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SEMIFLEX CABLE SERIES T10

TABLE OF CONTENTS: T10 SEMIFLEX CABLE SERIES

SEMIFLEX CABLE DESCRIPTION LEGEND

T10 or TX10	1	2
	1- Cable Series	**2- Jacket Configuration**
	412 - 0.412" Cable Series	" " - Unjacketed
	500 - 0.500" Cable Series	VI - Unjacketed, Tracer Coded
	565 - 0.565" Cable Series	J - Jacketed
	625 - 0.625" Cable Series	JX - Jacketed, Extra Thick Jacket
	700 - 0.703" Cable Series	JXVI - Jacketed, Extra Thick Jacket, Tracer Coded
	750 - 0.750" Cable Series	JVI - Jacketed, Tracer Coded
	840 - 0.840" Cable Series	MS - Jacketed, Messengered
	875 - 0.875" Cable Series	JB - Jacketed, Flooded - Underground
	1000 - 1.000" Cable Series	JBX - Jacketed, Flooded - Underground, Extra Thick Jacket
	1160 - 1.160" Cable Series	JBXVI - Jacketed, Flooded - Underground, Extra Thick Jacket, Tracer Coded
		JBVI - Jacketed, Flooded - Underground, Tracer Coded
		JBF - Jacketed, Flooded - Aerial*
		JBFVI - Jacketed, Flooded - Aerial*, Tracer Coded
		JBA - Jacketed, Armored
		JBAVI - Jacketed, Armored, Tracer Coded
		V - NEC - Article 820, CATV (UL) Listed, Unjacketed
		SC - Solid Copper Inner Conductor

Example: Part Number T10750JBFVI

T10 750 JBF VI

- T10 — TFC T10
- 750 — 0.750" Cable Series
- JBF — Jacketed, Flooded, Aerial*
- VI — Tracer Coded

Part Number TX10565JB

TX10 565 JB

- TX10 — TFC TX10
- 565 — 0.565" Cable Series
- JB — Jacketed, Flooded, Underground

* Aerial Non-dripping flooding compound

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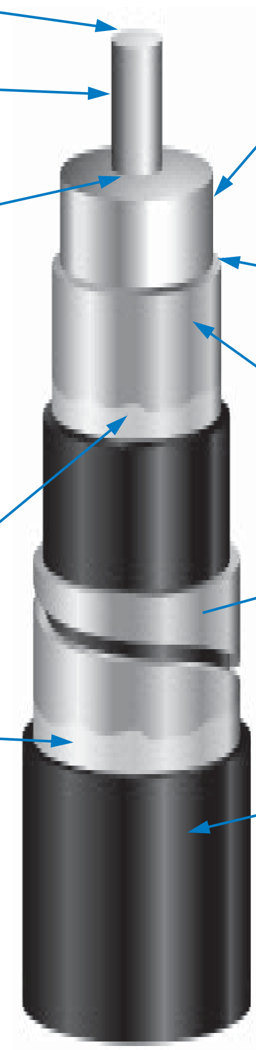
Amphenol

SEMIFLEX CABLE SERIES T10-TX10

DETAILS OF CONSTRUCTION AND MATERIAL



CENTER CONDUCTOR
Copper-clad aluminum or solid copper

CONDUCTOR COATING
Proprietary polymer adhesive coating to provide moisture blocking, bonding the dielectric and enhancing foam structure stability.

DIELECTRIC
Foamed polyethylene produced by gas injection in combination with proprietary nucleating agents and enhanced dimensional uniformity to meet 1 GHz requirements. Federal specifications LP-390 and ASTM D-1248 are applicable to the polyethylene prior to the foaming.

FLOODING COMPOUNDS

- **SELF-HEALING**
Cold flowing, low molecular weight flooding compound for self-healing of jacket damage. Intended for underground installations.

- **NON-FLOWING**
Intended for aerial applications, non-dripping flooding compound.

DIELECTRIC ADHESIVE COATING
Proprietary polymer adhesive coating to bond core to outer conductor for improved handling and strength characteristics in cold weather.

OUTER CONDUCTOR
Seamless high purity electrical grade aluminum tube. (ASTM B-221).

JACKET ADHESIVE
Proprietary non-residue polymer adhesive (Not used on cables with flooding compounds).

ARMOR
A 0.010 inch thick steel tape per SAE/AISI 1010 for steel.

JACKET*
Abrasion resistant, low coefficient of friction medium density black polyethylene (Federal Specification LP-390 and ASTM D-1248 jacketing material).
* Sequential footage marking on all jacketed cables (meter marking on request).

Extra thick jacket is also available.

Not Shown:

MESSENGER
- T10 Semiflex: Galvanized 0.109 inch (2.77mm) solid steel wire (ASTM A-326); galvanized 0.188 inch (4.78mm) or 0.250 inch (6.35 mm) stranded steel wire (ASTM A-475).
- TX10 Semiflex: Galvanized 0.188 inch (4.78mm) or 0.250 inch (6.35 mm) stranded wire (ASTM A-475).

Pictured: T10 Semiflex Cable, Armored, with flooding compound

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FEATURES AND BENEFITS

The T10 and TX10 Semiflex Cable Series offer a number of product features which enhance product performance and system operation.

BEND RADIUS

Both T10 and TX10 cables exhibit reduced bend radii to easily accommodate vault and pedestal placement. Refer to cable series data sheets for minimum bend radius specification.

BONDING

The bonded construction of semiflex cable begins at the center conductor to dielectric interface. Bonding serves as corrosion protection resulting from moisture ingress and facilitates stripping of the dielectric without leaving a harmful residue. Continuing from the dielectric to the outer conductor, controlled bonding provides adhesion strength to -40 °C, drastically reducing center conductor pull-outs due to extreme temperature changes. In addition, bonding improves handling and facilitates the use of standard connectors. Further bonding of the outer conductor to jacket prevents concealment of aluminum sheath damage, identifying problems before the cable is installed.

T10 and TX10 semiflex cables' unique bonded construction allows all components to operate together as a single unit. A fully bonded composite construction offers the benefits of increased pull strength and resistance to possible sidewall pressure damage during installation. Triple bonding also solves the instances of connector pull-outs, further reducing cable service problems after installaton.

FLOODING COMPOUND

Flooding compounds come in a cold flowing, self-healing form for underground installations and a non-dripping aerial application form. Flooding compounds are used as an additional layer of corrosion protection.

Where greater protection is required, Times offers an armored construction. A flooded steel tape and jacket are layered over the standard flooded jacketed cable, increasing mechanical strength necessary for rodent protection and rocky soil.

1 GHz BANDWIDTH

T10 and TX10 are sweep tested to 1 GHz. Specifying 1 GHz bandwidth for rebuilds, upgrades or new plant allows a system to handle future increasing capacity needs demanded by more channels, high definition television and other emerging technologies.

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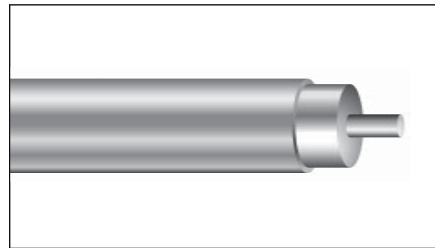
SEMIFLEX CABLE SERIES T10-TX10

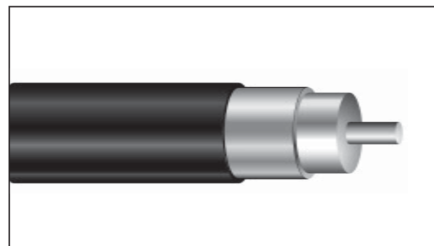
UNJACKETED

Application: Recommended for aerial installations in a non-corrosive environment, unjacketed semiflex cable features bonding of the center conductor to the dielectric and dielectric to the outer conductor. This bonding prevents moisture ingress and facilitates connectorization since it leaves no harmful residue.



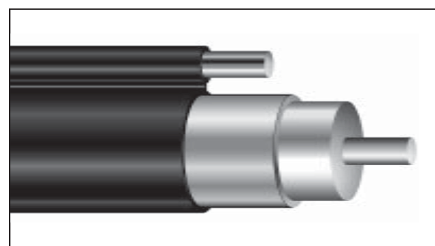
JACKETED

Application: For aerial applications in urban and coastal environments, Jacketed semiflex cable is recommended where highly corrosive conditions may exist. This cable features a triple bonding of the center conductor to the dielectric, dielectric to the outer conductor and outer conductor to the jacket and is designed to withstand more abrasion and mechanical abuse than an unjacketed version. With an extra thick jacket, this cable will withstand more abrasion and mechanical abuse than the standard jacketed burial cable.



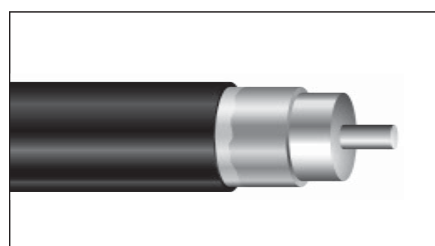
MESSENGERED

Application: Messengered semiflex cable is recommended for aerial feeder installations where strand installation is not practical. T10412 and T10500 semiflex cable is designed with a strong, integral, galvanized solid steel wire which supports the cable in aerial installations. TX10625 and TX10565 semiflex cable features a jacketed galvanized stranded steel wire which also acts as a support, relieving the cable from undue tension. Resting ladders on messengered cable is strongly discouraged and is poor practice.



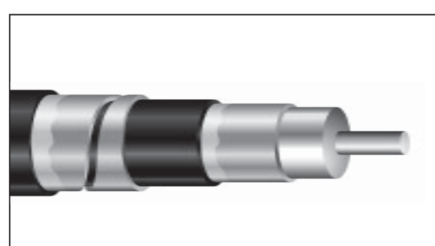
JACKETED BURIAL

Application: Jacketed Burial semiflex cable is recommended for underground applications in conduit or direct burial installations. This version features a cold flowing, self-healing flooding compound for underground applications, providing an additional layer of corrosion protection. For aerial applications, non-dripping flooding compound is used which also serves as an additional layer of corrosion protection.



ARMORED

Application: Where cable is exposed to extensive mechanical abuse and rodent attack, armored semiflex cable is recommended. Used for direct burial applications, Armored semiflex cable features a flooded steel tape and jacket which are layered over the standard flooded jacketed cable to increase mechanical strength.



T10 412 SERIES SEMIFLEX CABLE

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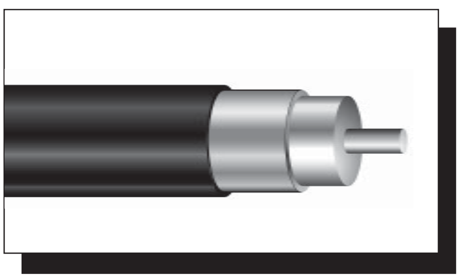
TFC Amphenol

PART NUMBERS

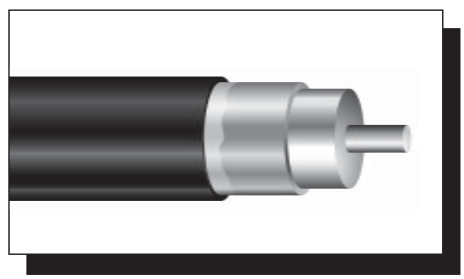
CONSTRUCTION	CENTER CONDUCTOR Copper-Clad Aluminum Part Number
Unjacketed	T10412
Unjacketed, Tracer Coded	T10412VI
Jacketed	T10412J
Jacketed, Extra Thick Jacket	T10412JX
Jacketed, Extra Thick Jacket, Tracer Coded	T10412JXVI
Jacketed, Tracer Coded	T10412JVI
Jacketed Messengered	T10412MS
Jacketed Flooded, Underground	T10412JB
Jacketed Flooded, Underground, Extra Thick Jacket	T10412JBX
Jacketed Flooded, Underground, Extra Thick Jacket, Tracer Coded	T10412JBXVI
Jacketed Flooded, Underground, Tracer Coded	T10412JBVI
Jacketed Flooded, Aerial*	T10412JBF
Jacketed Flooded, Aerial,* Tracer Coded	T10412JBFVI
Jacketed Armored	T10412JBA
Jacketed Armored, Tracer Coded	T10412JBAVI
NEC - Article 820, CATV Listed, Unjacketed	T10412V

*Used for aerial applications due to non-flowing, non-dripping compound.

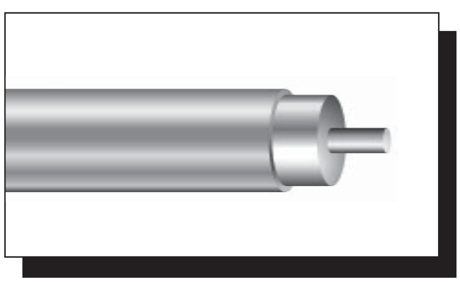
Note: Standard colored tracer stripes are red, yellow, green, blue, white, and slate. For other color combinations, please contact a customer service representative or your area sales representative.



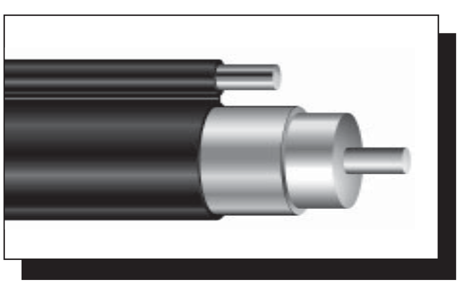
Jacketed



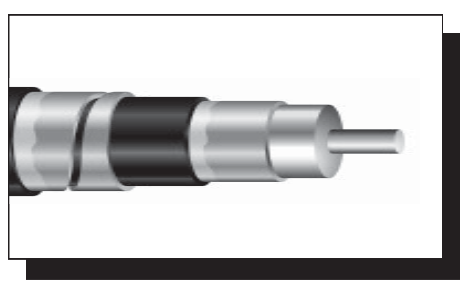
Jacketed Burial



Unjacketed



Messengered



Armored

Customers are reminded that they are SOLELY responsible for confirming that all products are properly installed and used in accordance with all applicable codes and regulations.

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412 SERIES SEMIFLEX CABLE T10

PHYSICAL SPECIFICATIONS

NOMINAL DIMENSIONS	UNJACKETED*		JACKETED		EXTRA THICK JACKET		MESSENGERED		JACKETED BURIAL		EXTRA THICK JACKETED BURIAL		ARMORED	
	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)
Conductor	0.088	(2.24)	0.088	(2.24)	0.088	(2.24)	0.088	(2.24)	0.088	(2.24)	0.088	(2.24)	0.088	(2.24)
Dielectric	0.362	(9.19)	0.362	(9.19)	0.362	(9.19)	0.362	(9.19)	0.362	(9.19)	0.362	(9.19)	0.362	(9.19)
Outer Conductor Thickness	0.025	(0.64)	0.025	(0.64)	0.025	(0.64)	0.025	(0.64)	0.025	(0.64)	0.025	(0.64)	0.025	(0.64)
Outer Conductor Diameter	0.412	(10.5)	0.412	(10.5)	0.412	(10.5)	0.412	(10.5)	0.412	(10.5)	0.412	(10.5)	0.412	(10.5)
First Jacket	—	—	0.470	(11.9)	0.542	(13.8)	0.480	(12.2)	0.480	(12.2)	0.552	(14.0)	0.480	(12.2)
Messenger	—	—	—	—	—	—	0.109	(2.77)	—	—	—	—	—	—
Armor	—	—	—	—	—	—	—	—	—	—	—	—	0.500	(12.7)
Second Jacket	—	—	—	—	—	—	—	—	—	—	—	—	0.600	(15.2)
Nominal Weight (lb/kft) (kg/km)[1]	58	(86)	75	(112)	98	(146)	126	(188)	78	(116)	102	(152)	159	(237)
Nominal Weight (per reel) lb (kg)[2]	252	(114)	301	(137)	372	(169)	479	(217)	310	(141)	382	(173)	577	(262)
Nominal Length (per reel) feet (m)	3000	(914)	3000	(914)	3000	(914)	3000	(914)	3000	(914)	3000	(914)	3000	(914)
Maximum Pull Force lbf (N)	250	(1112)	250	(1112)	250	(1112)	900	(4003)	250	(1112)	250	(1112)	250	(1112)
Minimum Bend Radius in (mm)	3.0	(76)	2.5	(64)	2.5	(64)	3.0	(76)	3.0	(76)	3.0	(76)	8.4	(213)
Messenger Break Strength lbf (N)	—	—	—	—	—	—	1800	(8007)	—	—	—	—	—	—
Reel Size (inches) (Flange x Width)[3]	36 x 22		36 x 22		36 x 22		42 x 22		36 x 22		36 x 22		42 x 22	
Reel Size (centimeters) (Flange x Width)[3]	91 x 56		91 x 56		91 x 56		107 x 56		91 x 56		91 x 56		107 x 56	

* All T10 Unjacketed Cable is available rated per **NEC Article 820 - CATV**

[1]cable minus reel, [2] cable plus reel, [3] Width is outside flange to outside flange

ELECTRICAL SPECIFICATIONS

Nominal DC Resistance @ 68°F (20°C)	**Ohms per 1000**	
Copper-Clad Aluminum Center Conductor	**feet**	**meters**
Center Conductor	2.06	6.76
Outer Conductor	0.44	1.44
Loop	2.50	8.20
Nominal Capacitance	15.6 pF/ft (51.2 pF/m)	
Impedance	75 ± 2 Ohms	
Velocity of Propagation	87% nominal	

MAXIMUM ATTENUATION @ 68°F (20°C)

Frequency MHz	dB per 100 feet	dB per 100 meters
5	0.20	0.66
55	0.68	2.24
211	1.35	4.44
250	1.49	4.89
270	1.55	5.09
300	1.64	5.38
330	1.73	5.66
350	1.78	5.84
400	1.91	6.27
450	2.03	6.66
500	2.15	7.05
550	2.26	7.41
600	2.37	7.78
750	2.68	8.79
870	2.90	9.52
1000	3.13	10.27

Attenuation increases with increasing temperature and decreases with decreasing temperature at the rate of 0.1% / °F (0.18% / °C)

Specifications subject to change without notice.

Customers are reminded that they are SOLELY responsible for confirming that all products are properly installed and used in accordance with all applicable codes and regulations.

T10 500 SERIES SEMIFLEX CABLE

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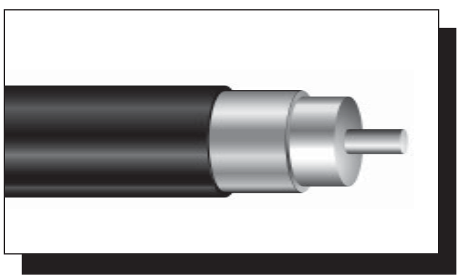
PART NUMBERS

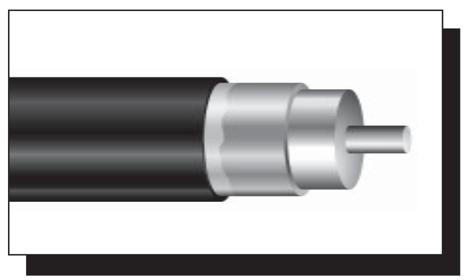
CONSTRUCTION	CENTER CONDUCTOR Copper-Clad Aluminum Part Number
Unjacketed	T10500
Unjacketed, Tracer Coded	T10500VI
Jacketed	T10500J
Jacketed, Extra Thick Jacket	T10500JX
Jacketed, Extra Thick Jacket, Tracer Coded	T10500JXVI
Jacketed, Tracer Coded	T10500JVI
Jacketed Messengered	T10500MS
Jacketed Flooded, Underground	T10500JB
Jacketed Flooded, Underground, Extra Thick Jacket	T10500JBX
Jacketed Flooded, Underground, Extra Thick Jacket, Tracer Coded	T10500JBXVI
Jacketed Flooded, Underground, Tracer Coded	T10500JBVI
Jacketed Flooded, Aerial*	T10500JBF
Jacketed Flooded, Aerial,* Tracer Coded	T10500JBFVI
Jacketed Armored	T10500JBA
Jacketed Armored, Tracer Coded	T10500JBAVI
NEC - Article 820, CATV Listed, Unjacketed	T10500V

*Used for aerial applications due to non-flowing, non-dripping compound.

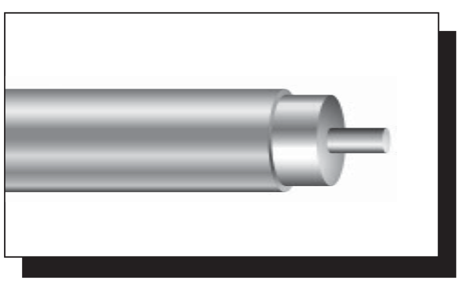
Note: Standard colored tracer stripes are red, yellow, green, blue, white, and slate. For other color combinations, please contact a customer service representative or your area sales representative.



