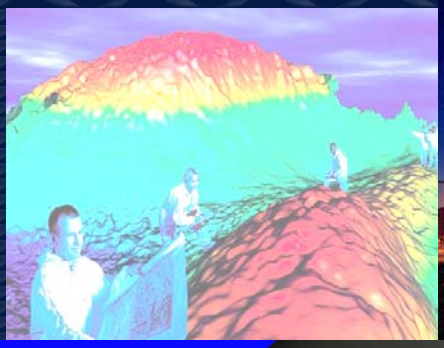
Amphenol Spectra-Strip

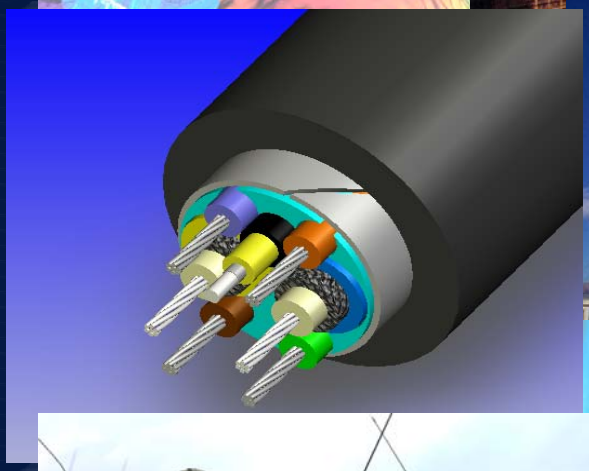
Fiber Optics

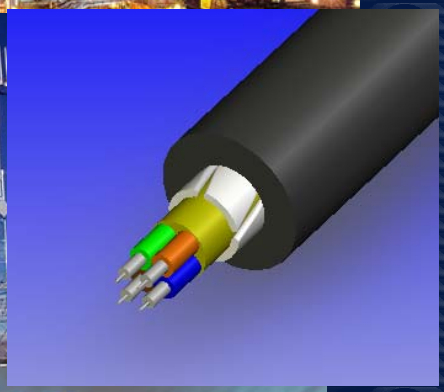
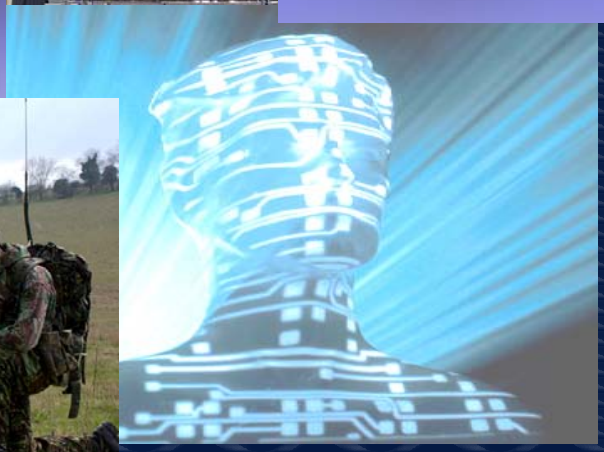
720 Sherman Avenue, Hamden CT, 06514 USA

161/162/163 Series

Ruggedized Fiber Optic Cables for Harsh Outdoor Environments






Amphenol Spectra-Strip

Fiber Optics

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Introduction

Amphenol Corporation is a world leader in harsh environment Interconnect systems. The Spectra-Strip division has been engineering high performance bulk cables for more than 30 years. The division has developed and deployed worldwide a comprehensive range of fiber optic cables specifically to meet the various harsh environments encountered in outdoor applications.

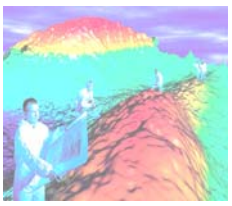
161 and 162 Series Harsh Environment Cables

Designed primarily for the Military, Petro-Chemical, Geo-Physics, and WiMAX, markets.
:

Military Used in field deployable communications and data links. Radiation resistant fibers are tested according to TIA/EIA 455-64 (Procedures for Measuring Radiation- Induced Attenuation in Optical Fibers), and comply or exceed the ITU recommendations G.651 and IEC 60793-2-10 Optical Fiber Specifications. Amphenol Military Tactical Cables are CECOM certified. (See CECOM Document A3302584)

Petro-Chemical Harsh environments characterize petrochemical applications. Cables in these locations require additional protective properties. Our cable designs having reduced friction, high tensile strength and water blocking contribute to a long cable service life.

