



HDTV-SDI CABLING MATERIAL SELECTION

Broadcast stations and postproduction studios in many countries around the world are currently being required to change their systems to handle high definition (HDTV) digital signals, in addition to SDTV digital signals. The SDTV-SDI transmission speed is 270Mbps, while the HDTV-SDI transmission speed is much higher at 1.485Gbps. The following explains the selection of cabling materials for such transition periods.

CABLING MATERIAL SELECTION

Both coaxial cables and fiber-optic cables are used for HDTV-SDI cabling.

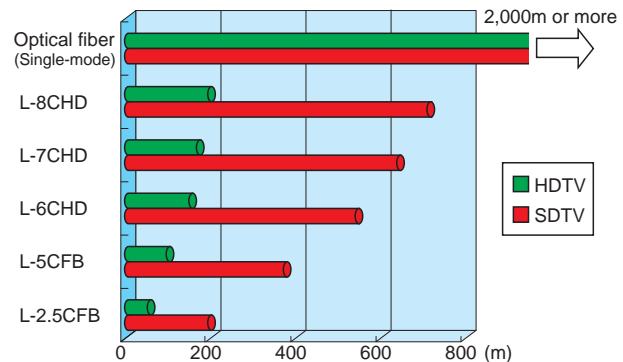
Coaxial cables are used for relatively short transmission distances, as shown in the table on the right. For example, L-2.5CFB is better suited to cabling inside an equipment rack, and L-5CFB is a more appropriate choice for cabling between racks. Likewise, Canare's specially developed L-8CHD (high-foam coaxial cable) is ideal for cabling between rooms.

On the other hand, as can be seen from the fact that fiber-optic cables are now widely used in the communications field, they are better suited for long-distance transmission. Because the cost of fiber-optic transmission equipment can be expected to continue to fall, fiber optics is expected to make further inroads into the short-distance transmission field in the near future.

HDTV-SDI Transmission Distance

Cabling Material		SDTV (270Mbps)	HDTV (1.485Gps)
Coaxial cable	L-2.5CFB	195	55
	L-5CFB	370	100
	L-6CHD	540	150
	L-7CHD	620	170
	L-8CHD	710	200
Optical fiber (single mode)		2,000 or more	

(Unit: m)



Technical Note

Characteristic Impedance

Imagine a coaxial cable that extends forever. The frequency impedance as registered on the sending-end of such a cable is referred to as "characteristic impedance." Real cables are fixed in length, allowing the characteristic impedance to be measured and the cables terminated by applying resistance of equal value. The end result is the configuration of a cable that seems limitless in length. (See Fig. 1)

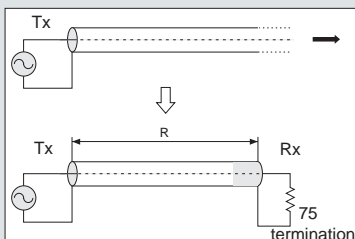


Fig. 1 Limited and Unlimited Length Coaxial Cables

Voltage Standing-Wave Ratio (VSWR) and Return Loss

Terminating the receiving end of a limited length coaxial cable using a resistance value not equal to its characteristic impedance creates a reflected wave that returns back down the cable to the sending end. The result is interference developing between the traveling wave and the return wave which results in a standing wave that causes voltage levels to fluctuate. The degree to which terminating resistance matches the characteristic impedance is indicated using the VSWR or voltage standing-wave ratio standard shown in Fig. 2. Going hand in hand with the VSWR ratio is the return loss factor which measures the size of the reflected wave current in relation to the traveling wave current. (See Fig. 3)

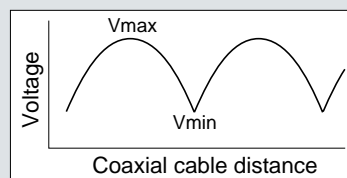


Fig. 2 Voltage Distribution Over Coaxial Cable

VSWR	Return Loss (dB)
2	9.5
1.5	14
1.2	20
1.1	26
1.05	32
1.02	40
1.01	46.1

Fig. 3 VSWR to Return Loss Conversion Table

As shown in this table, the specifications of HDTV-SDI coaxial cable interfaces are specified by ARIB Standard BTA S-004B. Because the 75Ω type generally provides better electrical characteristics than the 50Ω type, both connectors and cables must be rated for 75Ω. If the HDTV-SDI transmission system uses a mixture of 50Ω connectors and 75Ω cables or 75Ω connectors and 50Ω cables, the impedance mismatch will significantly increase return loss, which in turn generates jitter, causing bit errors. Note that impedance ratings are not clearly indicated on some commercially available BNC connectors and coaxial cables. When using such commercial products for HDTV-SDI signal transmission path, be sure to always check to ensure that their nominal impedance is 75Ω before use.