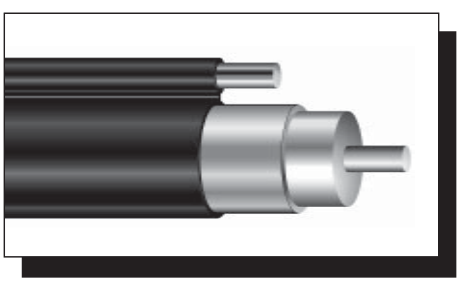
Jacketed



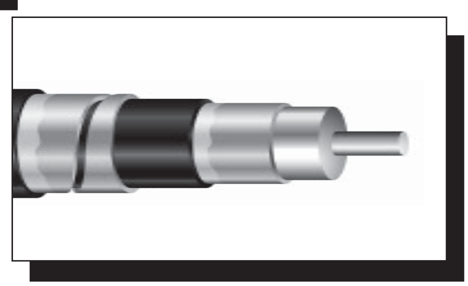
Jacketed Burial



Unjacketed



Messengered



Armored

Customers are reminded that they are SOLELY responsible for confirming that all products are properly installed and used in accordance with all applicable codes and regulations.

500 SERIES SEMIFLEX CABLE T10

PHYSICAL SPECIFICATIONS

NOMINAL DIMENSIONS	UNJACKETED*		JACKETED		EXTRA THICK JACKET		MESSENGERED		JACKETED BURIAL		EXTRA THICK JACKETED BURIAL		ARMORED	
	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)
Conductor	0.109	(2.77)	0.109	(2.77)	0.109	(2.77)	0.109	(2.77)	0.109	(2.77)	0.109	(2.77)	0.109	(2.77)
Dielectric	0.450	(11.4)	0.450	(11.4)	0.450	(11.4)	0.450	(11.4)	0.450	(11.4)	0.450	(11.4)	0.450	(11.4)
Outer Conductor Thickness	0.025	(0.64)	0.025	(0.64)	0.025	(0.64)	0.025	(0.64)	0.025	(0.64)	0.025	(0.64)	0.025	(0.64)
Outer Conductor Diameter	0.500	(12.7)	0.500	(12.7)	0.500	(12.7)	0.500	(12.7)	0.500	(12.7)	0.500	(12.7)	0.500	(12.7)
First Jacket	—	—	0.560	(14.2)	0.630	(16.0)	0.580	(14.7)	0.570	(14.5)	0.640	(16.3)	0.570	(14.5)
Messenger	—	—	—	—	—	—	0.109	(2.77)	—	—	—	—	—	—
Armor	—	—	—	—	—	—	—	—	—	—	—	—	0.590	(15.0)
Second Jacket	—	—	—	—	—	—	—	—	—	—	—	—	0.690	(17.5)
Nominal Weight (lb/kft) (kg/km)[1]	78	(116)	99	(147)	126	(188)	154	(229)	103	(153)	130	(193)	199	(296)
Nominal Weight (per reel) lb (kg)[2]	269	(122)	319	(145)	409	(186)	479	(217)	328	(149)	419	(190)	588	(267)
Nominal Length (per reel) feet (m)	2450	(747)	2450	(747)	2450	(747)	2450	(747)	2450	(747)	2450	(747)	2450	(747)
Maximum Pull Force lbf (N)	300	(1334)	300	(1334)	300	(1334)	900	(4003)	300	(1334)	300	(1334)	300	(1334)
Minimum Bend Radius in (mm)	4.0	(102)	3.5	(89)	3.5	(89)	4.0	(102)	4.0	(102)	4.0	(102)	9.7	(246)
Messenger Break Strength lbf (N)	—	—	—	—	—	—	1800	(8007)	—	—	—	—	—	—
Reel Size (inches) (Flange x Width)[3]	36 x 22		36 x 22		42 x 22		42 x 22		36 x 22		42 x 22		42 x 22	
Reel Size (centimeters) (Flange x Width)[3]	91 x 56		91 x 56		107 x 56		107 x 56		91 x 56		107 x 56		107 x 56	

* All T10 Unjacketed Cable is available rated per **NEC Article 820 - CATV**

[1]cable minus reel, [2] cable plus reel, [3] Width is outside flange to outside flange

ELECTRICAL SPECIFICATIONS

Nominal DC Resistance @ 68°F (20°C)	Ohms per 1000	
Copper-Clad Aluminum Center Conductor	**feet**	**meters**
Center Conductor	1.34	4.40
Outer Conductor	0.36	1.18
Loop	1.70	5.58
Nominal Capacitance	15.6 pF/ft	(51.2 pF/m)
Impedance	75 ± 2 Ohms	
Velocity of Propagation	87% nominal	

MAXIMUM ATTENUATION @ 68°F (20°C)

Frequency MHz	dB per 100 feet	dB per 100 meters
5	0.16	0.52
55	0.55	1.80
211	1.08	3.55
250	1.19	3.92
270	1.24	4.07
300	1.31	4.30
330	1.38	4.54
350	1.43	4.69
400	1.53	5.02
450	1.63	5.35
500	1.73	5.68
550	1.82	5.97
600	1.91	6.27
750	2.16	7.09
870	2.35	7.69
1000	2.53	8.30

Attenuation increases with increasing temperature and decreases with decreasing temperature at the rate of 0.1% / °F (0.18% / °C)

Specifications subject to change without notice.

Customers are reminded that they are SOLELY responsible for confirming that all products are properly installed and used in accordance with all applicable codes and regulations.

625 SERIES SEMIFLEX CABLE

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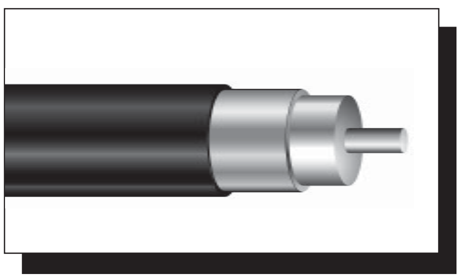
PART NUMBERS

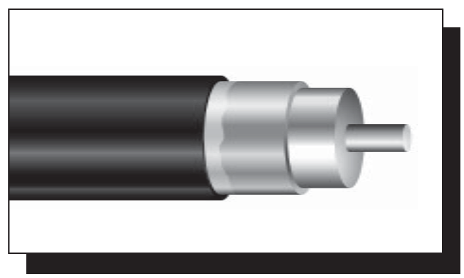
CONSTRUCTION	CENTER CONDUCTOR Copper-Clad Aluminum Part Number
Unjacketed	T10625
Unjacketed, Tracer Coded	T10625VI
Jacketed	T10625J
Jacketed, Extra Thick Jacket	T10625JX
Jacketed, Extra Thick Jacket, Tracer Coded	T10625JXVI
Jacketed, Tracer Coded	T10625JVI
Jacketed Messengered	T10625MS
Jacketed Flooded, Underground	T10625JB
Jacketed Flooded, Underground, Extra Thick Jacket	T10625JBX
Jacketed Flooded, Underground, Extra Thick Jacket, Tracer Coded	T10625JBXVI
Jacketed Flooded, Underground, Tracer Coded	T10625JBVI
Jacketed Flooded, Aerial*	T10625JBF
Jacketed Flooded, Aerial,*Tracer Coded	T10625JBFVI
Jacketed Armored	T10625JBA
Jacketed Armored, Tracer Coded	T10625JBAVI
NEC - Article 820, CATV Listed, Unjacketed	T10625V

*Used for aerial applications due to non-flowing, non-dripping compound.

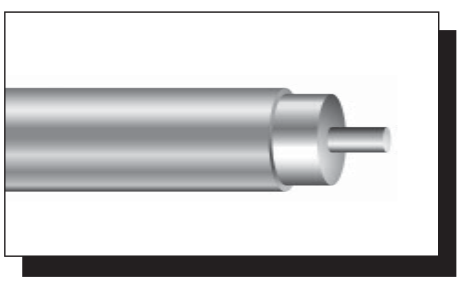
Note: Standard colored tracer stripes are red, yellow, green, blue, white, and slate. For other color combinations, please contact a customer service representative or your area sales representative.



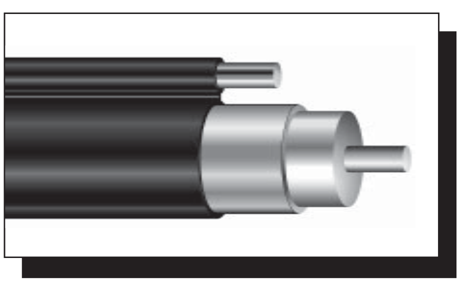
Jacketed



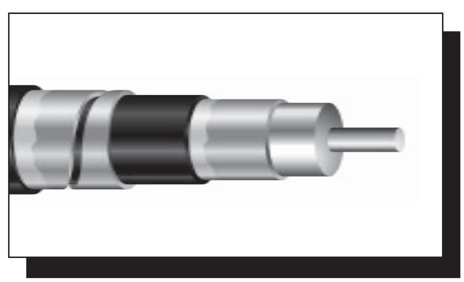
Jacketed Burial



Unjacketed



Messengered



Armored

TIMES FIBER COMMUNICATIONS, INC.®
203-265-8500 800-677-2288

TFC Amphenol

625 SERIES SEMIFLEX CABLE T10

PHYSICAL SPECIFICATIONS

NOMINAL DIMENSIONS	UNJACKETED*		JACKETED		EXTRA THICK JACKET		MESSENGERED		JACKETED BURIAL		EXTRA THICK JACKETED BURIAL		ARMORED	
	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)
Conductor	0.136	(3.45)	0.136	(3.45)	0.136	(3.45)	0.136	(3.45)	0.136	(3.45)	0.136	(3.45)	0.136	(3.45)
Dielectric	0.563	(14.3)	0.563	(14.3)	0.563	(14.3)	0.563	(14.3)	0.563	(14.3)	0.563	(14.3)	0.563	(14.3)
Outer Conductor Thickness	0.031	(0.79)	0.031	(0.79)	0.031	(0.79)	0.031	(0.79)	0.031	(0.79)	0.031	(0.79)	0.031	(0.79)
Outer Conductor Diameter	0.625	(15.9)	0.625	(15.9)	0.625	(15.9)	0.625	(15.9)	0.625	(15.9)	0.625	(15.9)	0.625	(15.9)
First Jacket	—	—	0.685	(17.4)	0.755	(19.2)	0.705	(17.9)	0.695	(17.7)	0.765	(19.4)	0.695	(17.7)
Messenger	—	—	—	—	—	—	0.188	(4.78)	—	—	—	—	—	—
Armor	—	—	—	—	—	—	—	—	—	—	—	—	0.715	(18.2)
Second Jacket	—	—	—	—	—	—	—	—	—	—	—	—	0.815	(20.7)
Nominal Weight (lb/kft) (kg/km)[1]	122	(182)	147	(219)	180	(268)	249	(371)	151	(225)	185	(275)	268	(399)
Nominal Weight (per reel) lb (kg)[2]	399	(181)	461	(209)	587	(266)	758	(344)	472	(214)	599	(272)	803	(364)
Nominal Length (per reel) feet (m)	2450	(747)	2450	(747)	2450	(747)	2450	(747)	2450	(747)	2450	(747)	2450	(747)
Maximum Pull Force lbf (N)	475	(2113)	475	(2113)	475	(2113)	1995	(8874)	475	(2113)	475	(2113)	475	(2113)
Minimum Bend Radius in (mm)	5.0	(127)	4.5	(114)	4.5	(114)	5.0	(127)	5.0	(127)	5.0	(127)	11.4	(290)
Messenger Break Strength lbf (N)	—	—	—	—	—	—	3990	(17748)	—	—	—	—	—	—
Reel Size (inches) (Flange x Width)[3]	42 x 22		42 x 22		48 x 28		50 x 28		42 x 22		48 x 28		48 x 28	
Reel Size (cm) (Flange x Width)[3]	107 x 56		107 x 56		122 x 71		127 x 71		107 x 56		122 x 71		122 x 71	

* All T10 Unjacketed Cable is available rated per **NEC Article 820 - CATV**

[1]cable minus reel, [2] cable plus reel, [3] Width is outside flange to outside flange

ELECTRICAL SPECIFICATIONS

Nominal DC Resistance @ 68°F (20°C)	Ohms per 1000	
Copper-Clad Aluminum Center Conductor	**feet**	**meters**
Center Conductor	0.86	2.82
Outer Conductor	0.23	0.75
Loop	1.09	3.58
Nominal Capacitance	15.6 pF/ft (51.2 pF/m)	
Impedance	75 ± 2 Ohms	
Velocity of Propagation	87% nominal	

MAXIMUM ATTENUATION @ 68°F (20°C)

Frequency MHz	dB per 100 feet	dB per 100 meters
5	0.13	0.43
55	0.45	1.46
211	0.89	2.92
250	0.98	3.22
270	1.02	3.35
300	1.08	3.54
330	1.14	3.75
350	1.18	3.87
400	1.27	4.17
450	1.35	4.43
500	1.43	4.69
550	1.51	4.95
600	1.58	5.18
750	1.79	5.87
870	1.95	6.40
1000	2.11	6.92

Attenuation increases with increasing temperature and decreases with decreasing temperature at the rate of 0.1% / °F (0.18% / °C)

Specifications subject to change without notice.

T10 750 SERIES SEMIFLEX CABLE

TIMES FIBER COMMUNICATIONS, INC.®
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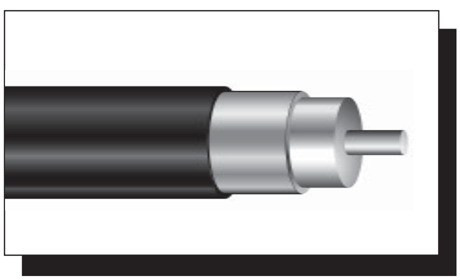
TFC Amphenol

PART NUMBERS

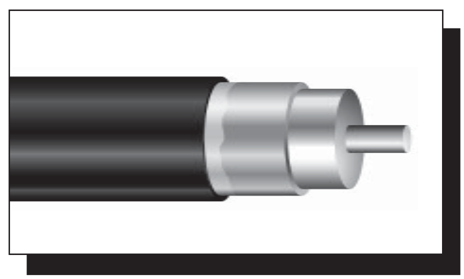
CONSTRUCTION	CENTER CONDUCTOR Copper-Clad Aluminum Part Number
Unjacketed	T10750
Unjacketed, Tracer Coded	T10750VI
Jacketed	T10750J
Jacketed, Exta Thick Jacket	T10750JX
Jacketed, Extra Thick Jacket, Tracer Coded	T10750JXVI
Jacketed, Tracer Coded	T10750JVI
Jacketed Messengered	T10750MS
Jacketed Flooded, Underground	T10750JB
Jacketed Flooded, Underground, Extra Thick Jacket	T10750JBX
Jacketed Flooded, Underground, Extra Thick Jacket, Tracer Coded	T10750JBXVI
Jacketed Flooded, Underground, Tracer Coded	T10750JBVI
Jacketed Flooded, Aerial*	T10750JBF
Jacketed Flooded, Aerial,* Tracer Coded	T10750JBFVI
Jacketed Armored	T10750JBA
Jacketed Armored, Tracer Coded	T10750JBAVI
NEC - Article 820, CATV Listed, Unjacketed	T10750V

*Used for aerial applications due to non-flowing, non-dripping compound.

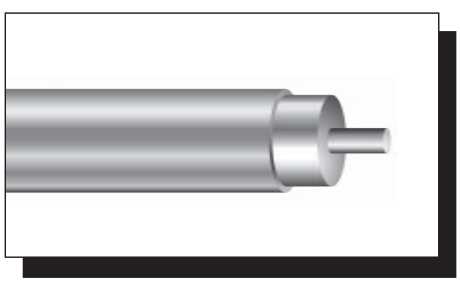
Note: Standard colored tracer stripes are red, yellow, green, blue, white, and slate. For other color combinations, please contact a customer service representative or your area sales representative.



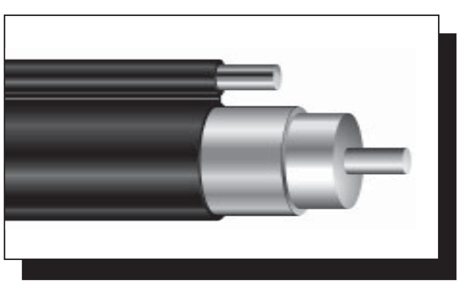
Jacketed



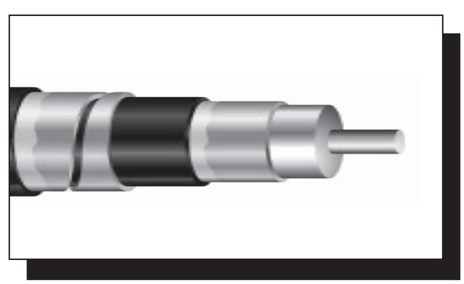
Jacketed Burial



Unjacketed



Messengered



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TFC Amphenol

750 SERIES SEMIFLEX CABLE T10

PHYSICAL SPECIFICATIONS

NOMINAL DIMENSIONS	UNJACKETED*		JACKETED		EXTRA THICK JACKET		MESSENGERED		JACKETED BURIAL		EXTRA THICK JACKETED BURIAL		ARMORED	
	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)
Conductor	0.166	(4.22)	0.166	(4.22)	0.166	(4.22)	0.166	(4.22)	0.166	(4.22)	0.166	(4.22)	0.166	(4.22)
Dielectric	0.678	(17.2)	0.678	(17.2)	0.678	(17.2)	0.678	(17.2)	0.678	(17.2)	0.678	(17.2)	0.678	(17.2)
Outer Conductor Thickness	0.036	(0.91)	0.036	(0.91)	0.036	(0.91)	0.036	(0.91)	0.036	(0.91)	0.036	(0.91)	0.036	(0.91)
Outer Conductor Diameter	0.750	(19.1)	0.750	(19.1)	0.750	(19.1)	0.750	(19.1)	0.750	(19.1)	0.750	(19.1)	0.750	(19.1)
First Jacket	—	—	0.820	(20.8)	0.880	(22.4)	0.850	(21.6)	0.830	(21.1)	0.890	(22.6)	0.830	(21.1)
Messenger	—	—	—	—	—	—	0.250	(6.35)	—	—	—	—	—	—
Armor	—	—	—	—	—	—	—	—	—	—	—	—	0.850	(21.6)
Second Jacket	—	—	—	—	—	—	—	—	—	—	—	—	0.950	(24.1)
Nominal Weight (lb/kft) (kg/km)[1]	173	(257)	208	(310)	241	(359)	380	(566)	213	(317)	247	(368)	351	(522)
Nominal Weight (per reel) lb (kg)[2]	578	(262)	669	(303)	752	(341)	1255	(569)	682	(309)	766	(347)	1121	(508)
Nominal Length (per reel) feet (m)	2500	(762)	2500	(762)	2500	(762)	2500	(762)	2500	(762)	2500	(762)	2500	(762)
Maximum Pull Force lbf (N)	675	(3003)	675	(3003)	675	(3003)	3325	(14790)	675	(3003)	675	(3003)	675	(3003)
Minimum Bend Radius in (mm)	7.0	(178)	6.0	(152)	6.0	(152)	7.0	(178)	7.0	(178)	7.0	(178)	13.3	(338)
Messenger Break Strength lbf (N)	—	—	—	—	—	—	6650	(29581)	—	—	—	—	—	—
Reel Size (inches) (Flange x Width)[3]	48 x 28		50 x 28		50 x 28		63 x 30		50 x 28		50 x 28		57 x 28	
Reel Size (centimeters) (Flange x Width)[3]	122 x 71		127 x 71		127 x 71		160 x 76		127 x 71		127 x 71		145 x 71	

* All T10 Unjacketed Cable is available rated per **NEC Article 820 - CATV**

[1]cable minus reel, [2] cable plus reel, [3] Width is outside flange to outside flange

ELECTRICAL SPECIFICATIONS

Nominal DC Resistance @ 68°F (20°C)	Ohms per 1000	
Copper-Clad Aluminum Center Conductor	**feet**	**meters**
Center Conductor	0.58	1.90
Outer Conductor	0.17	0.56
Loop	0.75	2.46
Nominal Capacitance	15.6 pF/ft (51.2 pF/m)	
Impedance	75 ± 2 Ohms	
Velocity of Propagation	87% nominal	

MAXIMUM ATTENUATION @ 68°F (20°C)

Frequency MHz	dB per 100 feet	dB per 100 meters
5	0.11	0.36
55	0.37	1.21
211	0.73	2.41
250	0.81	2.65
270	0.84	2.76
300	0.89	2.92
330	0.94	3.08
350	0.97	3.18
400	1.05	3.44
450	1.12	3.67
500	1.18	3.87
550	1.25	4.10
600	1.31	4.30
750	1.48	4.86
870	1.61	5.28
1000	1.74	5.71

Attenuation increases with increasing temperature and decreases with decreasing temperature at the rate of 0.1% / °F (0.18% / °C)

Specifications subject to change without notice.