Geo-Physics Used in seismic analysis and oil field exploration. On land or sea, the methods of cable deployment can be harsh. Spectra-Strip's cable is manufactured with the high abrasion and cut through resistance this market requires.



WiMAX Used for antenna signal and power. A high level of UV resistance is required for tower applications, as well as water blocking to prevent water damage in the cable. Our designs incorporate an OFNR rating and LSHF constructions for when one end is terminated in a control room.

Amphenol Spectra-Strip

Fiber Optics

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161 and 162 Series General Cable Specifications

Complies to the following Standards:

- CECOM A3159879
- IEC 60794-1
- Def-Stan 60-1 (UK Military)

Radiation Resistance (if applicable)	MIL-PRF-49291/7 (SMF) / 1 (50um) / 6 (62.5) or the more generic TIA-EIA 455-64.
Fiber Count	2 or 4
Fiber Color Coding	TIA 598-C or customer request.
Cable Marking	Part number and length per customer option
Max Weight	161 Series: 21 lb/kft; 162 Series: 30 lb/kft
Temperature Range	Polyurethane: - 60°, + 85° C
	Low Smoke Hal-Free: -40°, + 85° C
	Spectraploy: - 60°, + 85° C
Operating Tensile Strength	1000 lbs (TIA-455-33-B)
Crush Resistance.	>2000N/cm (EIA/TIA-455-41)
Abrasion	1000 strokes at 85°C (Polyurethane Jackets only)
Impact	100 Impacts (DOD-STD-1678, Method 2030)
Min Bend Radius	Long Term: 5X Cable OD; Installation: 10X Cable OD
Cyclic Flexing	2000 cycles @ -46°C, +25°C, +71°C (DOD-STD-1678, Method 2010, Procedure II)
Tear Resistance	96N/mm (Polyurethane Jackets only)
Cold Bend tests	Exceeds requirements at – 47°C (DOD-STD-1678, Method 2020, Procedure III)
UV Aging	No change in tensile after 800 hours exposure in Xenon Weatherometer Test
Fungus	No growth after 28 days exposure (MILSTD-810F, Method 508.5)
Flammability	Polyurethane Jackets: Passes 60° Angle Flammability Test per MIL-PRF-85045F Low Smoke Hal-Free Jackets: UL OFNR Riser Rated
Connector Retention	Used with military tactical field connectors for max connector retention (1000 lbs)
Color	Black Matte (Standard) High gloss finish available upon request

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161 and 162 Series Optical Characteristics

Characteristics	FIBER TYPE		
	SMF	50um MMF	62.5um MMF
Compliance	ITU G.652.B IEC 60793-2-50	ITU G.651 IEC 60793-2-10	ITU G.651 IEC 60793-2-10
Core Diameter	MFD @ 1310nm = 9.2um +/- 0.4 MFD @ 1550nm = 10.5um +/- 0.8	50µm ± 2.5	62.5 µm +/- 2.5
Cladding Diameter	125 µm ± 1.0	125 µm ± 1.0	125 µm +/- 1.0
Coating Diameter	500 µm ± 15	500 µm ± 15	500 µm +/- 15
Buffer Diameter	900 µm ± 50	900 µm ± 50	900 µm +/- 50
Clad Non-Circularity	1% Max	1% Max	1% Max
Core/Clad Concentricity Error	0.8um Max	1.5um Max	1.5um Max
Coating/Clad Concentricity Error	10.0um Max	10.0um Max	10.0um Max
Buffer Material	Hard Elastomer	Hard Elastomer	Hard Elastomer
Buffer Concentricity	80% Min	80% Min	80% Min
Numerical Aperture	N/A	0.230 ± 0.15	0.275 ± 0.15
Fiber Prooftest	≥ 690 MPa	≥ 690 MPa	≥ 690 MPa
Attenuation @1310nm @1550nm	≤1.0 dB/km ≤1.0 dB/km	N/A	N/A
Attenuation @ 850nm @ 1300nm	N/A	≤3.50 dB/km ≤1.25 dB/km	≤3.50 dB/km ≤1.25 dB/km
Overfill Bandwidth* @ 850nm @1300nm	N/A	 ≥500MHz·km ≥500MHz·km	 ≥300MHz·km ≥600MHz·km
RML/EMB$_c$ Bandwidth* @ 850nm @ 1300nm	N/A	 ≥500MHz·km ≥600MHz·km	 ≥385MHz·km ≥700MHz·km
Chromatic Dispersion @ 1310nm @ 1550nm	 ≤3 ps/nm/km ≤18 ps/nm/km	N/A	N/A