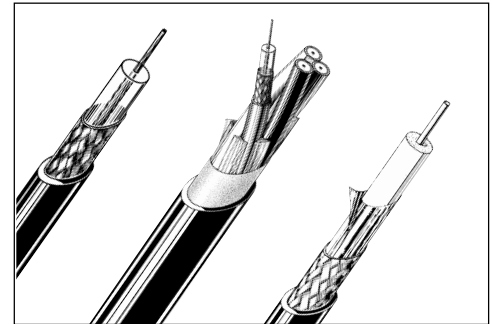


Canare 75Ω BNC connectors

Cabling Materials and Electrical Characteristics
(HDTV-SDI coaxial cable interface)

(ARIB standard)

Connector		75Ω BNC connector
Cable		75Ω coaxial cable
Electrical Characteristics	Transmission Loss	20dB or less (742.5MHz)
	Reflection	15dB or less (5MHz - 742.5MHz)
	Return Loss	10dB or less (742.5MHz - 1.485GHz)



Canare 75Ω coaxial cables

Technical Note

Matched and Mismatched Connectors

The return loss is 26dB or less (VSWR=1.1) for frequencies up to 2 GHz in 75Ω coaxial cables using 75Ω BNC connectors. If 50Ω BNC connectors are attached to both ends of the same cable, the return loss takes on the characteristics shown in Fig. 4, below, when frequencies exceed 100MHz. This makes it incapable of transmitting signals with any accuracy.

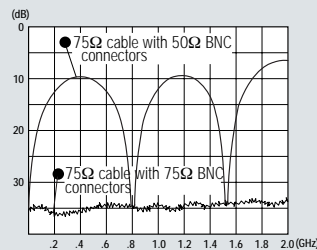


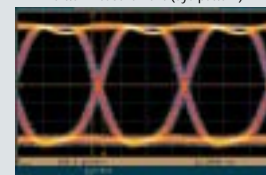
Fig. 4 Matched and Mismatched Impedances

Jitter

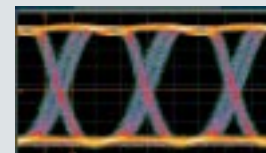
Digital signals are made up of stepped waveforms spaced at a fixed interval called the "timing sequence." Receivers must detect and monitor this timing in order to accurately read the signal. Shifts in the waveform—which must intrinsically maintain a fixed interval—can be introduced by such factors as irregular equipment conditions or overly long transmission lines, causing signal distortion. Such shifts in the timing axes of transmitted and received signal waveforms are referred to as 'jitter'. Increasing amounts of jitter distortion can lead to bit error, which may result in picture deterioration or horizontal noise interference.

One tool regularly used to measure jitter is the oscilloscope. Owing to its distinctive shape, the measured waveform is called an "eye pattern," with the jitter expressed by the width of the area where the rising and falling edges of the waveforms cross each other. This jitter value is specified by the ARIB (SMPTE) Standard shown in the accompanying table.

Jitter measurement (eye pattern)



a) Waveform jitter = 93ps



b) Waveform jitter = 210ps

Reasons for Wide Use of 75Ω Coaxial Cable

Calculation results for impedances and corresponding attenuation rates in coaxial cables are shown in Fig. 5 below. The levels of characteristic impedance requiring only minimal attenuation were 60Ω for lines with polyethylene insulation, 75Ω for foam PE (50%) insulation and 95Ω for air insulation. This is why 75Ω cable is used for longer distance transmissions.