875 SERIES SEMIFLEX CABLE

TIMES FIBER COMMUNICATIONS, INC.®
203-265-8500 800-677-2288

Amphenol

PART NUMBERS

CONSTRUCTION	CENTER CONDUCTOR Copper-Clad Aluminum Part Number
Unjacketed	T10875
Unjacketed, Tracer Coded	T10875VI
Jacketed	T10875J
Jacketed, Extra Thick Jacket	T10875JX
Jacketed, Extra Thick Jacket, Tracer Coded	T10875JXVI
Jacketed, Tracer Coded	T10875JVI
Jacketed Messengered	T10875MS
Jacketed Flooded, Underground	T10875JB
Jacketed Flooded, Underground, Extra Thick Jacket	T10875JBX
Jacketed Flooded, Underground, Extra Thick Jacket, Tracer Coded	T10875JBXVI
Jacketed Flooded, Underground, Color Coded	T10875JBVI
Jacketed Flooded, Aerial*	T10875JBF
Jacketed Flooded, Aerial,* Tracer Coded	T10875JBFVI
Jacketed Armored	T10875JBA
Jacketed Armored, Tracer Coded	T10875JBAVI
NEC - Article 820, CATV Listed, Unjacketed	T10875V

*Used for aerial applications due to non-flowing, non-dripping compound.

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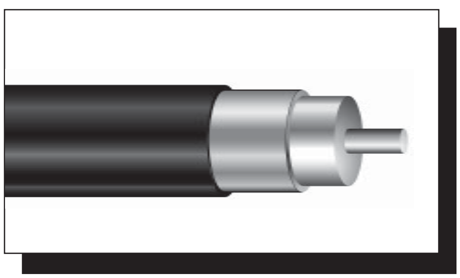
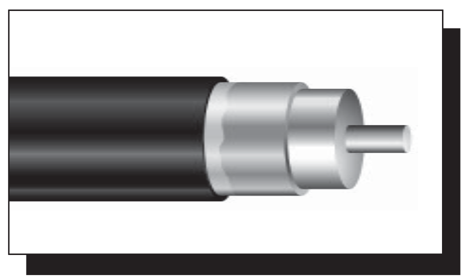
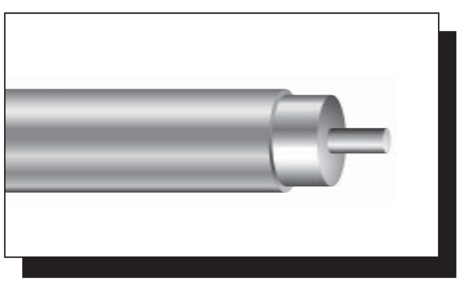


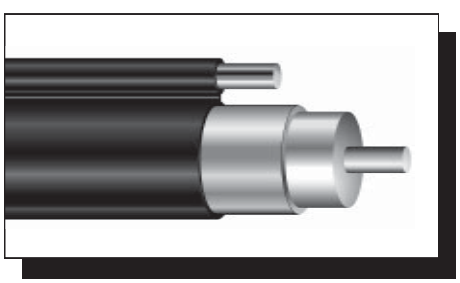
Jacketed



Jacketed Burial



Unjacketed



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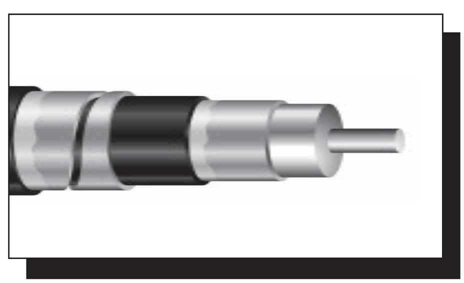

Armored

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TFC Amphenol

875 SERIES SEMIFLEX CABLE T10

PHYSICAL SPECIFICATIONS

NOMINAL DIMENSIONS	UNJACKETED*		JACKETED		EXTRA THICK JACKET		MESSENGERED		JACKETED BURIAL		EXTRA THICK JACKETED BURIAL		ARMORED	
	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)
Conductor	0.194	(4.93)	0.194	(4.93)	0.194	(4.93)	0.194	(4.93)	0.194	(4.93)	0.194	(4.93)	0.194	(4.93)
Dielectric	0.797	(20.2)	0.797	(20.2)	0.797	(20.2)	0.797	(20.2)	0.797	(20.2)	0.797	(20.2)	0.797	(20.2)
Outer Conductor Thickness	0.039	(0.99)	0.039	(0.99)	0.039	(0.99)	0.039	(0.99)	0.039	(0.99)	0.039	(0.99)	0.039	(0.99)
Outer Conductor Diameter	0.875	(22.2)	0.875	(22.2)	0.875	(22.2)	0.875	(22.2)	0.875	(22.2)	0.875	(22.2)	0.875	(22.2)
First Jacket	—	—	0.945	(24.0)	1.005	(25.5)	0.975	(24.8)	0.955	(24.3)	1.015	(25.8)	0.955	(24.3)
Messenger	—	—	—	—	—	—	0.250	(6.35)	—	—	—	—	—	—
Armor	—	—	—	—	—	—			—	—	—	—	0.975	(24.8)
Second Jacket	—	—	—	—	—	—			—	—	—	—	1.075	(27.3)
Nominal Weight (lb/1000 ft) (kg/km)[1]	227	(338)	268	(399)	306	(455)	442	(658)	274	(408)	312	(464)	432	(643)
Nominal Weight (per reel) lb (kg)[2]	800	(363)	901	(409)	994	(451)	1569	(712)	916	(415)	1010	(458)	1364	(619)
Nominal Length (per reel) feet (m)	2450	(747)	2450	(747)	2450	(747)	2450	(747)	2450	(747)	2450	(747)	2450	(747)
Maximum Pull Force lbf (N)	875	(3892)	875	(3892)	875	(3892)	3325	(14790)	875	(3892)	875	(3892)	875	(3892)
Minimum Bend Radius in (mm)	8.0	(203)	7.0	(178)	7.0	(178)	8.0	(203)	8.0	(203)	8.0	(203)	15.0	(381)
Messenger Break Strength lbf (N)	—	—	—	—	—	—	6650	(29581)	—	—	—	—	—	—
Reel Size (inches) (Flange x Width)[3]	57 x 28		57 x 28		57 x 28		72 x 30		57 x 28		57 x 28		63 x 30	
Reel Size (centimeters) (Flange x Width)[3]	145 x 71		145 x 71		145 x 71		183 x 76		145 x 71		145 x 71		160 x 76	

* All T10 Unjacketed Cable is available rated per **NEC Article 820 - CATV**

[1]cable minus reel, [2] cable plus reel, [3] Width is outside flange to outside flange

ELECTRICAL SPECIFICATIONS

Nominal DC Resistance @ 68°F (20°C)	**Ohms per 1000**	
Copper-Clad Aluminum Center Conductor	**feet**	**meters**
Center Conductor	0.42	1.38
Outer Conductor	0.13	0.43
Loop	0.55	1.80
Nominal Capacitance	15.6 pF/ft (51.2 pF/m)	
Impedance	75 ± 2 Ohms	
Velocity of Propagation	87% nominal	

MAXIMUM ATTENUATION @ 68°F (20°C)

Frequency MHz	dB per 100 feet	dB per 100 meters
5	0.09	0.30
55	0.32	1.04
211	0.64	2.09
250	0.70	2.31
270	0.73	2.40
300	0.78	2.56
330	0.82	2.68
350	0.84	2.76
400	0.91	2.99
450	0.97	3.18
500	1.03	3.38
550	1.09	3.58
600	1.14	3.74
750	1.29	4.23
870	1.41	4.63
1000	1.53	5.02

Attenuation increases with increasing temperature and decreases with decreasing temperature at the rate of 0.1% / °F (0.18% / °C)

Specifications subject to change without notice.

1000 SERIES SEMIFLEX CABLE

TIMES FIBER COMMUNICATIONS, INC.®
203-265-8500 800-677-2288

PART NUMBERS

CONSTRUCTION	CENTER CONDUCTOR Copper-Clad Aluminum Part Number
Unjacketed	T101000
Unjacketed, Tracer Coded	T101000VI
Jacketed	T101000J
Jacketed, Extra Thick Jacket	T101000JX
Jacketed, Extra Thick Jacket, Tracer Coded	T101000JXVI
Jacketed, Tracer Coded	T101000JVI
Jacketed Messengered	—
Jacketed Flooded, Underground	T101000JB
Jacketed Flooded, Underground, Extra Thick Jacket	T101000JBX
Jacketed Flooded, Underground, Extra Thick Jacket, Tracer Coded	T101000JBXVI
Jacketed Flooded, Underground, Tracer Coded	T101000JBVI
Jacketed Flooded, Aerial*	T101000JBF
Jacketed Flooded, Aerial,* Tracer Coded	T101000JBFVI
Jacketed Armored	T101000JBA
Jacketed Armored, Tracer Coded	T101000JBAVI
NEC - Article 820, CATV Listed, Unjacketed	T101000V

*Used for aerial applications due to non-flowing, non-dripping compound.

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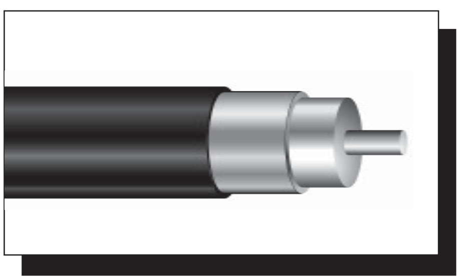
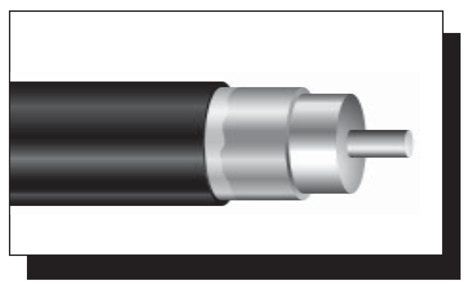
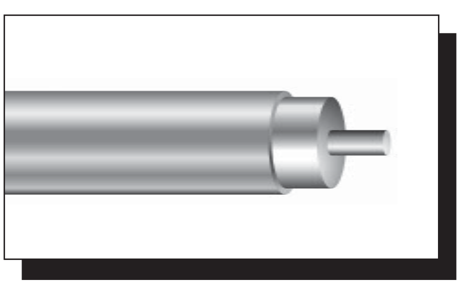


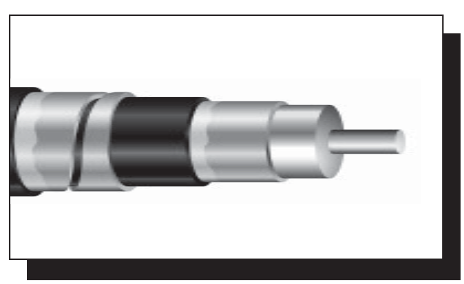
Jacketed



Jacketed Burial



Unjacketed



Armored

Customers are reminded that they are SOLELY responsible for confirming that all products are properly installed and used in accordance with all applicable codes and regulations.

1000 SERIES SEMIFLEX CABLE T10

PHYSICAL SPECIFICATIONS

NOMINAL DIMENSIONS	UNJACKETED*		JACKETED		EXTRA THICK JACKET		JACKETED BURIAL		EXTRA THICK JACKETED BURIAL		ARMORED	
	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)
Conductor	0.220	(5.59)	0.220	(5.59)	0.220	(5.59)	0.220	(5.59)	0.220	(5.59)	0.220	(5.59)
Dielectric	0.890	(22.6)	0.890	(22.6)	0.890	(22.6)	0.890	(22.6)	0.890	(22.6)	0.890	(22.6)
Outer Conductor Thickness	0.055	(1.40)	0.055	(1.40)	0.055	(1.40)	0.055	(1.40)	0.055	(1.40)	0.055	(1.40)
Outer Conductor Diameter	1.000	(25.4)	1.000	(25.4)	1.000	(25.4)	1.000	(25.4)	1.000	(25.4)	1.000	(25.4)
First Jacket	—	—	1.080	(27.4)	1.130	(28.7)	1.090	(27.7)	1.140	(29.0)	1.090	(27.7)
Messenger	—	—	—	—	—	—	—	—	—	—	—	—
Armor	—	—	—	—	—	—	—	—	—	—	1.110	(28.2)
Second Jacket	—	—	—	—	—	—	—	—	—	—	1.210	(30.7)
Nominal Weight (lb/1000 ft) (kg/km)[1]	323	(481)	377	(561)	412	(613)	384	(571)	420	(625)	563	(838)
Nominal Weight (per reel) lb (kg)[2]	1049	(476)	1201	(545)	1286	(583)	1217	(552)	1303	(591)	1826	(828)
Nominal Length (per reel) feet (m)	2300	(701)	2300	(701)	2300	(701)	2300	(701)	2300	(701)	2300	(701)
Maximum Pull Force lbf (N)	1300	(5783)	1300	(5783)	1300	(5783)	1300	(5783)	1300	(5783)	1300	(5783)
Minimum Bend Radius in (mm)	9.0	(229)	8.0	(203)	8.0	(203)	9.0	(229)	9.0	(229)	16.9	(429)
Messenger Break Strength lbf (N)	—	—	—	—	—	—	—	—	—	—	—	—
Reel Size (inches) (Flange x Width)[3]	63 x 30		63 x 30		63 x 30		63 x 30		63 x 30		72 x 30	
Reel Size (centimeters) (Flange x Width)[3]	160 x 76		160 x 76		160 x 76		160 x 76		160 x 76		183 x 76	

* All T10 Unjacketed Cable is available rated per **NEC Article 820 - CATV**

[1]cable minus reel, [2] cable plus reel, [3] Width is outside flange to outside flange

ELECTRICAL SPECIFICATIONS

Nominal DC Resistance @ 68°F (20°C)	Ohms per 1000	
Copper-Clad Aluminum Center Conductor	**feet**	**meters**
Center Conductor	0.33	1.08
Outer Conductor	0.08	0.26
Loop	0.41	1.35
Nominal Capacitance	15.6 pF/ft (51.2 pF/m)	
Impedance	75 ± 2 Ohms	
Velocity of Propagation	87% nominal	

MAXIMUM ATTENUATION @ 68°F (20°C)

Frequency MHz	dB per 100 feet	dB per 100 meters
5	0.08	0.26
55	0.29	0.95
211	0.58	1.92
250	0.64	2.11
270	0.67	2.20
300	0.72	2.36
330	0.76	2.48
350	0.78	2.56
400	0.84	2.76
450	0.90	2.95
500	0.96	3.15
550	1.01	3.31
600	1.06	3.48
750	1.21	3.97
870	1.33	4.35
1000	1.44	4.72

Attenuation increases with increasing temperature and decreases with decreasing temperature at the rate of 0.1% / °F (0.18% / °C)

Specifications subject to change without notice.

Customers are reminded that they are SOLELY responsible for confirming that all products are properly installed and used in accordance with all applicable codes and regulations.

T10 SEMIFLEX CABLE SERIES

TFC Amphenol

ATTENUATION SUMMARY (maximum) @ 68°F (20°C)

Frequency MHz	Series 412 dB/100 feet	Series 412 dB/100 meters	Series 500 dB/100 feet	Series 500 dB/100 meters	Series 625 dB/100 feet	Series 625 dB/100 meters	Series 750 dB/100 feet	Series 750 dB/100 meters	Series 875 dB/100 feet	Series 875 dB/100 meters	Series 1000 dB/100 feet	Series 1000 dB/100 meters
5	0.20	0.66	0.16	0.52	0.13	0.43	0.11	0.36	0.09	0.30	0.08	0.26
55	0.68	2.24	0.55	1.80	0.45	1.46	0.37	1.21	0.32	1.04	0.29	0.95
211	1.35	4.44	1.08	3.55	0.89	2.92	0.73	2.41	0.64	2.09	0.58	1.92
250	1.49	4.89	1.19	3.92	0.98	3.22	0.81	2.65	0.70	2.31	0.64	2.11
270	1.55	5.09	1.24	4.07	1.02	3.35	0.84	2.76	0.73	2.40	0.67	2.20
300	1.64	5.38	1.31	4.30	1.08	3.54	0.89	2.92	0.78	2.56	0.72	2.36
330	1.73	5.66	1.38	4.54	1.14	3.75	0.94	3.08	0.82	2.68	0.76	2.48
350	1.78	5.84	1.43	4.69	1.18	3.87	0.97	3.18	0.84	2.76	0.78	2.56
400	1.91	6.27	1.53	5.02	1.27	4.17	1.05	3.44	0.91	2.99	0.84	2.76
450	2.03	6.66	1.63	5.35	1.35	4.43	1.12	3.67	0.97	3.18	0.90	2.95
500	2.15	7.05	1.73	5.68	1.43	4.69	1.18	3.87	1.03	3.38	0.96	3.15
550	2.26	7.41	1.82	5.97	1.51	4.95	1.25	4.10	1.09	3.58	1.01	3.31
600	2.37	7.78	1.91	6.27	1.58	5.18	1.31	4.30	1.14	3.74	1.06	3.48
750	2.68	8.79	2.16	7.09	1.79	5.87	1.48	4.86	1.29	4.23	1.21	3.97
870	2.90	9.52	2.35	7.69	1.95	6.40	1.61	5.28	1.41	4.63	1.33	4.35
1000	3.13	10.27	2.53	8.30	2.11	6.92	1.74	5.71	1.53	5.02	1.44	4.72

Attenuation increases with increasing temperature and decreases with decreasing temperature at the rate of 0.1%/°F (0.18%/°C).

TABLE OF CONTENTS: TX10 SEMIFLEX CABLE SERIES

TX10 565 SERIES SEMIFLEX CABLE

TIMES FIBER COMMUNICATIONS, INC.®
203-265-8500 800-677-2288

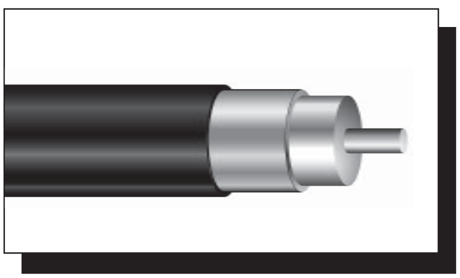
TFC Amphenol

PART NUMBERS

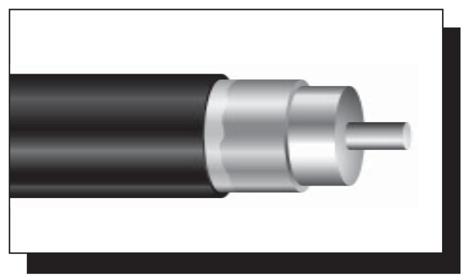
CONSTRUCTION	CENTER CONDUCTOR Copper-Clad Aluminum Part Number
Jacketed	TX10565J
Jacketed, Tracer Coded	TX10565JVI
Jacketed Messengered	TX10565MS
Jacketed Flooded, Underground	TX10565JB
Jacketed Flooded, Underground, Extra Thick Jacket	TX10565JBX
Jacketed Flooded, Underground, Extra Thick Jacket, Tracer Coded	TX10565JBXVI
Jacketed Flooded, Underground, Tracer Coded	TX10565JBVI
Jacketed Flooded, Aerial*	TX10565JBF
Jacketed Flooded, Aerial,* Tracer Coded	TX10565JBFVI
Jacketed Armored	TX10565JBA
Jacketed Armored, Tracer Coded	TX10565JBAVI

*Used for aerial applications due to non-flowing, non-dripping compound.

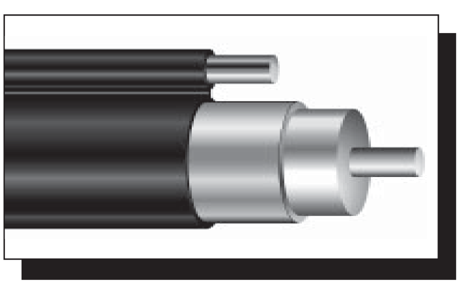
Note: Standard colored tracer stripes are red, yellow, green, blue, white, and slate. For other color combinations, please contact a customer service representative or your area sales representative.