*Enhanced Bandwidth Options available for Multimode Fiber Cables

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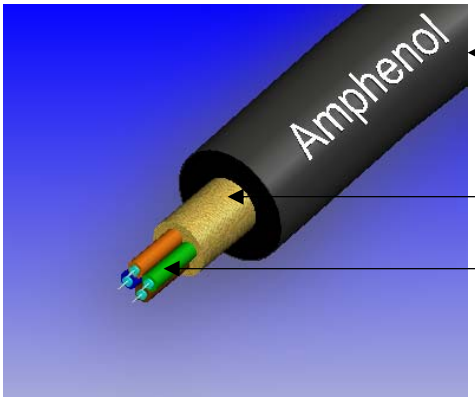
Standard 161 Series Harsh Environment Distribution Cables

Part Number	Optical Fibers	Radiation Hardened	Fiber Construction (µm)	Cable Diameter	Jacket Material
161-0100-002	2 SM	N	9/125/500/900	5.0mm	Polyurethane FR
161-0100-004	4 SM	N	9/125/500/900	5.5mm	Polyurethane FR
161-0200-002	2 SM	Y	9/125/500/900	5.8mm	Polyurethane FR
161-0200-004	4 SM	Y	9/125/500/900	5.8mm	Polyurethane FR
161-0300-002	2 MM	N	50/125/500/900	5.8mm	Polyurethane FR
161-0300-004	4 MM	N	50/125/500/900	5.8mm	Polyurethane FR
161-0400-002	2 MM	Y	50/125/500/900	5.8mm	Polyurethane FR
161-0400-004	4 MM	Y	50/125/500/900	5.8mm	Polyurethane FR
161-0500-002	2 MM	N	62.5/125/500/900	5.0mm	Polyurethane FR
161-0500-004	4 MM	N	62.5/125/500/900	5.5mm	Polyurethane FR
161-0505-002	2 MM	N	62.5/125/500/900	5.8mm	LSHF
161-0505-004	4 MM	N	62.5/125/500/900	5.8mm	LSHF
161-0600-002	2 MM	Y	62.5/125/500/900	5.8mm	Polyurethane FR
161-0600-004	4 MM	Y	62.5/125/500/900	5.8mm	Polyurethane FR

Note: All cable is available with optional Fluid Penetration Resistance, complying with EIA/TIA 455-82B. In applications that do not require the highest level of abrasion resistance and toughness an optional lower cost Spectraploy® jacket is available. Contact your Spectra-Strip representative for details.



161 series Distribution Cable

Mining

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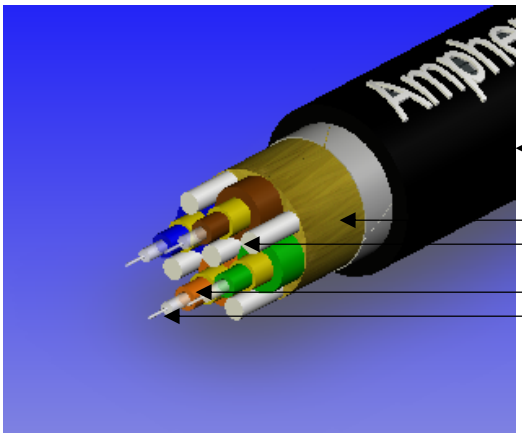
Standard 162 Series Harsh Environment Breakout Cables