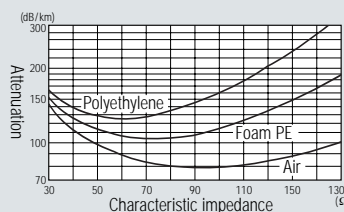


Fig. 5 Impedance Levels That Minimize Attenuation Conditions:
Outer conductor; copper braid; insulation 0.0 5mm
Inner conductor; solid copper; frequency 200MHz

SDTV	HDTV
≤740ps	≤135ps

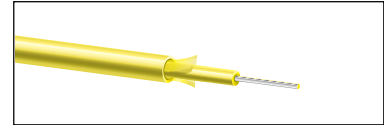
Specified jitter values (by the ARIB(SMPTE) Standard)

FIBER-OPTIC INTERFACE

As shown in the table below, HDTV-SDI fiber-optic interface specifications are covered by ARIB Standard BTA S-004B. Although the fiber-optic cable may have excellent characteristics in terms of signal transmission, it may be liable to the influence of tension or bends that exceed its permissible range, as well as to humidity or dust. In particular, care must be exercised during installation since tension is more apt to be applied to the interface. To ensure stable light signal transmission, be sure to handle the interface properly, and correctly clean the fiber-optic connectors.



(Canare fiber-optic cable with SC connector)

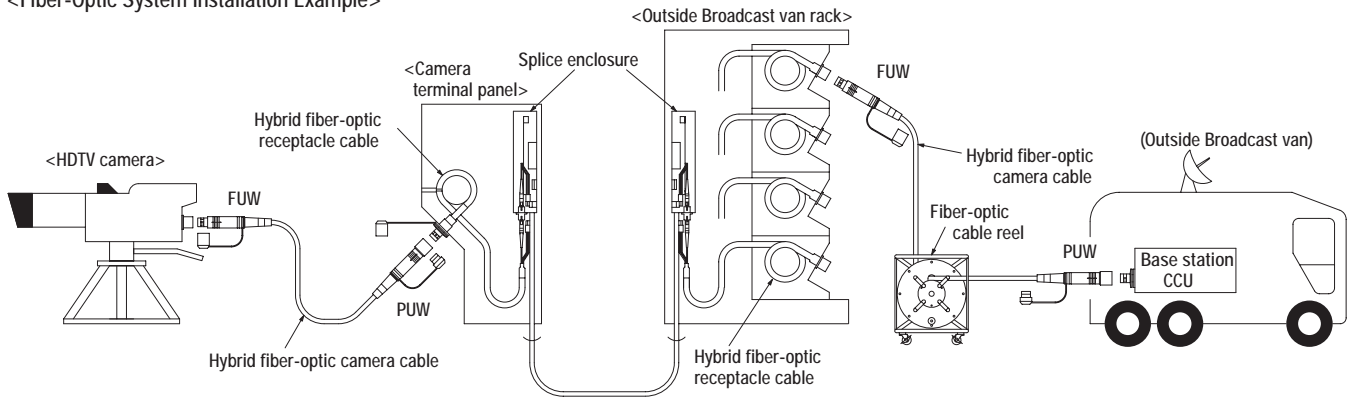


(Canare fiber-optic cord)

Optical Characteristics (HDTV-SDI Fiber-Optic Interface) (ARIB Standard)

Fiber-Optic Connector		SC conn
Optical Fiber		1.3um range zero-distribution single mode
Light Characteristics	Wavelength	1310nm+40nm
	Max. Spectacle Half-Value Width	10nm
	Timing Jitter	Within 1UI (673ps)
	Alignment Jitter	Within 0.2UI (135ps)

<Fiber-Optic System Installation Example>



Technical Note

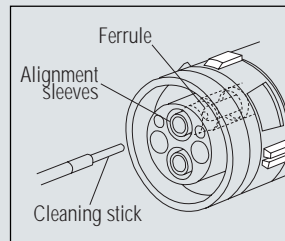
MAINTAINING FIBER-OPTIC HYBRID CONNECTORS

The connector sections to be cleaned are the key parts, including the tips and sides of ferrules, the interior walls of alignment sleeves and the interior and exterior of connector shells. Note that scratches and particles of foreign matter on the tip of the ferrule can have a disabling effect on fiber-optic transmission. The following procedures should be used when cleaning fiber-optic connectors.