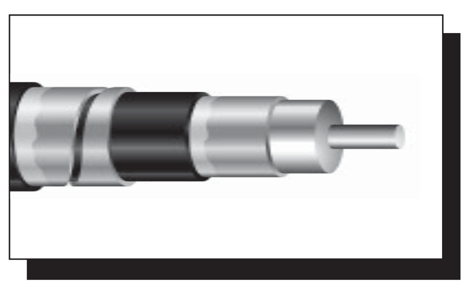
Jacketed



Jacketed Burial



Messengered



Armored

TIMES FIBER COMMUNICATIONS, INC.®
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565 SERIES SEMIFLEX CABLE TX10

PHYSICAL SPECIFICATIONS

NOMINAL DIMENSIONS	JACKETED		MESSENGERED		JACKETED BURIAL		EXTRA THICK JACKETED BURIAL		ARMORED	
	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)
Conductor	0.129	(3.28)	0.129	(3.28)	0.129	(3.28)	0.129	(3.28)	0.129	(3.28)
Dielectric	0.519	(13.2)	0.519	(13.2)	0.519	(13.2)	0.519	(13.2)	0.519	(13.2)
Outer Conductor Thickness	0.023	(0.58)	0.023	(0.58)	0.023	(0.58)	0.023	(0.58)	0.023	(0.58)
Outer Conductor Diameter	0.565	(14.4)	0.565	(14.4)	0.565	(14.4)	0.565	(14.4)	0.565	(14.4)
First Jacket	0.625	(15.9)	0.645	(16.4)	0.635	(16.1)	0.705	(17.9)	0.635	(16.1)
Messenger	—	—	0.188	(4.78)	—	—	—	—	—	—
Armor	—	—	—	—	—	—	—	—	0.655	(16.6)
Second Jacket	—	—	—	—	—	—	—	—	0.755	(19.2)
Nominal Weight (lb/1000 ft) (kg/km)[1]	107	(159)	208	(310)	111	(165)	142	(211)	218	(324)
Nominal Weight (per reel) lb (kg)[2]	384	(174)	656	(298)	393	(178)	494	(224)	681	(309)
Nominal Length (per reel) feet (m)	2450	(747)	2450	(747)	2450	(747)	2450	(747)	2450	(747)
Maximum Pull Force lbf (N)	350	(1557)	1995	(8874)	350	(1557)	350	(1557)	350	(1557)
Minimum Bend Radius in (mm)	5.1	(130)	5.1	(130)	7.5	(191)	7.5	(191)	11	(279)
Messenger Break Strength lbf (N)	—	—	3990	(17748)	—	—	—	—	—	—
Reel Size (inches) (Flange x Width)[3]	44 x 22		48 x 28		44 x 22		48 x 28		48 x 28	
Reel Size (centimeters) (Flange x Width)[3]	112 x 56		122 x 71		112 x 56		122 x 71		122 x 71	

[1]cable minus reel, [2] cable plus reel, [3] Width is outside flange to outside flange

ELECTRICAL SPECIFICATIONS

Nominal DC Resistance @ 68°F (20°C)	Ohms per 1000	
Copper-Clad Aluminum Center Conductor	**feet**	**meters**
Center Conductor	0.96	3.15
Outer Conductor	0.34	1.12
Loop	1.30	4.27
Nominal Capacitance	15.2 pF/ft (49.9 pF/m)	
Impedance	75 ± 2 Ohms	
Velocity of Propagation	89% nominal	

MAXIMUM ATTENUATION @ 68°F (20°C)

Frequency MHz	dB per 100 feet	dB per 100 meters
5	0.14	0.46
55	0.47	1.55
211	0.93	3.06
250	1.03	3.38
270	1.07	3.51
300	1.13	3.71
330	1.19	3.91
350	1.23	4.04
400	1.32	4.33
450	1.40	4.59
500	1.49	4.89
550	1.56	5.12
600	1.64	5.38
750	1.85	6.07
870	2.01	6.58
1000	2.17	7.12

Attenuation increases with increasing temperature and decreases with decreasing temperature at the rate of 0.1% / °F (0.18% / °C)

Specifications subject to change without notice.

TX10 700 SERIES SEMIFLEX CABLE

TIMES FIBER COMMUNICATIONS, INC.®
203-265-8500 800-677-2288

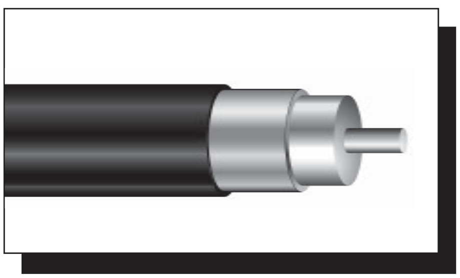
TFC Amphenol

PART NUMBERS

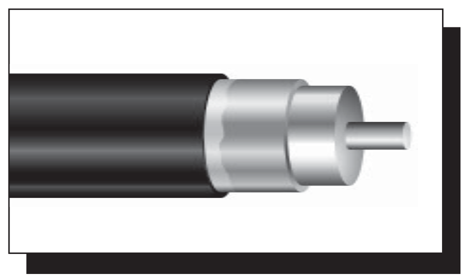
CONSTRUCTION	CENTER CONDUCTOR Copper-Clad Aluminum Part Number
Jacketed	TX10700J
Jacketed, Tracer Coded	TX10700JVI
Jacketed Messengered	TX10700MS
Jacketed Flooded, Underground	TX10700JB
Jacketed Flooded, Underground, Extra Thick Jacket	TX10700JBX
Jacketed Flooded, Underground, Extra Thick Jacket, Tracer Coded	TX10700JBXVI
Jacketed Flooded, Underground, Tracer Coded	TX10700JBVI
Jacketed Flooded, Aerial*	TX10700JBF
Jacketed Flooded, Aerial,* Tracer Coded	TX10700JBFVI
Jacketed Armored	TX10700JBA
Jacketed Armored, Tracer Coded	TX10700JBAVI

*Used for aerial applications due to non-flowing, non-dripping compound.

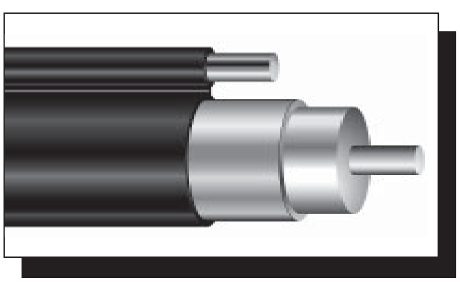
Note: Standard colored tracer stripes are red, yellow, green, blue, white, and slate. For other color combinations, please contact a customer service representative or your area sales representative.



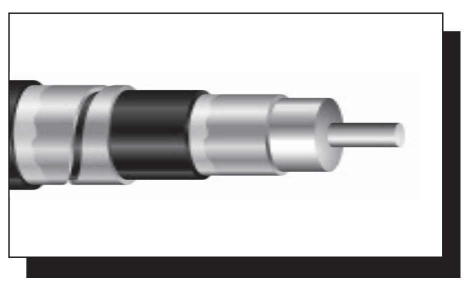
Jacketed



Jacketed Burial



Messengered



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TIMES FIBER COMMUNICATIONS, INC.®
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TFC Amphenol

700 SERIES SEMIFLEX CABLE TX10

PHYSICAL SPECIFICATIONS

NOMINAL DIMENSIONS	JACKETED		JACKETED MESSENGERED		JACKETED BURIAL		EXTRA THICK JACKETED BURIAL		ARMORED	
	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)
Conductor	0.163	(4.14)	0.163	(4.14)	0.163	(4.14)	0.163	(4.14)	0.163	(4.14)
Dielectric	0.653	(16.6)	0.653	(16.6)	0.653	(16.6)	0.653	(16.6)	0.653	(16.6)
Outer Conductor Thickness	0.025	(0.64)	0.025	(0.64)	0.025	(0.64)	0.025	(0.64)	0.025	(0.64)
Outer Conductor Diameter	0.703	(17.9)	0.703	(17.9)	0.703	(17.9)	0.703	(17.9)	0.703	(17.9)
First Jacket	0.765	(19.4)	0.783	(19.9)	0.775	(19.7)	0.843	(21.4)	0.775	(19.7)
Messenger	—	—	0.188	(4.78)	—	—	—	—	—	—
Armor	—	—	—	—	—	—	—	—	0.795	(20.2)
Second Jacket	—	—	—	—	—	—	—	—	0.885	(22.5)
Nominal Weight (lb/1000 ft) (kg/km)[1]	152	(226)	254	(378)	157	(234)	193	(287)	280	(417)
Nominal Weight (per reel) lb (kg)[2]	528	(239)	811	(368)	540	(245)	631	(286)	850	(386)
Nominal Length (per reel) feet (m)	2500	(762)	2500	(762)	2500	(762)	2500	(762)	2500	(762)
Maximum Pull Force lbf (N)	500	(2224)	1995	(8874)	500	(2224)	500	(2224)	500	(2224)
Minimum Bend Radius in (mm)	6.5	(165)	6.5	(165)	10.0	(254)	10.0	(254)	13.0	(330)
Messenger Break Strength lbf (N)	—	—	3990	(17748)	—	—	—	—	—	—
Reel Size (inches) (Flange x Width)[3]	48 x 28		54 x 28		48 x 28		50 x 28		50 x 28	
Reel Size (centimeters) (Flange x Width)[3]	122 x 71		137 x 71		122 x 71		127 x 71		127 x 71	

[1]cable minus reel, [2] cable plus reel, [3] Width is outside flange to outside flange

ELECTRICAL SPECIFICATIONS

Nominal DC Resistance @ 68°F (20°C)	Ohms per 1000	
Copper-Clad Aluminum Center Conductor	**feet**	**meters**
Center Conductor	0.60	1.97
Outer Conductor	0.25	0.82
Loop	0.85	2.79
Nominal Capacitance	15.2 pF/ft (49.9 pF/m)	
Impedance	75 ± 2 Ohms	
Velocity of Propagation	89% nominal	

MAXIMUM ATTENUATION @ 68°F (20°C)

Frequency MHz	dB per 100 feet	dB per 100 meters
5	0.11	0.36
55	0.37	1.21
211	0.74	2.43
250	0.82	2.68
270	0.85	2.79
300	0.90	2.95
330	0.95	3.11
350	0.98	3.21
400	1.05	3.44
450	1.12	3.67
500	1.19	3.90
550	1.25	4.10
600	1.31	4.30
750	1.49	4.89
870	1.62	5.31
1000	1.75	5.74

Attenuation increases with increasing temperature and decreases with decreasing temperature at the rate of 0.1% / °F (0.18% / °C)

Specifications subject to change without notice.

TX10 840 SERIES SEMIFLEX CABLE

TIMES FIBER COMMUNICATIONS, INC.®
203-265-8500 800-677-2288

TFC Amphenol

PART NUMBERS

CONSTRUCTION	CENTER CONDUCTOR Copper-Clad Aluminum Part Number
Jacketed	TX10840J
Jacketed, Tracer Coded	TX10840JVI
Jacketed Messengered	TX10840MS
Jacketed Flooded, Underground	TX10840JB
Jacketed Flooded, Underground, Extra Thick Jacket	TX10840JBX
Jacketed Flooded, Underground, Extra Thick Jacket, Tracer Coded	TX10840JBXVI
Jacketed Flooded, Underground, Tracer Coded	TX10840JBVI
Jacketed Flooded, Aerial*	TX10840JBF
Jacketed Flooded, Aerial,* Tracer Coded	TX10840JBFVI
Jacketed Armored	TX10840JBA
Jacketed Armored, Tracer Coded	TX10840JBAVI

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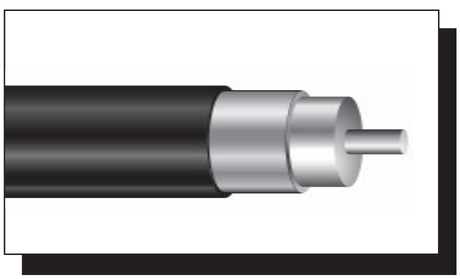
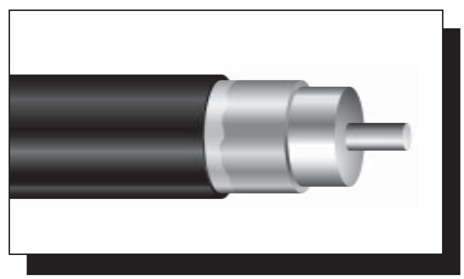
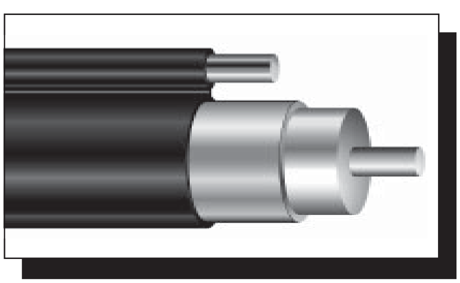


Jacketed



Jacketed Burial



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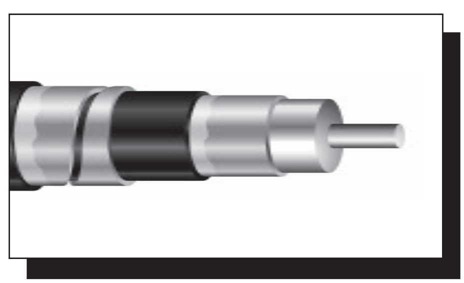

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TIMES FIBER COMMUNICATIONS, INC.®
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TFC Amphenol

840 SERIES SEMIFLEX CABLE TX10

PHYSICAL SPECIFICATIONS

NOMINAL DIMENSIONS	JACKETED		MESSENGERED		JACKETED BURIAL		EXTRA THICK JACKETED BURIAL		ARMORED	
	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)
Conductor	0.194	(4.93)	0.194	(4.93)	0.194	(4.93)	0.194	(4.93)	0.194	(4.93)
Dielectric	0.780	(19.8)	0.780	(19.8)	0.780	(19.8)	0.780	(19.8)	0.780	(19.8)
Outer Conductor Thickness	0.030	(0.76)	0.030	(0.76)	0.030	(0.76)	0.030	(0.76)	0.030	(0.76)
Outer Conductor	0.840	(21.3)	0.840	(21.3)	0.840	(21.3)	0.840	(21.3)	0.840	(21.3)
First Jacket	0.910	(23.1)	0.940	(23.9)	0.920	(23.4)	0.980	(24.9)	0.920	(23.4)
Messenger	—	—	0.250	(6.35)	—	—			—	—
Armor	—	—	—	—	—	—			0.940	(23.9)
Second Jacket	—	—	—	—	—	—			1.040	(26.4)
Nominal Weight (lb/1000 ft) (kg/km)[1]	214	(318)	388	(577)	220	(327)	257	(382)	372	(554)
Nominal Weight (per reel) lb (kg)[2]	769	(349)	1437	(652)	783	(355)	936	(425)	1218	(552)
Nominal Length (per reel) feet (m)	2450	(747)	2450	(747)	2450	(747)	2450	(747)	2450	(747)
Maximum Pull Force lbf (N)	700	(3114)	3325	(14790)	700	(3114)	700	(3114)	700	(3114)
Minimum Bend Radius in (mm)	7.5	(191)	7.5	(191)	12.5	(318)	12.5	(318)	15.0	(381)
Messenger Break Strength lbf (N)	—	—	6650	(29581)	—	—			—	—
Reel Size (inches) (Flange x Width)[3]	57 x 28		72 x 30		57 x 28		63 x 30		63 x 30	
Reel Size (centimeters) (Flange x Width)[3]	145 x 71		183 x 76		145 x 71		160 x 76		160 x 76	

[1]cable minus reel, [2] cable plus reel, [3] Width is outside flange to outside flange

ELECTRICAL SPECIFICATIONS

Nominal DC Resistance @ 68°F (20°C)	Ohms per 1000	
Copper-Clad Aluminum Center Conductor	**feet**	**meters**
Center Conductor	0.42	1.38
Outer Conductor	0.18	0.59
Loop	0.60	1.97
Nominal Capacitance	15.2 pF/ft (49.9 pF/m)	
Impedance	75 ± 2 Ohms	
Velocity of Propagation	89% nominal	

MAXIMUM ATTENUATION @ 68°F (20°C)

Frequency MHz	dB per 100 feet	dB per 100 meters
5	0.09	0.30
55	0.32	1.04
211	0.64	2.09
250	0.70	2.31
270	0.73	2.40
300	0.77	2.53
330	0.82	2.68
350	0.84	2.76
400	0.91	2.99
450	0.97	3.18
500	1.03	3.38
550	1.09	3.58
600	1.14	3.74
750	1.30	4.27
870	1.41	4.63
1000	1.53	5.02

Attenuation increases with increasing temperature and decreases with decreasing temperature at the rate of 0.1% / °F (0.18% / °C)

Specifications subject to change without notice.

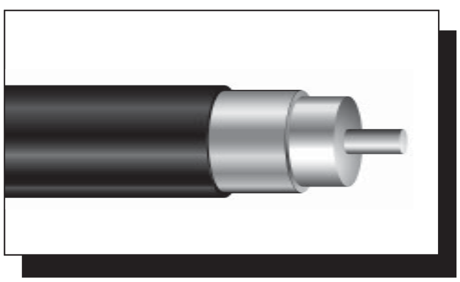
TX10 1160 SERIES SEMIFLEX CABLE

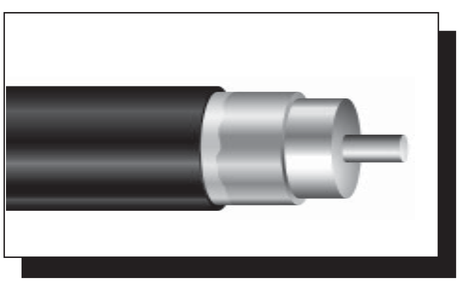
PART NUMBERS

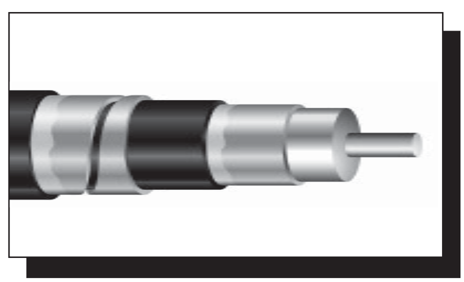
CONSTRUCTION	CENTER CONDUCTOR Copper-Clad Aluminum Part Number
Jacketed	TX101160J
Jacketed, Tracer Coded	TX101160JVI
Jacketed Messengered	—
Jacketed Flooded, Underground	TX101160JB
Jacketed Flooded, Underground, Extra Thick Jacket	—
Jacketed Flooded, Underground, Extra Thick Jacket, Tracer Coded	—
Jacketed Flooded, Underground, Tracer Coded	TX101160JBVI
Jacketed Flooded, Aerial*	TX101160JBF
Jacketed Flooded, Aerial,* Tracer Coded	TX101160JBFVI
Jacketed Armored	TX101160JBA
Jacketed Armored, Tracer Coded	TX101160JBAVI

*Used for aerial applications due to non-flowing, non-dripping compound.

Note: Standard colored tracer stripes are red, yellow, green, blue, white, and slate. For other color combinations, please contact a customer service representative or your area sales representative.


Jacketed


Jacketed Burial


Armored

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1160 SERIES SEMIFLEX CABLE TX10

PHYSICAL SPECIFICATIONS

NOMINAL DIMENSIONS	JACKETED		JACKETED BURIAL		ARMORED	
	inches	(mm)	inches	(mm)	inches	(mm)
Conductor	0.269	(6.83)	0.269	(6.83)	0.269	(6.83)
Dielectric	1.062	(27.0)	1.062	(27.0)	1.062	(27.0)
Outer Conductor Thickness	0.049	(1.24)	0.049	(1.24)	0.049	(1.24)
Outer Conductor Diameter	1.160	(29.5)	1.160	(29.5)	1.160	(29.5)
First Jacket	1.250	(31.8)	1.260	(32.0)	1.260	(32.0)
Armor	—	—	—	—	1.280	(32.5)
Second Jacket	—	—	—	—	1.380	(35.1)
Nominal Weight (lb/1000 ft) (kg/km)[1]	431	(641)	439	(653)	645	(960)
Nominal Weight (per reel) lb (kg)[2]	1391	(631)	1407	(638)	1840	(835)
Nominal Length (per reel) feet (m)	2100	(640)	2100	(640)	2100	(640)
Maximum Pull Force lbf (N)	1500	(6672)	1500	(6672)	1500	(6672)
Minimum Bend Radius in (mm)	10.5	(267)	10.5	(267)	20.0	(508)
Messenger Break Strength, lbf (N)						
Reel Size (inches) (Flange x Width)[3]	72 x 30		72 x 30		72 x 30	
Reel Size (centimeters) (Flange x Width)[3]	183 x 76		183 x 76		183 x 76	

[1]cable minus reel, [2] cable plus reel, [3] Width is outside flange to outside flange

ELECTRICAL SPECIFICATIONS

Nominal DC Resistance @ 68°F (20°C)	Ohms per 1000	
Copper-Clad Aluminum Center Conductor	**feet**	**meters**
Center Conductor	0.22	0.72
Outer Conductor	0.08	0.26
Loop	0.30	0.98
Nominal Capacitance	15.2 pF/ft (49.9 pF/m)	
Impedance	75 ± 2 Ohms	
Velocity of Propagation	89% nominal	

MAXIMUM ATTENUATION @ 68°F (20°C)

Frequency MHz	dB per 100 feet	dB per 100 meters
5	0.07	0.23
55	0.24	0.78
211	0.48	1.58
250	0.53	1.76
270	0.56	1.84
300	0.59	1.94
330	0.63	2.06
350	0.65	2.13
400	0.70	2.30
450	0.75	2.46
500	0.80	2.62
550	0.84	2.76
600	0.89	2.92
750	1.01	3.31
870	1.11	3.64
1000	1.20	3.94

Attenuation increases with increasing temperature and decreases with decreasing temperature at the rate of 0.1% / °F (0.18% / °C)

Specifications subject to change without notice.