Part Number	Optical Fibers	Radiation Hardened	Fiber Construction (µm)	Sub-Unit Jacket Material	Cable Diameter	Jacket Material
162-0100-202	2	N	9/125/500/900	PE	6.5mm	Polyurethane FR
162-0100-204	4	N	9/125/500/900	PE	7.0mm	Polyurethane FR
162-0200-202	2	Y	9/125/500/900	PE	6.5mm	Polyurethane FR
162-0200-204	4	Y	9/125/500/900	PE	7.0mm	Polyurethane FR
162-0300-202	2	N	50/125/500/900	PE	6.5mm	Polyurethane FR
162-0300-204	4	N	50/125/500/900	PE	7.0mm	Polyurethane FR
162-0400-202	2	Y	50/125/500/900	PE	6.5mm	Polyurethane FR
162-0400-204	4	Y	50/125/500/900	PE	7.0mm	Polyurethane FR
162-0500-202	2	N	62.5/125/500/900	PE	6.5mm	Polyurethane FR
162-0500-204	4	N	62.5/125/500/900	PE	7.0mm	Polyurethane FR
162-0600-202	2	Y	62.5/125/500/900	PE	6.5mm	Polyurethane FR
162-0600-204	4	Y	62.5/125/500/900	PE	7.0mm	Polyurethane FR

Note: All cable is available with optional Fluid Penetration Resistance, complying with EIA/TIA 455-82B. Jacket options include LSHF and Spectraploy®. Contact your Spectra-Strip Representative for details



162 Series Breakout Cable

WiMAX antennas signal and power

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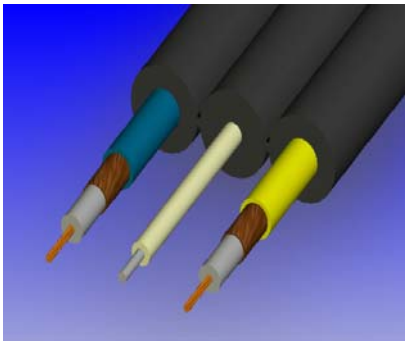
163 Series Hybrid Cables

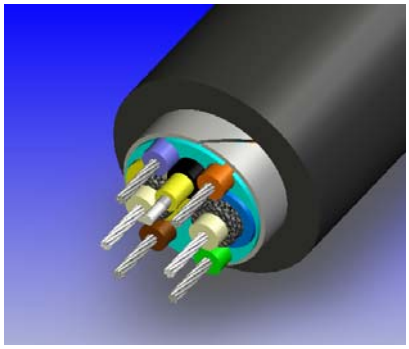
The 163 Series Cables are special designs with unique features developed for specific applications. These cables vary from low cost versions of existing 161 & 162 cables where applications do not require the highest level of mechanical performance, and cost is major consideration, to cables where superior optical performance is required. Variants include cables incorporating various fiber sizes, coatings of 245µm or 500 µm, heavily plasticized polyurethane for increased flexibility, fluid penetration resistance, rodent resistance and underwater applications.

Hybrid cables are also offered with a combination of optical fibers and copper electrical conductors, either power or data. Hybrid cables by their nature are special designs unique for a specific application.

163 Series Hybrid Copper / Fiber Examples



163-0899-998 Medical Sensor Cable, Hybrid Tri-Cord Zip with (1) 300/330/650 Step Index Multimode optical fiber and (2) 32 awg shielded copper singles. Medical Grade PVC Jacket, 65 Shore A.



163-0899-999 Medical Umbilicus Cable with (1)300/330/650 Breakout Optical Sub-Unit, (2) 30 awg Coax and (4) 28 awg TC singles. Medical Grade PVC Jacket, 85 Shore A.

