxn-10 Raman Rxn-30 Raman Rxn-40 Raman Rxn-40 mini	FOCA, EO(M)/SSCS, XXXM – Specification: Electro/Optical Cable; Length = XXX M; Connectors = EO (M) to SSCS	No standard length (limited by application)

KFOC1-AB?

Figure 3. KFOC1-AB?

> **NOTICE**

The question mark in KFOC1-AB**?** is either A, B, C, D, or Y depending on the length in m.

Analyzer	Probe	Description	Standard Length
Raman Rxn2, Raman Rxn4, Raman Rxn5, Legacy Rxn products	Probes that accept EO connectors; Probes that accept FC connectors	FOCA, EO(M)/FC, XXXM – Specification: Electro/Optical Cable; Length = XXX M; Connectors = EO (M) to FC	5 to 200 m (16.4 to 656.17 ft) in 5 m increments (limited by application)

> **NOTICE**

▶ This fiber-optic cable is compatible with some legacy Rxn products.
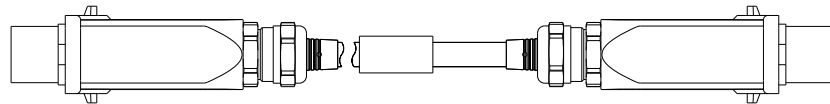
KFOC1-BC?

Figure 4. KFOC1-BC?

> **NOTICE**

The question mark in KFOC1-BC**?** is either A, B, C, D, or Y depending on the length in m.

Analyzer	Probe	Description	Standard Length
Raman Rxn2, Raman Rxn4, Raman Rxn5	Probes that accept EO connectors	FOCA, EO(M)/EO(F), XXXM – Specification: Electro/Optical Cable; Length = XXX M; Connectors = EO (M) to EO (M)	5 to 200 m (16.4 to 656.17 ft) in 5 m increments (limited by application)

KFOC1-BB?

Figure 5. KFOC1-BB?

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NOTICE

▶ The question mark in KFOC1-BB**?** is either A, B, C, D, or Y depending on the length in m.

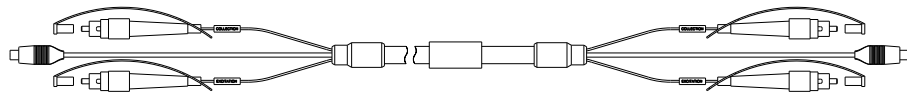| Analyzer	Probe	Description	Standard Length
Raman Rxn2, Raman Rxn4, Raman Rxn5	Probes that accept EO connectors	FOCA, EO(M)/EO(M), XXXM – Specification: Electro/Optical Cable; Length = XXX M; Connectors = EO (M) to EO (M)	5 to 200 m (16.4 to 656.17 ft) in 5 m increments (limited by application)

KFOC1-AA?

Figure 6. KFOC1-AA?

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NOTICE

▶ The question mark in KFOC1-AA**?** is either A, B, C, D, or Y depending on the length in m.

Analyzer	Probe	Description	Standard Length
Legacy Rxn platforms	Probes that accept FC connectors	FOCA, FC/FC, CSA, XXXM – Specification: Electro/Optical Cable; Length = XXX M; CSA-Rated; Connectors = FC to FC	5 to 200 m (16.4 to 656.17 ft) in 5 m increments (limited by application)

NOTICE

▶ This fiber-optic cable is compatible with some legacy Rxn products.

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