TX10 SEMIFLEX CABLE SERIES

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ATTENUATION SUMMARY (maximum) @ 68°F (20°C)

Frequency	TX10565		TX10700		TX10840		TX101160	
MHz	dB/100 feet	dB/100 meters	dB/100 feet	dB/100 meters	dB/100 feet	dB/100 meters	dB/100 feet	dB/100 meters
5	0.14	0.46	0.11	0.36	0.09	0.30	0.07	0.23
55	0.47	1.55	0.37	1.21	0.32	1.04	0.24	0.78
211	0.93	3.06	0.74	2.43	0.64	2.09	0.48	1.58
250	1.03	3.38	0.82	2.68	0.70	2.31	0.53	1.76
270	1.07	3.51	0.85	2.79	0.73	2.40	0.56	1.84
300	1.13	3.71	0.90	2.95	0.77	2.53	0.59	1.94
330	1.19	3.91	0.95	3.11	0.82	2.68	0.63	2.06
350	1.23	4.04	0.98	3.21	0.84	2.76	0.65	2.13
400	1.32	4.33	1.05	3.44	0.91	2.99	0.70	2.30
450	1.40	4.59	1.12	3.67	0.97	3.18	0.75	2.46
500	1.49	4.89	1.19	3.90	1.03	3.38	0.80	2.62
550	1.56	5.12	1.25	4.10	1.09	3.58	0.84	2.76
600	1.64	5.38	1.31	4.30	1.14	3.74	0.89	2.92
750	1.85	6.07	1.49	4.89	1.30	4.27	1.01	3.31
870	2.01	6.58	1.62	5.31	1.41	4.63	1.11	3.64
1000	2.17	7.12	1.75	5.74	1.53	5.02	1.20	3.94

Attenuation increases with increasing temperature and decreases with decreasing temperature at the rate of 0.1% / °F (0.18% / °C).

NUMERICAL INDEX

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NUMERICAL INDEX

TABLE OF CONTENTS: T10 DROP CABLE SERIES

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DROP CABLE DESCRIPTION LEGEND

A T 1 2 3 4 5 6 7 8 **A CORE CONFIGURATION**	B 9 10 11 12 13 **B JACKET CONFIGURATION**	C 14 15 16 17 **C ADD ONS**

1 Cable Series
59 - 59 Series Cable
6 - 6 Series Cable
7 - 7 Series Cable
11 - 11 Series Cable
15 - 15 Series Cable

2 Center Conductor Type
“ “ - Copper Clad Steel
C - Copper
SCS - Silver Plated Copper Clad Steel
A - Copper Clad Aluminum

3 Dielectric Type
“ “ - Foamed Polyethylene
P - Solid Polyethylene

4 Tape Type
“ “ - Sealed Tape
D - Dry (Unbonded) Tape
N - No Tape

5 Braid Coverage
60 - 60% Braid Coverage
Q - 60% / 40% Quadshield Coverage
Q53/32 - 53% / 32% Quadshield Coverage
Q60/36 - 60% / 36% Quadshield Coverage
Q53/34 - 53% / 34% Quadshield Coverage
T60 - 60% Trishield Coverage
T77 - 77% Trishield Coverage
TSF77 - 77% Trishield - Short Fold Coverage

6 Braid Type
“ “ - Aluminum Braid
C - Copper Braid
T - Tinned Copper Braid
S - Silver Copper Braid

7 Coaxial Members
“ “ - Single
SIAM - Siamese (Dual) Construction

8 Special (reserved)

9 Floodant
“ “ - Non-Flooded
F - Flooded, Underground
LT - Flooded, lifeTime™

10 Jacket Type
V - PVC
E - Polyethylene

11 Coloring
B - Black
C - Colors

12 Flame Retardant Ratings
V - Flame Retardant NEC CATV
R - Flame Retardant NEC CATVR
F - Flame Retardant (CSA) CMH Type
M - Flame Retardant (CSA) CMG Type
FR - Flame Retardant (No Rating)
L - Flame Retardant NEC CL2
Y - Flame Retardant NEC CM
YX - Flame Retardant NEC CMX-CM
YR - Flame Retardant NEC/CEC CMR-CMG

13 Tracer (Stripes)
“ “ - No Tracer Stripe
T - Tracer Stripe

14 Messenger
051M - 0.051” Messenger
062M - 0.062" Messenger
072M - 0.072" Messenger
083M - 0.083" Messenger
109M - 0.109" Messenger

15 Twisted Pairs
2X22 - 2 pair 22 AWG twisted pair
3X24 - 3 pair 24 AWG twisted pair
5X26 - 5 pair 26 AWG twisted pair
1X24 - 1 pair 24 AWG twisted pair

16 Twisted Pair Filling / Core
“ “ - Flooded, lifeTime™
F - Flooded, Underground
AC - Air Core Configuration

17 Shielding of Twisted Pairs
“ “ - Non Shielded Twisted Pair
S - Shielded Twisted Pair

Example: Part Number T660-VBV

T 6 60 - V B V
TFC
6 Series
60% Braid Coverage
Flame Retardant NEC CATV
Black
PVC Jacket

Part Number T11Q-LTVB-083M

T 11 Q - LT V B -083M
TFC
11 Series
60%-40% Quadshield Coverage
0.083” Messenger
Black
PVC Jacket
Flooded lifeTime

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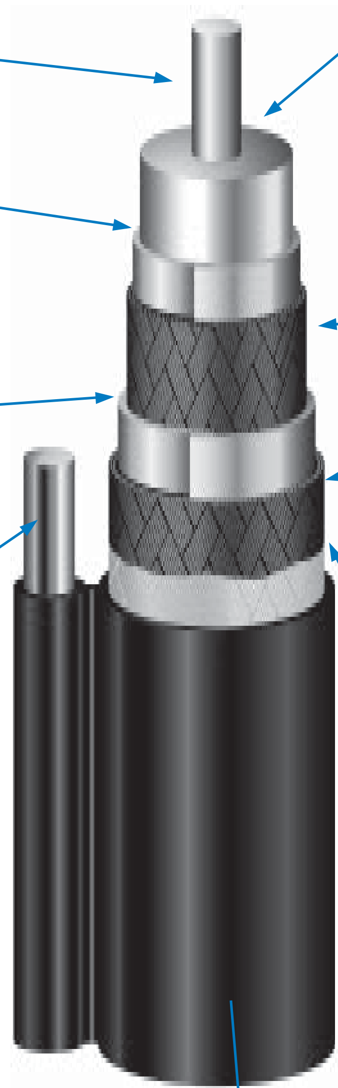
DROP CABLE SERIES T10

DETAILS OF CONSTRUCTION AND MATERIAL



CENTER CONDUCTOR
Copper-clad steel or solid copper

FIRST OUTER CONDUCTOR
Sealed aluminum-polypropylene-aluminum (APA) laminated tape longitudinally wrapped with an overlap around the dielectric to provide 100% coverage of the dielectric and long-term reliability of shielding performance.

THIRD OUTER CONDUCTOR
Unsealed aluminum-polypropylene-aluminum (APA) laminated tape, in conjunction with the second shield, provides an additional shield for improved signal isolation.

MESSENGER
PVC jacketed, galvanized steel wire integrally attached to cable jacket with easily separable PVC web (see note under Jacket) serves as support for cable.

DIELECTRIC
Closed cell, high velocity precision matrix foamed polyethylene which provides optimum dielectric hardness. The foam is bonded to the center conductor with a clean stripping, proprietary moisture-blocking polymer. Attenuation remains stable from 0% to 100% relative humidity.

SECOND OUTER CONDUCTOR
Standard coverage aluminum alloy wire braids improve shielding ability and provide additional mechanical strength.

FOURTH OUTER CONDUCTOR
Aluminum alloy wire braids, in conjuction with the first braids, sandwiches the second tape assuring good metallic contact in the overlap of the tape.

CORROSION RESISTANT PROTECTANT
(See further explanation under Features, p.36.)

Aerial
lifeTime™ is a dripless compound which remains functional over a temperature range of -40°F to 190°F (-40°C to +90°C).

Underground
Flooding compound having cold flow properties for self-healing of small jacket ruptures.

JACKET
Protective PVC applied over the braid to environmentally seal the construction. Both black and non-black jackets are UV resistant and may be used outdoors.

Note: Polyethylene jacket used on the 11 Series messengered versions using 0.109 inch (2.77mm) messenger wire, or by special request. Polyethylene jackets are utilized on underground drop cables.

Pictured is T10 Drop Cable, Quadshield version showing a complete drop cable construction including Times' exclusive lifeTime™ protectant.

T10 DROP CABLE SERIES

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FEATURES AND BENEFITS

The T10 Drop Cable Series is designed with reducing system operating costs in mind. The construction types offered in this series can be used in a variety of applications which can facilitate smooth system operation.

FLOODING COMPOUND

Recommended for burial cable applications, flooding compound is designed to provide additional internal corrosion protection. Flooding compound primarily prevents moisture ingress by flowing into any small area of jacket damage, acting as a self-healer.

TFC 's burial flooding compound for drop cable is a low viscous material that allows the compound to flow readily into the crevices of the cables outer braid and onto the taped outer conductor.

In addition to required viscosity and flow properties, flooding compounds are chosen for compatibility with the cable materials used and for overall chemical, oxidation and UV resistance properties. Flooding materials are also compounded for high tackiness to aluminum, polyethylene and PVC to ensure uniform and continuous material protection.

lifeTime™

Available exclusively from TFC, **lifeTime™** is a corrosion resistant protectant designed to form a barrier against moisture ingress and retard corrosion. A stable slightly tacky composition, **lifeTime™** is applied to the aluminum braid and underlying tape. It does not drip and retains its consistency through a wide range of temperatures. **lifeTime™** is used from the pole to the groundblock, is suitable for indoor use from the groundblock to the television set, and can solve problems related to remote dc powering such as interdiction.

The standard drop cable choice for many system operators, **lifeTime™** drop cable offers actual dollar saving benefits. Protecting against corrosion not only extends cable life, it also maintains performance. This means improved return on labor and material investment while minimizing maintenance costs as the system ages.

NEC

TFC manufactures **CATV**, **CATVR,** and **CATVP** drop cables that are NEC compliant. These cables are listed by Underwriter's Laboratories, (File #E86650) and meet the requirements of National Electric Code (NEC), Article 820, Community Antenna Television and Radio Distribution Systems.

In addition to requirements governing various installation methods and materials, the code sets forth different levels of fire, flame, or smoke performance for communication cables.

For more information, refer to Technical Note NEC #1044B.

BONDING

The bonded construction of drop cable begins with the center conductor to dielectric interface and continues from the dielectric to the tape.

A bonded center conductor serves as a guard against moisture ingress, defending against corrosion. In addition, the bonded dielectric, which prevents center conductor movement, facilitates connectorization by removing cleanly and easily. Finally, bonding of the dielectric to tape allows the overlapping tape to stay sealed during cable flexure, minimizing RF signal ingress/egress.

1 GHz BANDWIDTH

T10 drop cable is specified to have SRL sweep performance to 1 GHz. Specifying 1 GHz bandwidth for rebuilds, upgrades or new plant allows a system to handle future increasing capacity needs demanded by more channels, higher definition television and other emerging technologies.

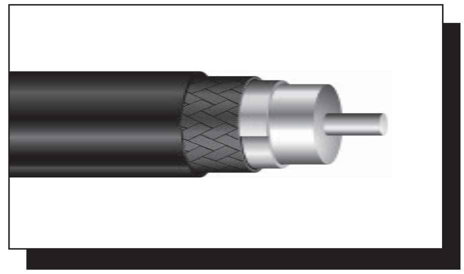
DROP CABLE SERIES T10

APPLICATION OF CONSTRUCTION TYPES

T10 Drop Cable Series offers a number of variations suited for different applications. Below is a listing which describes the recommended applications for each construction type. T10 Drop Cable Series is intended for applications from -40°F to +140°F and its attenuation remains stable from 0% to 100% relative humidity.

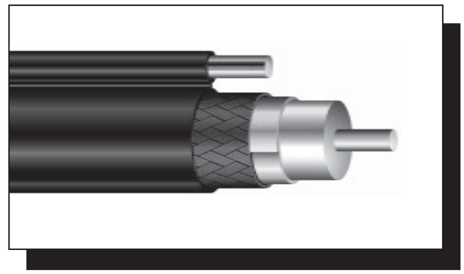
SINGLE

Single drop cable is well-suited for a wide range of general purpose indoor and outdoor applications.



MESSENGERED

Messengered cable is recommended for longer spans when higher strength is required to improve reliability in severe weather conditions. A galvanized steel messenger wire is integrally joined to the coaxial cable by an an overall extruded jacket and connecting web.



- POLE-TO-HOUSE

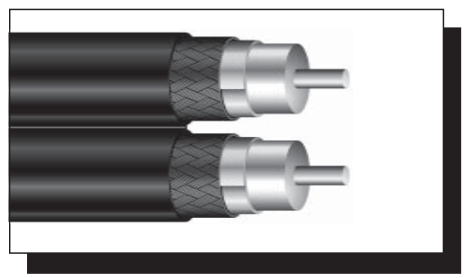
A high flex-life messenger wire is utilized making it ideal for wrapping around span clamps and “P” hooks. The wire can be easily cut for installation purposes and has superior break strength compared to other versions available in similar sizes. Messenger sizes vary; refer to specifications.

- POLE-TO-POLE

An extra high strength 0.109 inch (2.77mm) wire with an 1800 pound (8007N) break strength is used for clearance control between power and telephone cables and for resistance to heavy loading such as ice, wind and other hazardous conditions.

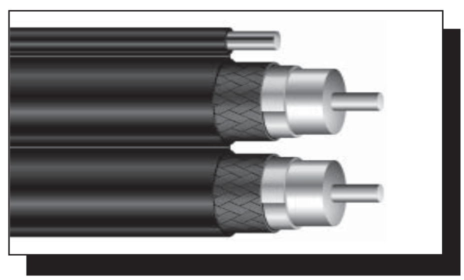
SIAMESE

Two single cables are joined by an overall extruded PVC jacket and connecting web for use in apartments and dual plant systems since it is more economical to install one siamese cable than two single cables.



SIAMESE MESSENGERED

A PVC jacketed, galvanized steel wire is integrally attached to the jacket of the siamese cable by an extruded web. The wire acts as a support for the cable in pole-to-house drops. Refer to MESSENGERED, Pole-to-House for an explanation of high flex-life wire.



T10 DROP CABLE SERIES

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BRAID COVERAGE DESCRIPTIONS

T10 Drop Cable is available in a wide selection of braid coverages. These coverage distinctions are designed to offer a choice of protection for a variety of environmental conditions. The descriptions below detail braid construction and environmental applications.

STANDARD

- Outer Conductor:
  1. Sealed APA Laminated Tape
  2. Aluminum Braid
- Braid Coverage Available:
  59 Series - 53% and 67%
  6 Series - 60%
  7 Series - 60%
  11 Series - 53% and 60%
- Low-medium RF noise environment application

PREMIUM

- Outer Conductor:
  1. Sealed APA Laminated Tape
  2. Aluminum Braid
- Braid Coverage Available:
  59 Series - 95%
  6 Series - 90%
  7 Series - 90%
  11 Series - 60%
- Medium-moderately high RF noise environment application

TRISHIELD

- Outer Conductor:
  1. Sealed APA Laminated Tape
  2. Aluminum Braid
  3. APA Laminated Tape
- Braid Coverage Available:
  59 Series - 53% and 77%
  6 Series - 60% and 77%
  7 Series - 77%
  11 Series -60%
- High RF noise environment and two way applications.

QUADSHIELD

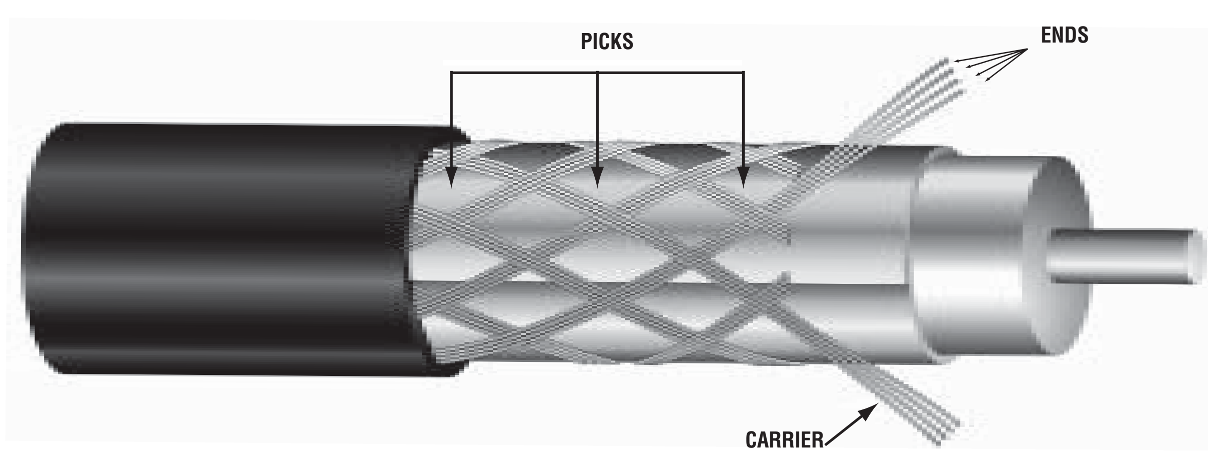
- Outer Conductor:
  1. Sealed APA Laminated Tape
  2. Inner Aluminum Braid
  3. APA Laminated Tape
  4. Outer Aluminum Braid
- Braid Coverage Available:
  59 Series - 53% Inner, 34% Outer
  6 Series - 60% Inner, 40% Outer
  7 Series - 60% Inner, 36% Outer
  11 Series - 53% Inner, 32% Outer
  11 Series - 60% Inner, 40% Outer
- Severe RF noise environment application, and two way applications.

In addition to the 100% shielding coverage provided by internal shielding tapes, wire braid provides additional shielding coverage. The percentage of coverage that a wire braid contributes is a function of the diameters of the wire braid and the underlying structure, the number of carriers (groups of wire ends), the number of individual wires in each carrier and the picks per inch (the points of crossing of the carriers). The following formulae are applicable:

Percent Coverage = $(2F - F^2) \times 100$

Where: $F = NPd/\sin A$
$A = \tan^{-1} [2 * pi * (D + 2*d) * (P/C)]$

And: C = Number of carriers (groups of ends)
N = Number of ends (strands) per carrier
P = Picks per inch (carrier crossing points)
d = Diameter of individual wire strand (inch)
D = Diameter of structure under the braid (inch)



59 SERIES DROP CABLE

PART NUMBERS

	BRAID COVERAGE					
CONSTRUCTION	**STANDARD**		**PREMIUM**	**TRISHIELD**		**QUADSHIELD**
Nominal Braid Coverage %	53	67	95	53	77	53 - 34
PVC Jacket (Regular)						
Single	T5953-VB	T5967-VB	T5995-VB	T59T53-VB	T59T77-VB	T59Q53/34-VB
Single (Colors)	T5953-VC	T5967-VC	T5995-VC	T59T53-VC	T59T77-VC	T59Q53/34-VC
Single Messengered	T5953-VB-051M	T5967-VB-051M	T5995-VB-051M	T59T53-VB-051M	T59T77-VB-051M	T59Q53/34-VB-051M
Siamese	T5953SIAM-VB	T5967SIAM-VB	T5995SIAM-VB	—	—	T59Q53/34SIAM-VB
Siamese (Colors)	T5953SIAM-VC	T5967SIAM-VC	—	—	—	T59Q53/34SIAM-VC
Siamese Messengered 072M	T5953SIAM-VB-072M	T5967SIAM-VB-	—	—	—	T59Q53/34SIAM-VB-072M
PVC Jacket (Underground Floodant)						
Single Flooded	T5953-FVB	T5967-FVB	T5995-FVB	T59T53-FVB	T59T77-FVB	T59Q53/34-FVB
Siamese Flooded	T5953SIAM-FVB	T5967SIAM-FVB	—	—	—	T59Q53/34SIAM-FVB
Polyethylene Jacket (Underground Floodant)						
Single Flooded	T5953-FEB	T5967-FEB	T5995-FEB	—	—	T59Q53/34-FEB
PVC Jacket (lifeTime™ Floodant)						
Single Flooded	T5953-LTVB	T5967-LTVB	T5995-LTVB	T59T53-LTVB	T59T77-LTVB	T59Q53/34-LTVB
Single Flooded Messengered	T5953-LTVB-051M	T5967-LTVB-051M	T5995-LTVB-051M	T59T53-LTVB-051M	T59T77-LTVB-051M	T59Q53/34-LTVB-051M
Siamese Flooded	T5953SIAM-LTVB	T5967SIAM-LTVB	T5995SIAM-LTVB	—	—	T59Q53/34SIAM-LTVB
Siamese Flooded Messengered	T5953SIAM-LTVB-072M	T5967SIAM-LTVB-072M	—	—	—	T59Q53/34SIAM-LTVB-072M
PVC Jacket, Flame Retardant – NEC Article 820 – "**CATV**"***						
Single	T5953-VBV	T5967-VBV	T5995-VBV	T59T53-VBV	T59T77-VBV	T59Q53/34-VBV
Single (Colors)	T5953-VCV	T5967-VCV	T5995-VCV	T59T53-VCV	T59T77-VCV	T59Q53/34-VCV
Siamese	T5953SIAM-VBV	T5967SIAM-VBV	T5995SIAM-VBV	—	—	T59Q53/34SIAM-VBV
Siamese (Colors)	T5953SIAM-VCV	T5967SIAM-VCV	—	—	—	T59Q53/34SIAM-VCV

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T10 59 SERIES DROP CABLE

PART NUMBERS

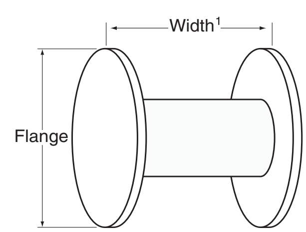
CONSTRUCTION	BRAID COVERAGE STANDARD		PREMIUM	TRISHIELD		QUADSHIELD
Nominal Braid Coverage %	53	67	95	53	77	53 - 34
PVC Jacket, Flame Retardant w/**lifeTime™ – NEC Article 820 – "CATV"*****						
Single Flooded	T5953-LTVBV	T5967-LTVBV	T5995-LTVBV	T59T53-LTVBV	T59T77-LTVBV	T59Q53/34-LTVBV
Single Flooded (Colors)	—	T5967-LTVCV	—	—	—	—
Siamese Flooded	T5953SIAM-LTVBV	T5967SIAM-LTVBV	T5995SIAM-LTVBV	—	—	T59Q53/34SIAM-LTVBV
PVC Jacket, Flame Retardant **– NEC Article 820 – "CATVR"*****						
Single	—	T5967-VBR	—	—	—	T59Q53/34-VBR
Siamese	—	T5967SIAM-VBR	—	—	—	—
PVC Jacket, Flame Retardant w/**lifeTime™ – NEC Article 820 – "CATVR"*****						
Single Flooded	—	T5967-LTVBR	—	—	—	T59Q53/34-LTVBR
Siamese Flooded	—	T5967SIAM-LTVBR	—	—	—	—

*** CSA - CMH: Change "V" to "F
CSA - CMG: Change "V" to "M"

NEC - CL2: Change "V" to "L"
NEC - CM: Change "V" to "Y"

REEL SIZE

CONSTRUCTION TYPE	REEL SIZE (Flange x Width)	
Series 59	**inches**	**centimeters**
Single & Trishield	12x9	30x23
Single Quadshield	12x9	30x23
Single Messengered	14.5x11	37x28
Siamese	16x11	41x28
Siamese Trishield & Quadshield	16x13	41x33
Siamese Messengered	18x13	46x33
Siamese Messengered Quadshield	18x13	46x33



[1] Width = outside flange to outside flange

MAXIMUM ATTENUATION @ 68°F (20°C)

Frequency MHz	dB per 100 feet	dB per 100 meters
5	0.86	2.82
55	2.05	6.73
211	3.80	12.47
250	4.10	13.45
270	4.22	13.85
300	4.45	14.60
330	4.66	15.29
350	4.80	15.75
400	5.10	16.73
450	5.40	17.72
500	5.70	18.70
550	5.95	19.52
600	6.20	20.34
750	6.97	22.87
870	7.57	24.85
1000	8.12	26.64

Attenuation increases with increasing temperature and decreases with decreasing temperature at the rate of 0.1% /°F (0.18% /°C)

Specifications subject to change without notice.