Patient Monitoring

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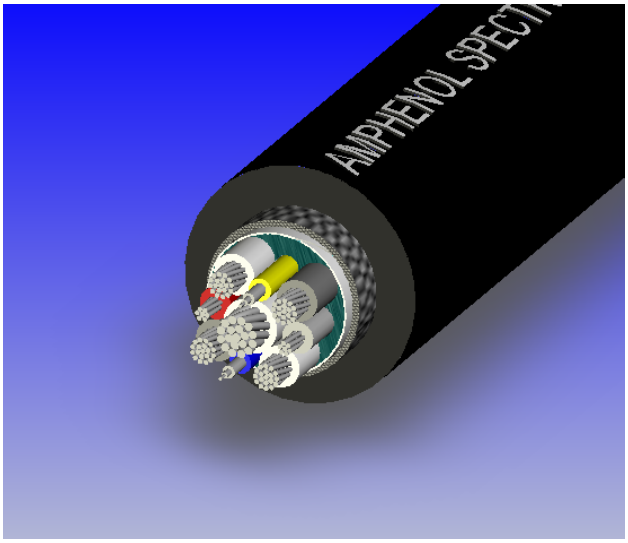
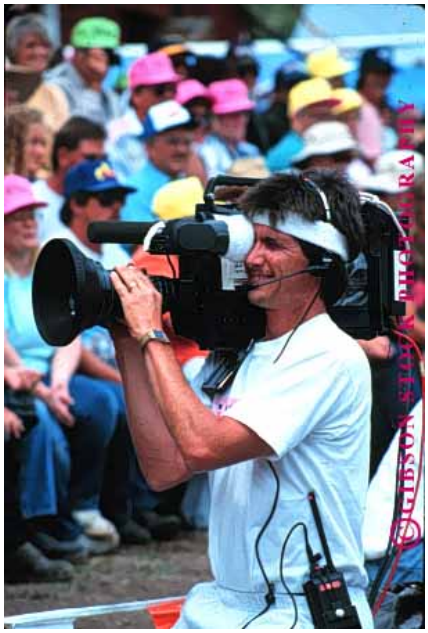
SMPTE Camera Cable
163-0199-999

Designed for HDTV broadcast camera interconnections, Spectra-Strip's SMPTE cable is a precision outdoor hybrid copper / fiber optic cable containing single-mode optical fibers and electrical conductors to convey video, audio, and control signals in a variety of environments where moisture, weather, and ozone resistance are required. It is designed to be used in conjunction with the SMPTE 304M connector interface standard. Cable consists of two tight, Hytrel buffered, single-mode optical fibers, four 20 AWG (19x32) and two 24 AWG (7x32) tinned copper conductors, insulated with PVC. These are cabled around a jacketed stranded galvanized steel strength member, with an overall 80% coverage tinned copper braid, and a tough, but flexible TPE jacket. These cables are compliant with SMPTE 311M.



SMPTE-311M Composite Single Mode Fiber Optic Camera Cable



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SMPTE Specifications

General Specifications		Optical Specifications	
Conductor	(4) 20 AWG TC 19/32 (2) 24 AWG TC 7/32	Attenuation	.8dB / km max @1310 and 1550nM
Conductor insulation	PVC	Proof test	100 min kpsi
Filler type	Fibrulated Polypropylene	MFD	9.5±1 µM
Center strength member	19 strand galvanized steel	Cladding OD	125 ± 1 µM
CSM insulation material	PVC .085" OD	Coating OD	500 ± 15 µM
Overall cable core wrap	Paper tissue	Concentricity Error	1 µM Max
Braid shield	38 AWG tinned copper, 80% min coverage	Coating Material	Acrylate
Jacket	TPE, Class 36, .362 nom OD, Black	Buffer OD	900 ± 50 µM
		Buffer material	Hard elastomer
Print legend	Amphenol / Spectra-Strip SMPTE-311M composite single-mode fiber optic camera cable		
Conformance	Complies with SMPTE 311M UL VW-1	Buffer colors	Blue, Yellow

Auxiliary Conductors		Signal Conductors		Mechanical Characteristics	
DC Loop Resistance	43 Ω / km max @ 20C	DC Loop Resistance	184 Ω km max @ 20C	Tensile strength	700 N min per FOTP-33
Insulation Resistance	10,000 MΩ km min @ 20C	Insulation Resistance	10,000 MΩ km min @ 20C	Bend radius	7X cable OD @ 20C per FOTP-37
Dielectric strength	1750 V rms @ 20C, 60Hz, 1 min	Dielectric strength	1750 V rms @ 20C, 60Hz, 1 min	Impact	20 cycles @ 5.88 N-m per FOTP-25
Insulation colors	Black, White	Insulation colors	Red, Grey	Crush	180 kg per FOTP-41
				Flex	15,000 cycles, 10X cable OD max, per FOTP-41 and UL -1581, section 1582