- For the Plugs (FUW), the interior surfaces of alignment sleeves and the tips of ferrules are to be cleaned with the non-alcohol treated cleaning stick using a gentle stroking action. The slender design of the cleaning stick enables alignment sleeves to be cleaned without having to detach them.
- For the Jack (PUW), it is important to clean both the tips and sides of the completely protruding ferrules with the cleaning stick.
- Both the male and female connector shells tend to attract dust and metal particles, so it is important to clean both the insides and outsides using cotton gauze or similar material.

*Contact Canare for information on the recommended cleaning stick.

*The alignment sleeve (split sleeve) keeps the ferrules in exact alignment with each other.

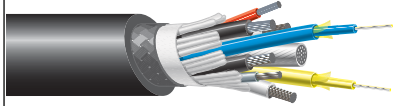


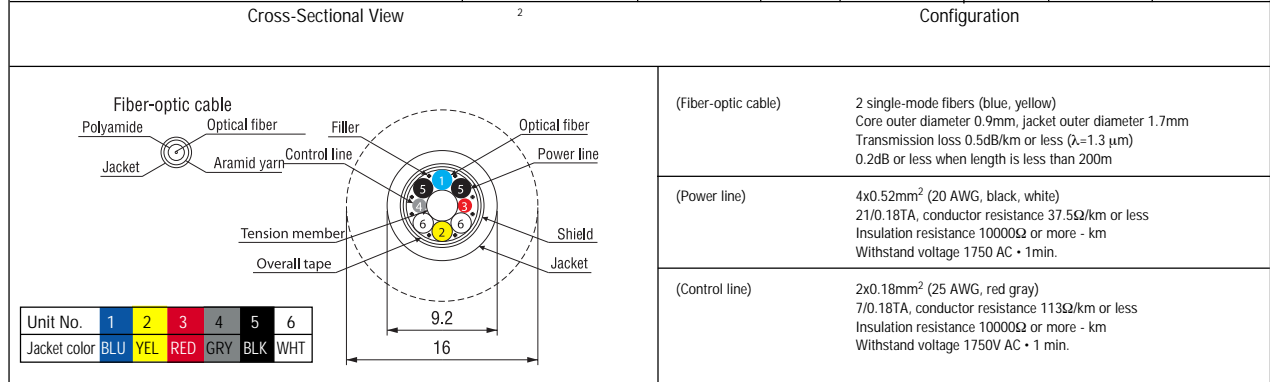
Before cleaning



After cleaning



Type	Model	Nom.O.D	Weight	Overall shield coverage	Tension tolerance	Bend radius tolerance	Temperature range
		mm	kg/100m	%	N		
 <p>LF-2SM9R Jacket color for LF-2SM9R, LF-2SM9, LF-2SM16: black</p>	LF-2SM9R	9.2	11.0	91.8	700 (71kgf)	Over 6 times cable outer diameter	-40°C~+70°C
	LF-2SM9						
	LF-2SM16	16.0	28.0				



• Other colors are also available on a custom-made basis. Please contact your Canare salesperson.

* Special order

LF-2SM9R

- Cable designed for studio and broadcast applications.
- Polyurethane jacket provides tear resistant characteristics.
- Elastomer used in the sheath construction ensures superb mechanical strength.

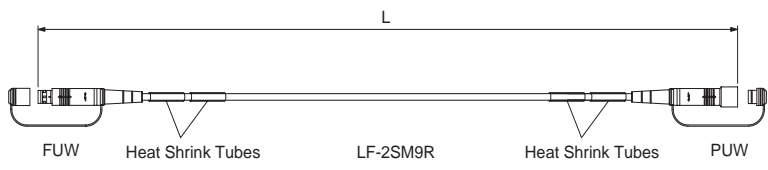

LF-2SM16

- Cable designed for studio applications
- Polyvinylchloride and polyurethane composite material used for the jacket.
- 16mm outer diameter double jacket configuration on the cable is designed to prevent cable from catching on skirt of camera pedestals.

LF-2SM9

- Cable designed for fixed installations.
- PVC jacket provides quiet movement.

• FUW - PUW (black)

Type	Model	Length (m)
	FCC10	10
	FCC20	20
	FCC30	30
	FCC50	50
	FCC100	100
	FCC150	150
	FCC200	200
	FCC50-WJ	50
	FCC100-WJ	100

* Special order

- Stainless steel connectors
- ARIB BTA standard S-1005B and SMPTE standard 304M compliant.
- Stainless steel tension member prevents kinks.