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TFC Amphenol 59 SERIES DROP CABLE

PHYSICAL SPECIFICATIONS

NOMINAL DIMENSIONS	STANDARD		PREMIUM		TRISHIELD		QUADSHIELD	
Braid Coverage %	53 and 67		95		53 and 77		53 - 34	
	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)
Conductor	0.0320	(0.81)	0.0320	(0.81)	0.0320	(0.81)	0.0320	(0.81)
Dielectric	0.144	(3.66)	0.144	(3.66)	0.144	(3.66)	0.144	(3.66)
Sealed APA Tape (1st Outer Conductor)	0.152	(3.86)	0.152	(3.86)	0.152	(3.86)	0.152	(3.86)
Aluminum Braid (2nd Outer Conductor)	0.176	(4.47)	0.176	(4.47)	0.176	(4.47)	0.176	(4.47)
Unsealed APA Tape (3rd Outer Conductor)	—	—	—	—	0.180	(4.57)	0.180	(4.57)
Aluminum Braid (4th Outer Conductor)	—	—	—	—	—	—	0.205	(5.21)
Jacket	0.240	(6.10)	0.240	(6.10)	0.244	(6.20)	0.265	(6.73)
Cable Width (Single)								
Messenger Diameter (Single)	0.051	(1.30)	0.051	(1.30)	0.051	(1.30)	0.051	(1.30)
Single Messengered Width	0.395	(10.0)	0.395	(10.0)	0.399	(10.1)	0.420	(10.7)
Siamese Width	0.525	(13.3)	0.525	(13.3)	—	—	0.575	(14.6)
Messenger Diameter (Siamese)	0.072	(1.83)	—	—	—	—	0.072	(1.83)
Siamese Messengered Width	0.702	(17.8)	—	—	—	—	0.752	(19.1)

Messenger Break Strength	Size		Minimum		Maximum	
	0.051 in	(1.30mm)	185 lb	(823 N)	245 lb	(1090 N)
	0.072 in	(1.83mm)	365 lb	(1624 N)	490 lb	(2180 N)

Cable Weight Minus Reel [lb/kft (kg/km)] See Pages 124, 145 for Cable Weight Plus Reel

	53 and 67		95		53		77		53 - 34	
Regular										
Single	23	(34)	24	(36)	22	(33)	24	(36)	27	(40)
Single Messengered	35	(52)	36	(54)	34	(51)	36	(54)	39	(58)
Siamese	46	(68)	48	(71)	—	—	—	—	54	(80)
Siamese Messengered	66	(98)	—	—	—	—	—	—	74	(110)
Underground										
Single Flooded	22	(33)	24	(36)	23	(34)	24	(36)	26	(39)
Siamese Flooded	45	(67)	—	—	—	—	—	—	52	(77)
lifeTime™										
Single Flooded	22	(33)	24	(36)	23	(34)	24	(36)	26	(39)
Single Flooded Messengered	34	(51)	36	(54)	35	(52)	36	(54)	38	(57)
Siamese Flooded	45	(67)	47	(70)	—	—	—	—	51	(76)
Siamese Flooded Messengered	65	(97)	—	—	—	—	—	—	72	(107)

ELECTRICAL SPECIFICATIONS

Nominal DC Resistance @ 68°F (20°C)	Ohms/kft. (Ohms/ km)											
Braid Coverage %	Standard				Premium		Trishield				Quadshield	
Conductors	53		67		95		53		77		53 - 34	
Center Conductor	48.2	(158)	48.2	(158)	48.2	(158)	48.2	(158)	48.2	(158)	48.2	(158)
Outer Conductor	12.1	(40)	10.0	(33)	6.52	(21)	8.43	(28)	6.70	(22)	6.52	(21)
Loop	60.3	(198)	58.2	(191)	54.7	(179)	56.6	(186)	54.9	(180)	54.7	(179)
Nominal Capacitance-all types	16.2 pF/ft (53.2 pF/m)											
Impedance	75 ± 3 Ohms											
Velocity of Propagation	85% nominal											

Specifications subject to change without notice.

T10 6 SERIES DROP CABLE

TIMES FIBER COMMUNICATIONS, INC.®
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TFC Amphenol

PART NUMBERS

	BRAID COVERAGE				
CONSTRUCTION	**STANDARD**	**PREMIUM**	**TRISHIELD**		**QUADSHIELD**
Nominal Braid Coverage %	60	90	60	77	60 - 40
PVC Jacket (Regular)					
Single	T660-VB	T690-VB	T6T60-VB	T6T77-VB	T6Q-VB
Single (Colors)	T660-VC	T690-VC	T6T60-VC	T6T77-VC	T6Q-VC
Single Messengered	T660-VB-051M	T690-VB-051M	T6T60-VB-051M	T6T77-VB-051M	T6Q-VB-051M
Siamese	T660SIAM-VB	—	—	—	T6QSIAM-VB
Siamese (Colors)	T660SIAM-VC	—	—	—	T6QSIAM-VC
Siamese Messengered	T660SIAM-VB-072M	T690SIAM-VB-072M	—	—	T6QSIAM-VB-072M
PVC Jacket (Underground Floodant)					
Single Flooded	T660-FVB	T690-FVB	T6T60-FVB	T6T77-FVB	T6Q-FVB
Siamese Flooded	T660SIAM-FVB	T690SIAM-FVB	—	—	T6QSIAM-FVB
Polyethylene Jacket (Underground Floodant)					
Single Flooded	T660-FEB	T690-FEB	T6T60-FEB	T6T77-FEB	T6Q-FEB
PVC Jacket (**lifeTime™** Floodant)					
Single Flooded	T660-LTVB	T690-LTVB	T6T60-LTVB	T6T77-LTVB	T6Q-LTVB
Single Flooded Messengered	T660-LTVB-051M	T690-LTVB-051M	T6T60-LTVB-051M	T6T77-LTVB-051M	T6Q-LTVB-051M
Siamese Flooded	T660SIAM-LTVB	—	—	—	T6QSIAM-LTVB
Siamese Flooded Messengered	T660SIAM-LTVB-072M	T690SIAM-LTVB-072M	—	—	T6QSIAM-LTVB-072M
PVC Jacket, Flame Retardant **– NEC Article 820 – "CATV"*** **					
Single	T660-VBV	T690-VBV	T6T60-VBV	T6T77-VBV	T6Q-VBV
Single (Colors)	T660-VCV	T690-VCV	T6T60-VCV	T6T77-VCV	T6Q-VCV
Siamese	T660SIAM-VBV	T690SIAM-VBV	—	—	T6QSIAM-VBV
Siamese (Colors)	T660SIAM-VCV	—	—	—	T6QSIAM-VCV
PVC Jacket, Flame Retardant w/**lifeTime™ – NEC Article 820 – "CATV"*** **					
Single Flooded	T660-LTVBV	T690-LTVBV	T6T60-LTVBV	T6T77-LTVBV	T6Q-LTVBV
Single Flooded (Colors)	T660-LTVCV	T690-LTVCV	T6T60-LTVCV	T6T77-LTVCV	T6Q-LTVCV
Siamese Flooded	T660SIAM-LTVBV	T690SIAM-LTVBV	—	—	T6QSIAM-LTVBV

*** CSA - CMH: Change "V" to "F"
CSA - CMG: Change "V" to "M"

NEC CL2: Change "V" to "L"
NEC CM: Change "V" to "Y"

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TFC Amphenol 6 SERIES DROP CABLE

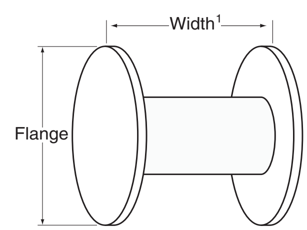
PART NUMBERS

	BRAID COVERAGE				
CONSTRUCTION	**STANDARD**	**PREMIUM**	**TRISHIELD**		**QUADSHIELD**
Nominal Braid Coverage %	60	90	60	77	60 - 40
PVC Jacket, Flame Retardant **– NEC Article 820 – "CATVR"***					
Single	T660-VBR	—	—	—	T6Q-VBR
Single (Colors)					
Siamese	T660SIAM-VBR	—	—	—	—
PVC Jacket, Flame Retardant w/**lifeTime™ – NEC Article 820 – "CATVR"***					
Single Flooded	—	—	—	—	T6Q-LTVBR
Siamese Flooded	T660SIAM-LTVBR	—	—	—	—

*** CSA - CMH: Change "V" to "F"   NEC - CL2: Change "V" to "L"
CSA - CMG: Change "V" to "M"   NEC - CM: Change "V" to "Y"

REEL SIZE

CONSTRUCTION TYPE	REEL SIZE (Flange x Width)	
Series 6	**inches**	**centimeters**
Single & Trishield	12x12	30x30
Single Quadshield	14.5x11	37x28
Single Messengered	114.5x11	37x28
Siamese	18x13	46x33
Siamese Trishield & Quadshield	18x13	46x33
Siamese Messengered	18x13	46x33
Siamese Messengered Quadshield	22x13	56x33



[1] Width = outside flange to outside flange

MAXIMUM ATTENUATION @ 68°F (20°C)

Frequency MHz	dB per 100 feet	dB per 100 meters
5	0.58	1.90
55	1.60	5.25
211	3.05	10.00
250	3.30	10.82
270	3.30	11.04
300	3.55	11.64
330	3.74	12.26
350	3.85	12.63
400	4.15	13.61
450	4.40	14.43
500	4.66	15.29
550	4.90	16.08
600	5.10	16.73
750	5.65	18.54
870	6.11	20.04
1000	6.55	21.49

Attenuation increases with increasing temperature and decreases with decreasing temperature at the rate of 0.1% /°F (0.18% /°C)

Specifications subject to change without notice.

TIMES FIBER COMMUNICATIONS, INC.®
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T10 6 SERIES DROP CABLE

PHYSICAL SPECIFICATIONS

NOMINAL DIMENSIONS	STANDARD		PREMIUM		TRISHIELD		QUADSHIELD	
Braid Coverage %	60		90		60 and 77		60 - 40	
	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)
Conductor	0.0403	(1.02)	0.0403	(1.02)	0.0403	(1.02)	0.0403	(1.02)
Dielectric	0.180	(4.57)	0.180	(4.57)	0.180	(4.57)	0.180	(4.57)
Sealed APA Tape (1st Outer Conductor)	0.188	(4.78)	0.188	(4.78)	0.188	(4.78)	0.188	(4.78)
Aluminum Braid (2nd Outer Conductor)	0.212	(5.38)	0.212	(5.38)	0.212	(5.38)	0.212	(5.38)
Unsealed APA Tape (3rd Outer Conductor)	—	—	—	—	0.216	(5.49)	0.216	(5.49)
Aluminum Braid (4th Outer Conductor)	—	—	—	—	—	—	0.241	(6.12)
Jacket	0.273	(6.93)	0.273	(6.93)	0.278	(7.06)	0.297	(7.54)
Cable Width (Single)								
Messenger Diameter (Single)	0.051	(1.30)	0.051	(1.30)	0.051	(1.30)	0.051	(1.30)
Single Messengered Width	0.428	(10.9)	0.428	(10.9)	0.433	(11.0)	0.452	(11.5)
Siamese Width	0.591	(15.0)	0.591	(15.0)	—	—	0.639	(16.2)
Messenger Diameter (Siamese)	0.072	(1.83)	—	—	—	—	0.072	(1.83)
Siamese Messengered Width	0.768	(19.5)	—	—	—	—	0.816	(20.7)

Messenger Break Strength	Size		Minimum		Maximum	
	0.051 in	(1.30 mm)	185 lb	(823 N)	245 lb	(1090 N)
	0.072 in	(1.83 mm)	365 lb	(1624 N)	490 lb	(2180 N)

Cable Weight Minus Reel [lb/kft (kg/km)] **See Pages 124, 125 for Cable Weight Plus Reel**

	60		90		60		77		60 - 40	
Regular										
Single	28	(42)	29	(43)	28	(42)	29	(43)	33	(49)
Single Messengered	40	(60)	41	(61)	40	(60)	41	(61)	45	(67)
Siamese	57	(85)	—	—	—	—	—	—	66	(98)
Siamese Messengered	77	(115)	—	—	—	—	—	—	86	(128)
Underground										
Single Flooded	27	(40)	29	(43)	29	(43)	30	(45)	31	(46)
Siamese Flooded	55	(82)	58	(86)	—	—	—	—	63	(94)
lifeTime™										
Single Flooded	27	(40)	29	(43)	29	(43)	30	(45)	31	(46)
Single Flooded Messengered	39	(58)	40	(60)	41	(61)	42	(63)	43	(64)
Siamese Flooded	55	(82)	—	—	—		—	—	63	(94)
Siamese Flooded Messengered	75	(112)	—	—	—	—	—	—	81	(121)

ELECTRICAL SPECIFICATIONS

Nominal DC Resistance @ 68°F (20°C)	Ohms/kft. (Ohms/km)									
Braid Coverage %	Standard		Premium		Trishield				Quadshield	
Conductors	60		90		60		77		60 - 40	
Center Conductor	30.4	(100)	30.4	(100)	30.4	(100)	30.4	(100)	30.4	(100)
Outer Conductor	9.13	(30)	5.74	(18)	6.57	(21)	5.49	(18)	4.85	(16)
Loop	39.6	(130)	36.0	(118)	36.9	(121)	35.9	(118)	35.3	(116)
Nominal Capacitance-all types	16.2 pF/ft (53.2 pF/m)									
Impedance	75 ± 3 Ohms									
Velocity of Propagation	85% nominal									

Specifications subject to change without notice.

Customers are reminded that they are SOLELY responsible for confirming that all products are properly installed and used in accordance with all applicable codes and regulations.

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Amphenol

7 SERIES DROP CABLE

PART NUMBERS

	BRAID COVERAGE			
CONSTRUCTION	**STANDARD**	**PREMIUM**	**TRISHIELD**	**QUADSHIELD**
Nominal Braid Coverage %	60	90	77	60 - 36
PVC Jacket (Regular)				
Single	T760-VB	—	T7T77-VB	T7Q60/36-VB
Single (Colors)	T760-VC	—	T7T77-VC	T7Q60/36-VC
Single Messengered	T760-VB-072M	—	—	T7Q60/36-VB-072M
PVC Jacket (Underground Floodant)				
Single Flooded	T760-FVB	—	—	T7Q60/36-FVB
Siamese Flooded	T760-FVC	—	—	T7Q60/36-FVC
Single Flooded	T760-FEB	—	—	—
Single Flooded (colors)	—	—	—	T7Q60/36-FEC
PVC Jacket (lifeTime™ Floodant)				
Single Flooded	T760-LTVB	—	—	T7Q60/36-LTVB
Single Flooded Messengered	T760-LTVB-072M	—	—	T7Q60/36-LTVB-072M
PVC Jacket Flame Retardant **– NEC Article 820 – "CATV"*****				
Single	T760-VBV	—	—	T7Q60/36-VBV
Single (colors)	—	—	T7T77-VCV	—
PVC Jacket Flame Retardant **– NEC Article 820 – "CATVR"*****				
Single	T760-VBR	—	—	T7Q60/36-VBR
PVC Jacket Flame Retardant w/ lifeTime™**– NEC Article 820 – "CATVR"*****				
Single Flooded	T760-LTVBR	—	—	T7Q60/36-LTVBR

*** CSA - CMH: Change "V" to "F" NEC CL2: Change "V" to "L"
CSA - CMG: Change "V" to "M" NEC CM: Change "V" to "Y"

7 SERIES DROP CABLE

TIMES FIBER COMMUNICATIONS, INC.®
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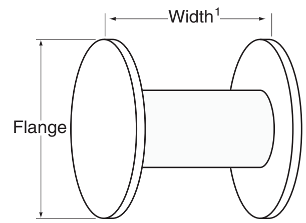
REEL SIZE

CONSTRUCTION TYPE	REEL SIZE (Flange x Width) inches	REEL SIZE (Flange x Width) centimeters
Series 7		
Single & Trishield	14.5x11	37x28
Single Quadshield	14.5x11	37x28
Single Messengered	16x13	41x33
Single Quadshield Messengered	18x13	46x33



[1] Width = outside flange to outside flange

MAXIMUM ATTENUATION @ 68°F (20°C)

Frequency MHz	dB per 100 feet	dB per 100 meters
5	0.47	1.54
55	1.25	4.10
211	2.36	7.74
250	2.56	8.40
270	2.68	8.78
300	2.82	9.25
330	2.96	9.72
350	3.05	10.01
400	3.27	10.73
450	3.46	11.35
500	3.67	12.04
550	3.85	12.63
600	4.05	13.28
750	4.57	14.99
870	4.96	16.28
1000	5.32	17.45

Attenuation increases with increasing temperature and decreases with decreasing temperature at the rate of 0.1% /°F (0.18% /°C)

Specifications subject to change without notice.

TIMES FIBER COMMUNICATIONS, INC.®
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TFC Amphenol

7 SERIES DROP CABLE T10

PHYSICAL SPECIFICATIONS

NOMINAL DIMENSIONS	STANDARD		PREMIUM		TRISHIELD		QUADSHIELD	
Braid Coverage %	60		90		77		60-36	
	inches	(mm)	inches	(mm)	inches	(mm)	inches	(mm)
Conductor	0.0508	(1.29)	0.0508	(1.29)	0.0508	(1.29)	0.0508	(1.29)
Dielectric	0.225	(5.72)	0.225	(5.72)	0.225	(5.72)	0.225	(5.72)
Sealed APA Tape (1st Outer Conductor)	0.233	(5.92)	0.233	(5.92)	0.233	(5.92)	0.233	(5.92)
Aluminum Braid (2nd Outer Conductor)	0.257	(6.53)	0.257	(6.53)	0.257	(6.53)	0.257	(6.53)
Unsealed APA Tape (3rd Outer Conductor)	—	—	—	—	0.261	(6.63)	0.261	(6.63)
Aluminum Braid (4th Outer Conductor)	—	—	—	—	—	—	0.286	(7.26)
Jacket	0.319	(8.10)	0.319	(8.10)	0.323	(8.20)	0.340	(8.64)
Cable Width (Single)								
Messenger Diameter (Single)	0.072	(1.83)	0.072	(1.83)	0.072	(1.83)	0.072	(1.83)
Single Messengered Width	0.496	(12.6)	0.496	(12.6)	0.500	(12.7)	0.517	(13.1)
Messenger Break Strength	**Size**		**Minimum**		**Maximum**			
	0.072 in (1.83mm)		365 lb (1624 N)		490 lb (2180 N)			
Cable Weight Minus Reel [lb/kft (kg/km)]	**See Pages 124, 125 for Cable Weight Plus Reel**							
Regular	60		90		80		60-36	
Single	38	(57)	—	—	37	(55)	42	(63)
Single Messengered	58	(86)	—	—	—	—	62	(92)
Underground								
Single Flooded (PVC)	37	(55)	—	—	—	—	41	(61)
Single Messengered (PE)	31	(46)	—	—	—	—	—	—
lifeTime™								
Single Flooded	37	(55)	—	—		—	41	(61)
Single Flooded Messengered	59	(88)	—	—	—	—	61	(91)

ELECTRICAL SPECIFICATIONS

Nominal DC Resistance @ 68°F (20°C)	Ohms/kft. (Ohms/km)							
Braid Coverage %	Standard		Premium		Trishield		Quadshield	
Conductors	60		90		77		60-36	
Center Conductor	19.1	(63)	—	—	19.1	(63)	19.1	(63)
Outer Conductor	7.74	(25)	—	—	4.65	(15)	4.34	(14)
Loop	26.8	(88)	—	—	23.8	(78)	23.4	(77)
Nominal Capacitance-all types	16.2 pF/ft (53.2 pF/m)							
Impedance	75 ± 3 Ohms							
Velocity of Propagation	85% nominal							

Specifications subject to change without notice.