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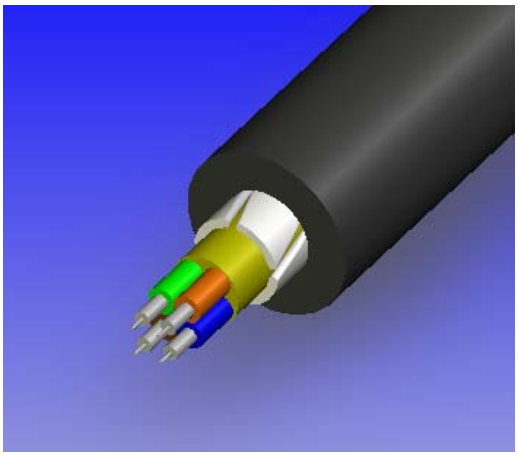
Rodent Resistant Cable



Amphenol 5.5mm Non-Metallic Rodent Resistant Cable

Rodents cause significant problems in cable environments. Their incessant need to chew in order to control tooth size is relentless. Standard industry practice is to use steel tapes to armor the cable. However, the lack of flexibility caused by a metallic sheath also has a deterring effect on cable installers. The result is not only additional expense in cable manufacturing but also in installation.

Flexible cable reinforcements are almost always applied around the cable core to provide strength during installation. By using these reinforcements to prevent rodents from damaging the optical fibers, costs are dramatically reduced. Amphenol's e-glass reinforcement design provides multiple advantages: First, it provides a highly flexible cable with diameter that is significantly smaller than metallic sheathed cables. Next, it provides tensile strength to the cable for installation. Further, it acts as a crush resistant layer dispersing the energy of any impact the cable may see. Finally, if a rodent should opt to chew on the cable it will find the glass fibers to be highly irritating to its lips and gums.

The cable is non-metallic and non-conductive. This eliminates potential damage to the cable and attached equipment from lightening strikes and other electrical hazards.

Amphenol's cable was tested for rodent resistance at the TNO laboratories in the Netherlands, an independent European institution experienced in testing with rodents. The test simulated worst conditions, entrapment of the rodent by the test cables.

Specification TL6020-003 requires a single rodent (e.g. a rat) placed in an entrapment simulation for a period of 8 hours. In this test the rodent is prevented by a barrier of cable from penetrating into an area to obtain food. Amphenol's 5.5mm Rodent Resistant Cable successfully passed this test.

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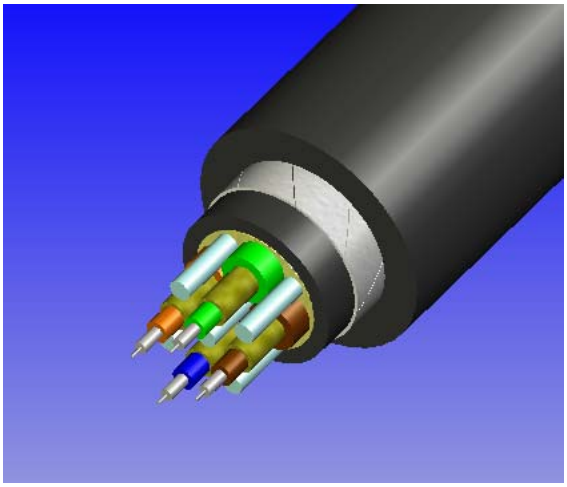
Rodent Resistant Cable

Amphenol 9.4mm Non-Metallic Rodent Resistant Cable

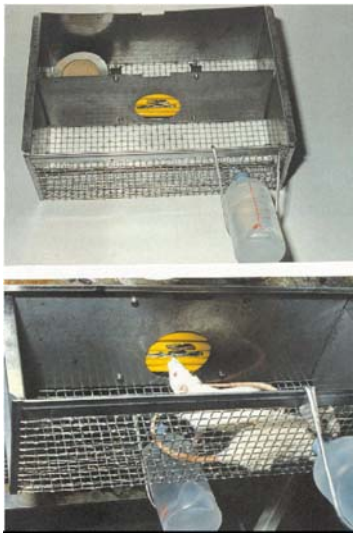


For greater rodent resistance Amphenol offers a 9.4mm diameter cable. This construction utilizes a double polyurethane jacket with the rodent resistant e-glass wrap positioned between the jacket layers.

Using the entrapment test previously described with three rats, this construction prevented penetration for a period of 96 hours without damage to the optical fibers or penetration through the inner jacket.

The 9.4mm cable further protects the fibers by using a breakout construction for the individual fibers. Fibers are individually jacketed with aramid strength members, and then cabled to form the inner core of the completed cable.

Optical characteristics for this cable family are identical to those listed for the 5.5mm construction. For further information contact Amphenol/Spectra-Strip Product Marketing



Test cage

Typical rodent damage in unprotected cable

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Rodent Resistant Cable Specifications

Description	Single Mode	50µm Multimode	62.5µm Multimode
Part Number	**161-0099-993 2-Fiber** **161-0099-994 4-Fiber**	**161-0399-994 2- Fiber** **161-0399-995 4- Fiber**	**161-0599-993 2- Fiber** **161-0599-994 4- Fiber**
Cable Specifications			
Jacket OD	5.5mm ± 2.5	5.5mm ± 2.5	5.5mm ± 2.5
Jacket Material	Polyurethane	Polyurethane	Polyurethane
Rodent Resistant Elements	e-glass	e-glass	e-glass
Strength Members	Aramids	Aramids	Aramids
Tensile Load Operation Installation	 2224 N (500 lbs) Max 3559 N (800 lbs) Max	 2224 N (500 lbs) Max 3559 N (800 lbs) Max	 2224 N (500 lbs) Max 3559 N (800 lbs) Max
Bend Radius Operation Installation	 27.5mm 55.0mm	 27.5mm 55.0mm	 27.5mm 55.0mm
Crush Resistance	1000N for 5 minutes	1000N for 5 minutes	1000N for 5 minutes
Impact Resistance	100 impacts	100 impacts	100 impacts
Cyclic Flex	1000 cycles	1000 cycles	1000 cycles
Temperature Range	-50ºC to +85ºC	-50ºC to +85ºC	-50ºC to +85ºC
Rodent Resistance Qualification	Per MILLE Technical Specification TL6020-003	Per MILLE Technical Specification TL6020-003	Per MILLE Technical Specification TL6020-003
Fiber Specifications			
Core	9.5µm ± 1	50µm ± 2.5	62.5µm ± 2.5
Cladding	125 µm ± 1	125 µm ± 1	125 µm ± 1
Coating	500 µm ± 15	500 µm ± 15	500 µm ± 15
Buffer	900 µm ± 50	900 µm ± 50	900 µm ± 50
Max Attenuation			
@ 1310nm	1.0 db/km	NA	NA
@ 1550nm	1.0 db/km	NA	NA
Max Attenuation			
@ 850nm	NA	3.0 db/km	3.2 db/km
@ 1300nm	NA	0.8 db/km	1.0 db/km
Min Bandwidth			
@ 850nm	NA	≥500 MHz-km	≥300 MHz-km
@ 1300nm	NA	≥500 MHz-km	≥600 MHz-km
Numerical Aperture	NA	0.200 ± 0.015	0.275 ± 0.015
Fiber Proof test	690 MPa	690 MPa	690 MPa

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Cabling technology

Spectra-Strip designs and builds all of its cabling equipment. The versatility of Spectra-Strip's cabling technology is especially well suited for Hybrid applications. Our cablers are modular in construction and feature planetary fiber rotation and precise electronic tension control of each element to maximize process control.

Planetary Fiber Optic Cabler

Tough testing for tough cables

Amphenol has developed specific products to meet the tough conditions encountered in these applications. Tight buffered planetary cabled optical fibers combined with aramid strength members and a selection of jacket materials based on the application result in exceptionally flexible, rugged, and survivable cables for tactical field use in demanding applications.

Our polyurethane jacketed cables provide the highest levels of abrasion resistance, toughness, excellent low temperature properties, crush resistance, flame retardancy and resistance to fungus and hydrolytic attack (high humidity and water contact).