T10 11 SERIES DROP CABLE

PART NUMBERS

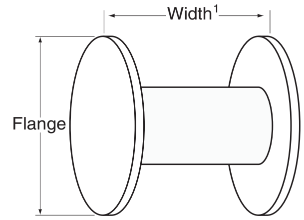
CONSTRUCTION	BRAID COVERAGE STANDARD	TRISHIELD	QUADSHIELD
Nominal Braid Coverage %	60	60	60 - 40
PVC Jacket (Regular)			
Single	T1160-VB	T11T60-VB	T11Q-VB
Single (Colors)	T1160-VC	T11T60-VC	—
Single Messengered (Pole-to-House)	T1160-VB-083M	T11T60-VB-083M	—
Single Messengered (Pole-to-Pole)	T1160-VB-109M	—	T11Q-VB-109M
PVC Jacket (Underground Floodant)			
Single Flooded	T1160-FVB	T11T60-FVB	—
Single Flooded (colors)	T1160-FVC	T11T60-FVC	—
Polyethylene Jacket			
Single Flooded	T1160-FEB	T11T60-FEB	T11Q-FEB
Single Flooded (Colors)	T1160-FEC	T11T60-FEC	T11Q-FEC
Single Messengered (Pole-to-House)	—	—	—
Single Messengered (Pole-to-Pole)	T1160-EB-109M	—	—
PVC Jacket (**lifeTime™** Floodant)			
Single Flooded	T1160-LTVB	T11T60-LTVB	T11Q-LTVB
Single Flooded Messengered (Pole-to-House)	T1160-LTVB-083M	T11T60-LTVB-083M	T11Q-LTVB-083M
Single Flooded Messengered (Pole-to-Pole)*	—	—	T11Q-LTVB-109M
PVC Jacket, Flame Retardant **– NEC Article 820 – "CATV "*****			
Single	T1160-VBV	T11T60-VBV	—
Single (Colors)	—	—	—
PVC Jacket, Flame Retardant w/**lifeTime™ – NEC Article 820 – "CATV"*****			
Single	—	—	T11Q-LTVBV
Single (Colors)	—	—	—
PVC Jacket, Flame Retardant **– NEC Article 820 – "CATVR"*****			
Single	T1160-VBR	—	T11Q-VBR
PVC Jacket, Flame Retardant w/**lifeTime™ – NEC Article 820 – "CATVR"*****			
Single	T1160-LTVBR	—	T11Q-LTVBR

*** CSA - CMH: Change "V" to "F"   NEC CL2: Change "V" to "L"
CSA - CMG: Change "V" to "M"   NEC CM: Change "V" to "Y"

11 SERIES DROP CABLE

REEL SIZE

CONSTRUCTION TYPE	REEL SIZE	
	(Flange x Width)	
Series 11	inches	centimeters
Single	18x13	46x33
Single Trishield	18x13	46x33
Single Quadshield	18x13	46x33
Single Messengered	22x13	56x33
Single Messengered Trishield	22x13	56x33
Single Messengered Quadshield	22x13	56x33



[1] Width = outside flange to outside flange

MAXIMUM ATTENUATION @ 68°F (20°C)

Frequency MHz	dB per 100 feet	dB per 100 meters
5	0.38	1.25
55	0.96	3.15
211	1.90	6.23
250	2.05	6.72
270	2.13	7.00
300	2.25	7.38
330	2.35	7.71
350	2.42	7.94
400	2.60	8.53
450	2.75	9.02
500	2.90	9.51
550	3.04	9.97
600	3.18	10.43
750	3.65	11.97
870	4.06	13.31
1000	4.35	14.27

Attenuation increases with increasing temperature and decreases
with decreasing temperature at the rate of 0.1% / °F (0.18% / °C)

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T10 11 SERIES DROP CABLE

PHYSICAL SPECIFICATIONS

NOMINAL DIMENSIONS	PREMIUM		TRISHIELD		QUADSHIELD	
Braid Coverage %	60		60		60 - 40	
	inches	(mm)	inches	(mm)	inches	(mm)
Conductor	0.0641	(1.63)	0.0641	(1.63)	0.0641	(1.63)
Dielectric	0.280	(7.11)	0.280	(7.11)	0.280	(7.11)
Sealed APA Tape (1st Outer Conductor)	0.288	(7.32)	0.288	(7.32)	0.288	(7.32)
Aluminum Braid (2nd Outer Conductor)	0.312	(7.92)	0.312	(7.92)	0.312	(7.92)
Unsealed APA Tape (3rd Outer Conductor)	—	—	0.316	(8.03)	0.316	(8.03)
Aluminum Braid (4th Outer Conductor)	—	—	—	—	0.341	(8.66)
Jacket	0.400	(10.2)	0.400	(10.2)	0.407	(10.3)
Cable Width						
Messenger Diameter (Pole-to-House)	0.083	(2.11)	0.083	(2.11)	0.083	(2.11)
Messenger Diameter (Pole-to-Pole)	0.109	(2.77)	0.109	(2.77)	0.109	(2.77)
Single Messengered (Pole-to-House)	0.608	(15.4)	0.608	(15.4)	0.615	(15.6)
Single Messengered (Pole-to-Pole)*	0.624	(15.9)	0.624	(15.9)	0.631	(16.0)

Messenger Break Strength	Size	Minimum	Maximum
	0.083 in (2.11 mm)	460 lb (2046 N)	622 lb (2767 N)
	0.109 in (2.77 mm)	1800 lb (8007 N)	2190 lb (9742 N)

Cable Weight Minus Reel [lb/kft (kg/km)] See Pages 124, 125 for Cable Weight Plus Reel

	PREMIUM		TRISHIELD		QUADSHIELD	
PVC Jacket Regular						
Single	58	(86)	56	(83)	58	(86)
Single Messengered (Pole-to-House)	86	(128)	84	(125)	—	—
Single Messengered (Pole-to-Pole)	100	(149)	—	—	—	—
Polyethylene Jacket Regular						
Single	48	(71)	—	—	—	—
Single Messengered (Pole-to-House)	—	—	—	—	—	—
Single Messengered (Pole-to-Pole)	86	(128)	—	—	100	(149)
Underground						
Single Flooded (PVC)	57	(85)	58	(86)	—	—
Single Flooded (PE)	48	(71)	49	(73)	49	(73)
lifeTime™						
Single Flooded	57	(85)	58	(86)	57	(85)
Single Flooded Messengered (Pole-to-House)	83	(124)	83	(124)	82	(122)
Single Flooded Messengered (Pole-to-Pole)	—	—	—	—	—	—

ELECTRICAL SPECIFICATIONS

Nominal DC Resistance @ 68°F (20°C)	Ohms/kft. (Ohms/km)					
Braid Coverage %	Premium		Trishield		Quadshield	
Conductors	60		60		60 - 40	
Center Conductor	12.1	(40)	12.1	(40)	12.1	(40)
Outer Conductor	6.48	(21)	4.55	(15)	3.55	(12)
Loop	18.6	(61)	16.7	(55)	15.7	(52)
Nominal Capacitance-all types	16.2 pF/ft (53.2 pF/m)					
Impedance	75 ± 3 Ohms					
Velocity of Propagation	85% nominal					

Specifications subject to change without notice.

Customers are reminded that they are SOLELY responsible for confirming that all products are properly installed and used in accordance with all applicable codes and regulations.

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DROP CABLE ATTENUATION

ATTENUATION SUMMARY (maximum) @ 68°F (20°C)

Frequency	59 Series		6 Series		7 Series		11 Series	
MHZ	dB/100 feet	dB/100 meters	dB/100 feet	dB/100 meters	dB/100 feet	dB/100 meters	dB/100 feet	dB/100 meters
5	0.86	2.82	0.58	1.90	0.47	1.54	0.38	1.25
55	2.05	6.73	1.60	5.25	1.25	4.10	0.96	3.15
211	3.80	12.47	3.05	10.00	2.36	7.74	1.90	6.23
250	4.10	13.45	3.30	10.82	2.56	8.40	2.05	6.72
270	4.22	13.85	3.37	11.04	2.68	8.78	2.13	7.00
300	4.45	14.60	3.55	11.64	2.82	9.25	2.25	7.38
330	4.66	15.29	3.74	12.26	2.96	9.72	2.35	7.71
350	4.80	15.75	3.85	12.63	3.05	10.01	2.42	7.94
400	5.10	16.73	4.15	13.61	3.27	10.73	2.60	8.53
450	5.40	17.72	4.40	14.43	3.46	11.35	2.75	9.02
500	5.70	18.70	4.66	15.29	3.67	12.04	2.90	9.51
550	5.95	19.52	4.90	16.08	3.85	12.63	3.04	9.97
600	6.20	20.34	5.10	16.73	4.05	13.28	3.18	10.43
750	6.97	22.87	5.65	18.54	4.57	14.99	3.65	11.97
870	7.57	24.85	6.11	20.04	4.96	16.28	4.06	13.31
1000	8.12	26.64	6.55	21.49	5.32	17.45	4.35	14.27

Attenuation increases with increasing temperature and decreases with decreasing temperature at the rate of 0.1% / °F (0.18% / °C)

T10

HEADEND SERIES DROP CABLE

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DETAILS OF CONSTRUCTION AND MATERIALS

- Center Conductor - Silver-plated copper-clad steel for long term low contact resistance, low attenuation and axial strength, with easy cable preparation and reliable connector attachment for "F" type fittings.
- Dielectric - Foam Polyethylene, low loss, high velocity providing optimum dielectric properties. The foam is bonded to the center conductor with an easily stripped, proprietary moisture-blocking polymer.
- Outer Conductor
  1. Sealed APA Laminated Tape
  2. 95% Aluminum Braid
  3. APA Laminated Tape
  4. 95% Aluminum Braid
- Jacket - Flame retardant PVC - NEC Article 820 - **"CATV"**

Application: Headend Cable is recommended for installation in headends where cable may be subjected to tight bends and mechanical abuse.

PART NUMBERS

DESCRIPTION
T59SCSQ95/95-VBV
T59SCSQ95/95-VCV

PHYSICAL SPECIFICATIONS

NOMINAL DIMENSIONS	inches	(mm)
Conductor	0.032	(0.81)
Dielectric	0.144	(3.66)
First Outer Conductor	0.152	(3.86)
Second Outer Conductor	0.176	(4.47)
Third Outer Conductor	0.180	(4.57)
Fourth Outer Conductor	0.205	(5.21)
Jacket	0.262	(6.65)
Cable Weight, lbs per kft (kg/km)	31	(46)

ELECTRICAL SPECIFICATIONS

	Ohms/1000 ft	(Ohms/km)
Nominal DC Resistance at 68°F (20°C)		
Center Conductor	25.3	(83.0)
Outer Conductor	3.57	(11.7)
Loop	28.9	(94.8)
Nominal Capacitance	16.3 pF/ft	(53.5 pF/m)
Impedance	75 ± 3 Ohms	
Velocity of Propagation	83% nominal	

MAXIMUM ATTENUATION @ 68°F (20°C)

Frequency MHz	dB per 100 feet	dB per 100 meters
5	0.86	2.82
55	2.05	6.73
211	3.80	12.47
250	4.10	13.45
270	4.22	13.85
300	4.45	14.60
330	4.66	15.29
350	4.80	15.75
400	5.10	16.73
450	5.40	17.72
500	5.70	18.70
550	5.95	19.52
600	6.20	20.34
750	6.97	22.87
870	7.57	24.85
1000	8.12	26.64

Attenuation increases with increasing temperature and decreases
with decreasing temperature at the rate of 0.1% / °F (0.18% / °C)

Specifications subject to change without notice.

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59	Single, 53%	T5953-VB	40
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59	Single, 53%, Colors	T5953-VC	40
59	Single, 53%, Colors, CATV NEC	T5953-VCV	40
59	Single Messengered, 53%	T5953-VB-051M	40
59	Single, Flooded, 53%	T5953-FVB	40
59	Single, Flooded, Polyethylene Jkt., 53%	T5953-FEB	40
59	Single, lifeTime™, 53%	T5953-LTVB	40
59	Single, lifeTime™, 53%, CATV NEC	T5953-LTVBV	41
59	Single Messengered, lifeTime™, 53%	T5953-LTVB-051M	40
59	Siamese, lifeTime™, 53%	T5953SIAM-LTVB	40
59	Siamese, lifeTime™, 53%, CATV NEC	T5953SIAM-LTVBV	41
59	Siamese Messengered, lifeTime™, 53%	T5953SIAM-LTVB-072M	40
59	Siamese, 53%	T5953SIAM-VB	40
59	Siamese, 53%, CATV NEC	T5953SIAM-VBV	40
59	Siamese, 53%, Colors	T5953SIAM-VC	40
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59	Siamese Flooded, 53%	T5953SIAM-FVB	40
59	Single, 67%	T5967-VB	40
59	Single, 67%, CATV NEC	T5967-VBV	40
59	Single, 67%, CATVR NEC	T5967-VBR	41
59	Single, 67%, Colors	T5967-VC	40
59	Single, 67%, Colors, CATV NEC	T5967-VCV	40
59	Single Messengered, 67%	T5967-VB-051M	40
59	Single Flooded, 67%	T5967-FVB	40
59	Single Flooded, Polyethylene Jkt., 67%	T5967-FEB	40
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59	Siamese, lifeTime™, 67%, CATVR NEC	T5967SIAM-LTVBR	41
59	Siamese Messengered, lifeTime™, 67%	T5967SIAM-LTVB-072M	40
59	Siamese, 67%	T5967SIAM-VB	40
59	Siamese, 67%, CATV NEC	T5967SIAM-VBV	40
59	Siamese, 67%, CATVR NEC	T5967SIAM-VBR	41
59	Siamese, 67%, Colors	T5967SIAM-VC	40
59	Siamese, 67%, Colors, CATV NEC	T5967SIAM-VCV	40
59	Siamese Messengered, 67%	T5967SIAM-VB-072M	40
59	Siamese Flooded, 67%	T5967SIAM-FVB	40
59	Single Flooded, Polyethylene Jkt., 53%-34%	T59Q53/34-FEB	40
59	Single, 53%-34%	T59Q53/34-VB	40
59	Single, 53%-34%, CATV NEC	T59Q53/34-VBV	40
59	Single, 53%-34%, CATVR NEC	T59Q53/34-VBR	41
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59	Siamese, lifeTime™, 95%	T5995SIAM-LTVB	40
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59	Single, Trishield, 53%, Colors	T59T53-VC	40
59	Single, Trishield, 53%, Colors, CATV NEC	T59T53-VCV	40
59	Single Messengered, Trishield, 53%	T59T53-VB-051M	40
59	Single Flooded, Trishield, 53%	T59T53-FVB	40
59	Single, lifeTime™, Trishield, 53%	T59T53-LTVB	40
59	Single, lifeTime™, Trishield, 53%, CATV NEC	T59T53-LTVBV	41
59	Single Messengered, lifeTime™, Trishield 53%	T59T53-LTVB-051M	40
59	Single, Trishield, 77%	T59T77-VB	40
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59	Single, Trishield, 77%, Colors	T59T77-VC	40
59	Single, Trishield, 77%, Colors, CATV NEC	T59T77-VCV	40
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6	Single, 60%-40%, Colors, CATVR NEC	T6Q-VCR	45

T10 DROP CABLE SUMMARY

Amphenol TFC

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6	Single, Flooded, 60%-40%	T6Q-FVB	44
6	Single, Flooded, Polyethylene Jkt., 60%-40%	T6Q-FEB	44
6	Single, lifeTime™, 60%-40%	T6Q-LTVB	44
6	Single, lifeTime™, 60%-40%, CATV NEC	T6Q-LTVBV	44
6	Single, lifeTime™, 60%-40%, CATVR NEC	T6Q-LTVBR	45
6	Single, lifeTime™, 60%-40%, Colors, CATV (UL)	T6Q-LTVCV	44
6	Single, Messengered, lifeTime™, 60%-40%	T6Q-LTVB-051M	44
6	Siamese, lifeTime™, 60%-40%	T6QSIAM-LTVB	44
6	Siamese, lifeTime™, 60%-40%, CATV (UL)	T6QSIAM-LTVBV	44
6	Siamese, Messengered, lifeTime™, 60%-40%	T6QSIAM-LTVB-072M	44
6	Siamese, 60%-40%	T6QSIAM-VB	44
6	Siamese, 60%-40%, CATV NEC	T6QSIAM-VBV	44
6	Siamese, 60%-40%, Colors	T6QSIAM-VC	44
6	Siamese, 60%-40%, Colors, CATV NEC	T6QSIAM-VCV	44
6	Siamese , Messengered, 60%-40%	T6QSIAM-VB-072M	44
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7	Single, 60%	T760-VB	48
7	Single, 60%, CATV NEC	T760-VBV	48
7	Single, 60%, CATVR NEC	T760-VBR	48
7	Single, 60%, Colors	T760-VC	48
7	Single, Messengered, 60%	T760-VB-072M	48
7	Single, Flooded, 60%	T760-FVB	48
7	Single, Flooded, 60%, Colors	T760-FVC	48
7	Single, Flooded, Polyethylene Jkt., 60%	T760-FEB	48
7	Single, lifeTime™, 60%	T760-LTVB	48
7	Single, lifeTime™, 60%, CATVR NEC	T760-LTVBR	48
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7	Single, Messengered, lifeTime™, 90%	T790-LTVB-072M	48
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7	Single, Flooded, Polyethylene Jkt., 60%-36%, Colors	T7Q60/36-FEC	48
7	Single, lifeTime™, 60%-36%	T7Q60/36-LTVB	48
7	Single, lifeTime™, 60%-36%, CATVR NEC	T7Q60/36-LTVBR	48
7	Single, Messengered, lifeTime™, 60%-36%	T7Q60/36-LTVB-072M	48
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11	Single, 53%, CATV NEC	T1153-VBV	52
11	Single, 53%, Colors	T1153-VC	52
11	Single, Messengered, 53%	T1153-VB-083M	52
11	Single, Messengered, Polyethylene Jkt., 53%	T1153-EB-083M	52
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Customers are reminded that they are SOLELY responsible for confirming that all products are properly installed and used in accordance with all applicable codes and regulations.