Amphenol/Spectra-Strip has a number of unique tests that go beyond industry norms and standard testing to insure our optical cables are well suited for the most demanding applications

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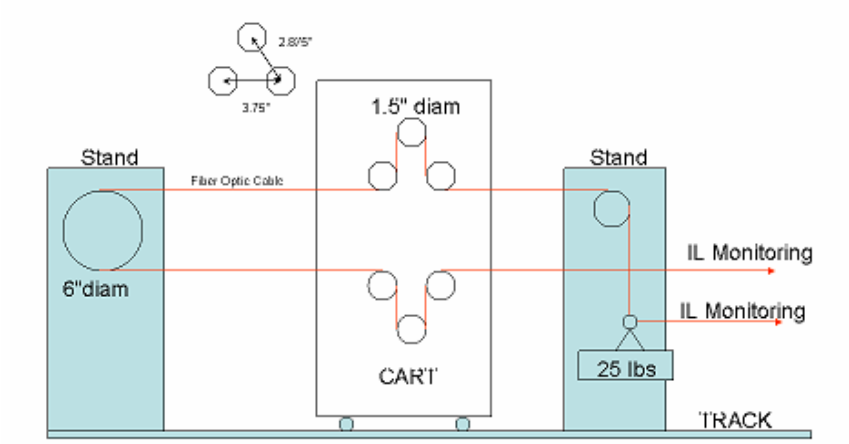
Dynamic Bend Sensitivity

The most demanding measure of bend sensitivity and ruggedness is the Rolling Flex Test.



Rolling Flex Test Outline

In this test the carriage is pulled back and forth along an 80 inch track, with one down and back trip considered one cycle. The cycle duration is 40 seconds. During testing a 25 pound load is applied to the cable. This test severely tests the cable, optical fibers and other components as a system. The pulley wrap illustration shows how the cable bends through the 1.5" pulleys. For a typical tactical distribution cable this would be Bend Radius of 3.3 X the cable diameter. All Amphenol Spectra-Strip Tactical Distribution Fiber Optic Cables are tested for at least 200 cycles. Tactical Breakout Cables have been subjected to up to 6000 cycles with no change in attenuation. The maximum real time deviation from the baseline attenuation reading is 0.5 dB, and the attenuation reading at the conclusion of the test is generally the same as the baseline reading.

Rolling Flex Test Pulley Wrap Detail

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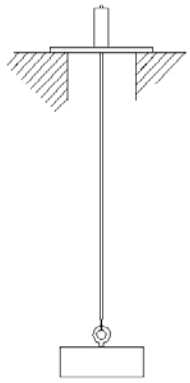
Aramid to Jacket Retention



The test procedure is illustrated to the right. On the top end the cable jacket is incased in an epoxy filled tube. At the other end a deadweight is attached to the cable's strength members. The cable must hold the weight for ≥5 minutes. Spectra-Strip's tactical cables typically hold a 91 lb weight for 5 minutes, then a 116 lb weight for an additional seven minutes without failure.

While the outer jacket material and the strength members incorporated are paramount to the ruggedness of the cable, it is essential these components act synergistically to increase survivability in extreme conditions. To do this the cable was designed to have the outer aramids embedded to the inside of the jacket wall to provide additional reinforcement. This test procedure was developed to insure reliability of jacket to aramid retention.

Connector to Cable Retention

Spectra-Strip determines the axial tension load for harsh environment cables which can be applied to a mated cable and connector without causing any detrimental effects on the cable or connector.

The typical tactical cable requirements are two-fold: A 400 lb load is applied to the cable/connector and maintained for four hours. Second, a separate pull test requires that cable disengagement from the connector or cable failure be in excess of 900 lbs.

Test equipment consists of an apparatus capable of applying gradual axial loads along a connector and a cable axis with devices for holding or clamping the cable. The apparatus shall be capable of gradually increasing the force until the connection between the cable and connector is severed.

Tactical cables and the connector backshells are then tested to failure. This separation generally occurs between 1000 and 1100 lbs.

OTDR Testing

Spectra-Strip performs a 100 % OTDR test on all reels of fiber optic cable

Amphenol Spectra-Strip

Fiber Optics

720 Sherman Avenue, Hamden CT, 06514 USA

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