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11	Single, Flooded, Polyethylene Jkt., 53%, Colors	T1153-FEC	52
11	Single, lifeTime™, 53%	T1153-LTVB	52
11	Single, lifeTime™, 53%, CATV NEC	T1153-LTVBV	52
11	Single, Messengered, lifeTime™, 53%	T1153-LTVB-083M	52
11	Single, Messengered, lifeTime™, Polyethylene Jkt., 53%	T1153-LTEB-109M	52
11	Single, 60%	T1160-VB	52
11	Single, 60%, CATV NEC	T1160-VBV	52
11	Single, 60%, CATVR NEC	T1160-VBR	52
11	Single, 60%, Colors	T1160-VC	52
11	Single, Messengered, 60%	T1160-VB-083M	52
11	Single, Messengered, 60%	T1160-VB-109M	52
11	Single, Messengered, Polyethylene Jkt., 60%	T1160-EB-109M	52
11	Single, Flooded, 60%	T1160-FVB	52
11	Single, Flooded, Polyethylene Jkt., 60%	T1160-FEB	52
11	Single, Flooded, 60%, Colors	T1160-FVC	52
11	Single, Flooded, Polyethylene Jkt., 60%, Colors	T1160-FEC	52
11	Single, lifeTime™, 60%	T1160-LTVB	52
11	Single, lifeTime™, 60%, CATVR NEC	T1160-LTVBR	52
11	Single, Messengered, lifeTime™, 60%	T1160-LTVB-083M	52
11	Single, Trishield, 77%	T11T77-VB	52
11	Single, Trishield, 77%, CATV NEC	T11T77-VBV	52
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11	Single, Flooded, Trishield, Polyethylene Jkt., 77%	T11T77-FEB	52
11	Single, Flooded, Trishield, 77%, Colors	T11T77-FVC	52
11	Single, Flooded, Trishield, Polyethylene Jkt., 77%Colors	T11T77-FEC	52
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11	Single, 53%-32%, CATV NEC	T11Q53/32-VBV	52
11	Single, 53%-32%, Colors, CATV NEC	T11Q53/32-VCV	52
11	Single, Messengered, 53%-32%	T11Q53/32-VB-083M	52
11	Single, Messengered, Polyethylene Jkt., 53%-32%	T11Q53/32-EB-109M	52
11	Single, Flooded, 53%-32%	T11Q53/32-FVB	52
11	Single, Flooded, Polyethylene Jkt., 53%-32%	T11Q53/32-FEB	52
11	Single, Flooded, 53%-32%, Colors	T11Q53/32-FVC	52
11	Single, Flooded, Polyethylene Jkt., 53%-32%, Colors	T11Q53/32-FEC	52
11	Single, lifeTime™, 53%-32%	T11Q53/32-LTVB	52
11	Single, lifeTime™, 53%-32%, CATV NEC	T11Q53/32-LTVBV	52
11	Single, Messengered, lifeTime™, 53%-32%	T11Q53/32-LTVB-083M	52
11	Single, Messengered, lifeTime™, 53%-32%	T11Q53/32-LTVB-109M	52
11	Single, Messengered, lifeTime™, Polyethylene Jkt., 53%-32%	T11Q53/32-LTEB-109M	52
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11	Single, 60%-40%, CATVR NEC	T11Q-VBR	52
11	Single, Flooded, Polyethylene Jkt., 60%-40%	T11Q-FEB	52
11	Single, Flooded, Polyethylene Jkt., 60%-40%, Colors	T11Q-FEC	52
11	Single, Messengered, 60%-40%	T11Q-VB-109M	52
11	Single, lifeTime™, 60%-40%	T11Q-LTVB	52
11	Single, lifeTime™, 60%-40%, CATV NEC	T11Q-LTVBV	52
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TFC Amphenol

TABLE OF CONTENTS: T10 DROP CABLE SERIES

FLEXIBLE FEEDER®

PART NUMBERS

	BRAID COVERAGE	
CONSTRUCTION	**STANDARD**	**QUADSHIELD**
Nominal Braid Coverage %	60	60-40
PVC Jacket (Regular)		
Single	TX15A60-VB	TX15AQ-VB
Single (Colors)	—	—
Single Messengered	TX15A60-VB-109M	TX15AQ-VB-109M
Polyethylene Jacket (Underground Floodant)		
Single Flooded	TX15A60-FEB	TX15AQ-FEB
Single Flooded (Colors)	—	TX15AQ-FEC
PVC Jacket (lifeTime™ Floodant)		
Single Flooded	TX15A60-LTVB	TX15AQ-LTVB
Single Flooded Messengered	—	TX15AQ-LTVB-109M
PVC Jacket, Flame Retardant – NEC Article 820 – "**CATV**"		
Single	TX15A60-VBV	TX15AQ-VBV
Single (Colors)	—	—
PVC Jacket, Flame Retardant – NEC Article 820 – "**CATVR**"		
Single	TX15A60-VBR	TX15AQ-VBR
Single (Colors)	—	—

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FLEXIBLE FEEDER®

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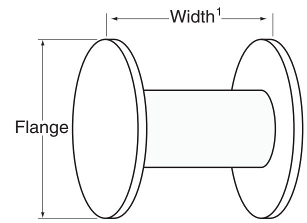
REEL SIZE

CONSTRUCTION TYPE	REEL SIZE (Flange x Width)	
Series 15	inches	centimeters
All Types	30x14	76x36



[1] Width = outside flange to outside flange

MAXIMUM ATTENUATION @ 68°F (20°C)

Frequency MHz	dB per 100 feet	dB per 100 meters
5	0.21	0.69
55	0.60	1.97
211	1.16	3.81
250	1.26	4.13
270	1.31	4.30
300	1.39	4.56
330	1.45	4.76
350	1.50	4.92
400	1.61	5.28
450	1.71	5.61
500	1.80	5.91
550	1.90	6.23
600	1.98	6.50
750	2.23	7.32
870	2.41	7.91
1000	2.59	8.50

Attenuation increases with increasing temperature and decreases with decreasing temperature at the rate of 0.1% /°F (0.18% /°C)

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FLEXIBLE FEEDER® TX

PHYSICAL SPECIFICATIONS

NOMINAL DIMENSIONS	STANDARD		QUADSHIELD	
Braid Coverage %	60		60-40	
	inches	(mm)	inches	(mm)
Conductor	0.109	(2.77)	0.1090	(2.77)
Dielectric	0.455	(11.8)	0.455	(11.6)
Sealed APA Tape (1st Outer Conductor)	0.463	(11.8)	0.463	(11.8)
Aluminum Braid (2nd Outer Conductor)	0.490	(12.4)	0.490	(12.4)
Unsealed APA Tape (3rd Outer Conductor)	—	—	0.494	(12.5)
Aluminum Braid (4th Outer Conductor)	—	—	0.523	(13.3)
Jacket	0.595	(15.1)	0.615	(15.6)
Cable Width (Single)				
Messenger Diameter (Single)	0.109	(2.77)	0.109	(2.77)
Single Messengered Width	0.814	(20.7)	0.847	(21.5)

Messenger Break Strength	**Size**	**Min**	**Max**
	0.109 in (2.77mm)	1800 lb (8007 N)	2190 lb (9742 N)

Cable Weight [lb./kft. (kg/km)]

Regular	60		60-40	
Single	101	(150)	115	(171)
Single Messengered	143	(213)	—	—
Underground				
Single Flooded (PVC)	—	—	—	—
Single Flooded (PE)	81	(121)	93	(138)
lifeTime™				
Single Flooded	99	(147)	112	(167)
Single Flooded Messengered	—	—	153	(228)

ELECTRICAL SPECIFICATIONS

Nominal DC Resistance @ 68°F (20°C)	**Ohms per kft. (Ohms/ km)**			
Braid Coverage %	Standard		Quadshield	
Conductors	60		60-40	
Center Conductor	1.35	(4.43)	1.35	(4.43)
Outer Conductor	4.42	(14.50)	2.50	(8.20)
Loop	5.77	(18.93)	3.85	(12.63)
Nominal Capacitance	15.5 pF/ft (50.9 pF/m)			
Impedance	75 ± 2 Ohms			
Velocity of Propagation	88% nominal			

Specifications subject to change without notice.

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NOTES

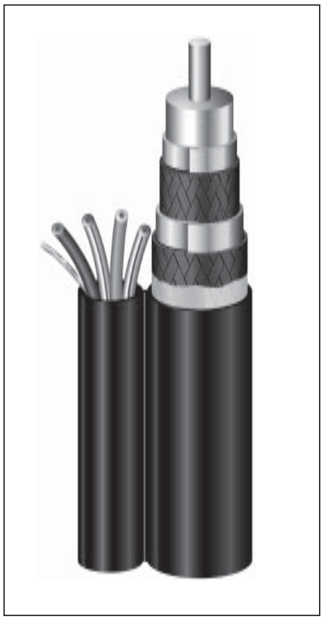
TFC Amphenol TeleDrop Cable Series T10

Standard Offerings	Series 59	Series 6	Series 7	Series 11
53% Braid Coverage, lifeTime™, Polyethylene Jacket, Black, 2 pair 22 AWG	T5953-LTEB-2X22	—	—	T1153-LTEB-2X22
53% Braid Coverage, lifeTime™, Polyethylene Jacket, Black, 2 pair 22 AWG, Shielded	T5953-LTEB-2X22S	—	—	T1153-LTEB-2X22S
53% Braid Coverage, lifeTime™, Polyethylene Jacket, Black, 2 pair 24 AWG	T5953-LTEB-2X24	—	—	T1153-LTEB-2X24
53% Braid Coverage, lifeTime™, Polyethylene Jacket, Black, 2 pair 24 AWG, Shielded	T5953-LTEB-2X24S	—	—	T1153-LTEB-2X24S
53% Braid Coverage, lifeTime™, PVC Jacket, Black, 2 pair 24 AWG	T5953-LTVB-2X24	—	—	—
53% Braid Coverage, lifeTime™, PVC Jacket, Color, 2 pair 24 AWG	T5953-LTVC-2X24	—	—	—
53% Braid Coverage, lifeTime™, Polyethylene Jacket, Black, 2 pair 26 AWG	T5953-LTEB-2X26	—	—	T1153-LTEB-2X26
53% Braid Coverage, lifeTime™, Polyethylene Jacket, Black, 2 pair 26 AWG, Shielded	T5953-LTEB-2X26S	—	—	T1153-LTEB-2X26S
60% Braid Coverage, lifeTime™, Polyethylene Jacket, Black, 2 pair 22 AWG	—	T660-LTEB-2X22	T760-LTEB-2X22	—
60% Braid Coverage, lifeTime™, Polyethylene Jacket, Black, 2 pair 22 AWG, Shielded	—	T660-LTEB-2X22S	T760-LTEB-2X22S	—
60% Braid Coverage, lifeTime™, Polyethylene Jacket, Color, 2 pair 22 AWG	—	T660-LTEC-2X22	—	—
60% Braid Coverage, lifeTime™, Polyethylene Jacket, Color, 2 pair 22 AWG, Shielded	—	T660-LTEC-2X22S	—	—
60% Braid Coverage, lifeTime™, PVC Jacket, Color, 2 pair 22 AWG, Shielded	—	T660-LTVC-2X22S	—	—
60% Braid Coverage, lifeTime™, Polyethylene Jacket, Black, 2 pair 24 AWG	—	T660-LTEB-2X24	T760-LTEB-2X24	—
60% Braid Coverage, lifeTime™, Polyethylene Jacket, Black, 2 pair 24 AWG, Shielded	—	T660-LTEB-2X24S	T760-LTEB-2X24S	—
60% Braid Coverage, lifeTime™, PVC Jacket, Color, 2 pair 24 AWG	—	T660-LTVC-2X24	—	—
60% Braid Coverage, lifeTime™, Polyethylene Jacket, Black, 2 pair 26 AWG	—	T660-LTEB-2X26	T760-LTEB-2X26	—
60% Braid Coverage, lifeTime™, Polyethylene Jacket, Black, 2 pair 26 AWG, Shielded	—	T660-LTEB-2X26S	—	—
60% Braid Coverage, lifeTime™, Polyethylene Jacket, Color, 2 pair 26 AWG	—	T660-LTEC-2X26	—	—
60% Braid Coverage, lifeTime™, PVC Jacket, Black, 2 pair 26 AWG	—	T660-LTVB-2X26	—	—
60% Braid Coverage, lifeTime™, PVC Jacket, Color, 2 pair 26 AWG	—	T660-LTVC-2X26	—	—
For NEC compliant products, please contact TFC Customer Service				

T10 TeleDrop Cable Series

TWISTED PAIRS ELECTRICAL PROPERTIES (per ASTM D-4566)

Impedance (nominal @ 1MHz)	100 Ohms
Mutual Capacitance (nominal)	58nf/km
Resistance Unbalance (maximum)	5%
Near End Crosstalk @ 772 kHz	-44dB min.
Far End Crosstalk @ 150 kHz	-83 +- 7 nf/mile min.



Features Standard TFC T10 Drop Cables Combined with:

- Standard color-coded twisted pairs - 22 AWG , 24 AWG, 26 AWG
- One (1) through six (6) pairs available
- Overall, flooded coaxial and paired core filled with moisture blocking corrosion protectant, TFC's lifeTime™
- Optional shield of laminated Aluminum/Poly/Aluminum tape
- Outer jacket of black weather resistant polyethylene flame retardant PVC, or PE

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Currently Under Revision

OVERVIEW

Many systems have experienced pull-outs (also referred to as “suck-outs”) where the center conductor of the cable slides out of the connector’s seize basket. This technical note discusses some of the factors that could cause suck-outs and a solution to minimize their occurrence.

NEED FOR PROPER EXPANSION LOOPS

Consider a span of cable 150 feet long, of 0.625 inch jacketed cable lashed to a 0.25 (1/4) inch steel strand. If the cable were installed at 70°F with 0.5% sag (0.75 foot mid-span) then the tension on the strand would be about 1,090 pounds. The tension on the cable would be 0 pounds.

If expansion loops are installed and the lashing wire does not restrain cable movement then the cable is free to expand and contract as the temperature changes. At 0°F the strand would have about 1580 pounds tension on it while the cable would only have the few pounds of tension required to expand the expansion loop.

If there is essentially no tension on the cable, how can a suck-out occur? In essence none can. But, if we consider the same span except without expansion loops or with the lashing wire so tight as to restrain cable movement, an entirely different set of conditions can occur.

PROBLEM OF NO EXPANSION LOOPS

Cable Tension

As the temperature drops, the cable and strand attempt to contract. But the cable, being largely composed of aluminum, contracts about twice as much as the steel support strand. Since the cable’s ends are fixed at the poles, tension on the cable increases. The cable, being elastic, elongates as a function of its elastic modulus. The increased tension reduces the sag slightly, but the additional cable from the reduction in sag is not enough to offset all the tension. At 0°F the total tension is about 2380 pounds. The steel strand supports about 1570 pounds, leaving the rest for the cable to accommodate. The tension on the center conductor will be about 124 pounds It should be noted that neither the cable nor the connector are designed to be load bearing elements which they will be under these conditions. At -40°F the center conductor tension is about 200 pounds, and its yield strength is exceeded. See Table 1.

Connector Interface

Examining the cable-connector interface, we can see a number of possible conditions that will ultimately result in a suck-out.

The first thought might be that the center conductor can-not move because it is held in place by the dielectric and sheath. However, this is not true for cables that do not have the dielectric bonded to the outer conductor. At low temperatures the core-to-sheath adhesion is insufficient to resist the tension. The reason is simple. The plastic core contracts about ten times more than the aluminum sheath. As the temperature decreases, the center conductor and dielectric are free to move inside the sheath. The next thought might be that the conductor won’t pull out because the seize basket is holding it in place. This is only partly true. Generally, a connector is designed to hold a conductor up to its yield point. As with any product, the connector pull force will vary from one connector to the next. However, even if every connector could hold the conductor to its yield, - 40°F could exceed the yield leaving the interface prone to suck-outs and conductor breakage. Metal fatigue could occur after a few cycles of stress beyond the yield, causing outages during severe temperature drops.

If the connector is not tightened properly, it cannot grip the conductor. This can easily be avoided by having the splicer follow the connector manufacturer’s recommendations. If this same span had been installed with adequate expansion loops and lashed not so tight as to restrain cable movement, suck-outs would have been minimized if not entirely avoided. The expansion loops provide the additional cable needed during temperature drops, thus avoiding cable and connector stress. Of course, if the cable is connected to some device that is bolted to the strand, expansion loops are required on both sides of the device.

Effects of Sag on Cable Tension

The following table provides calculated conductor tensions which may result in suck-outs from various initial sags and temperature drops.

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Table 1.

Center Conductor Tension (pounds)			
No Expansion Loops and/or Tight Lashing			
Sag @ 70°F	70°F	0°F	-40°F
0.5%	0	124	198
1.0%	0	97	169
1.5%	0	60	122
2.0%	0	38	72

**The yield strength of the 0.136 inch conductor is about 160 pounds. For those conditions listed in the table that exceed the yield, suck-outs and conductor breaks become very possible. If the connector is not fully tightened, conductor tensions of even less than 100 pounds may result in pull-outs.*

Solution

To solve the problems of suck-outs, all TFC semi-flexible coaxial cables have a dielectric that is bonded to the outer conductor. As the temperature drops, adhesion between the dielectric and outer conductor is not lost. Since its introduction, not a single center conductor pull-out has been reported on these types of cables. Although good construction practices, including proper sag and the use of expansion loops are still recommended, these cables, with dielectric bonded to the outer conductor, seem to have eliminated problems related to center conductor pull-outs.

OVERVIEW

T10 and TX10 trunk and feeder cable designs include a bond between the foamed dielectric and the aluminum sheath and a bond between the center conductor and the dielectric. The bonding treatment insures high core-to-sheath adhesion at cold temperatures, provides protection against center conductor pull-outs, and improves handling characteristics.

In the unflooded jacketed version, the jacket is bonded to the aluminum sheath. The bonded jacket provides enhanced corrosion protection, increased jacket toughness, higher pull strengths and avoidance of hidden damage to the underlying aluminum.

As with any high quality foamed cable, increased core-to-sheath adhesion makes it more difficult to pull off the aluminum sheath to expose the center conductor during cable preparation. The method to facilitate the removal of the aluminum sheath to expose the center conductor is provided herein. A conventional technique for removing the jacket, flooding compound, and center conductor coating are also provided. Even though the adhesive increases core-to-sheath adhesion, the dielectric can still be cored out cleanly, allowing the use of standard connectors.

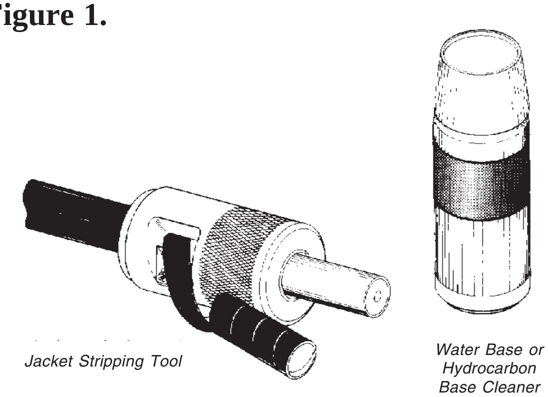
JACKET REMOVAL

Jacketed Flooded Cable

Sufficient jacket should be removed so that the jacket will not interfere with connector installation. Thus the length of jacket that should be removed depends on the type of connector that will be used and the length of center connector that will be exposed. The jacket should not be trimmed back too far because additional heat-shrink tubing will be necessary to protect the bare aluminum outer conductor.

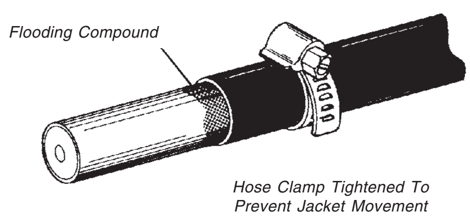
Before attempting to remove the jacket, assure that the cable is straight. With underground flooded cable (viscous flooding compound), or aerial flooded cable (non-viscous flooding compound), remove the jacket with a jacket stripping tool and clean off the flooding compound with an appropriate flooding compound remover intended for existing temperature conditions. See Figure 1.

Figure 1.



On underground cable, with clear viscous flooding compound, a hose clamp should be tightened on the jacket about 1/2 inch from the end to prevent the jacket from shrinking back. Heatshrink tubing will cover the clamp, cable and connector when the job is complete.

Figure 2.



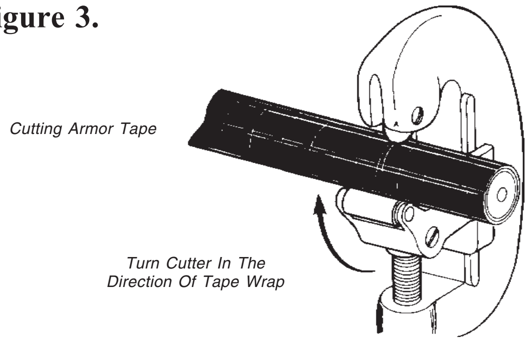
JACKETED NON-FLOODED CABLES

In unflooded jacketed constructions, the jacket is bonded to the aluminum. A special adhesive has been used to allow easy jacket removal and assure that no residue is left on the aluminum surface. Use a jacket stripping tool intended for the cable to remove the jacket.

ARMOR REMOVAL

If the cable is armored, the best approach is to use a tubing cutter to cut through the outer jacket and steel armor. The tubing cutter should be tightened a very small amount each turn until the tape is cut through. If the cutter is tightened too much the tape will catch and pull out of the jacket. After the steel tape is cut through, remove the outer jacket with a knife, and unwind the steel tape. Be careful, the tape has sharp edges and it is easy to get cut. Remove the jacket as described above.

Figure 3.



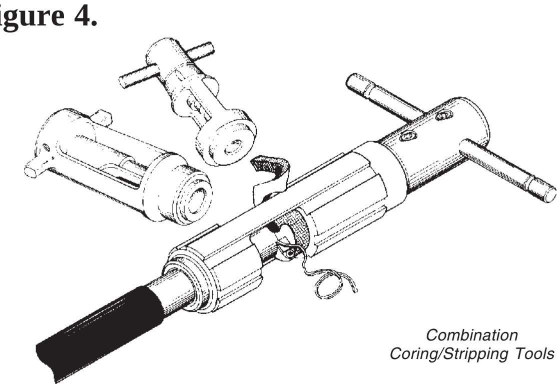
ALUMINUM SHEATH REMOVAL AND CORING METHODS

Several methods exist in the industry for coring standard trunk and feeder cables. One of these methods is listed as follows:

Combination Coring/Stripping Tool

In this method the aluminum sheath is removed, the dielectric cored, and the center conductor is exposed to the proper length in one step by using a power or manually operated combination coring/stripping tool. Determine the length the center conductor must extend from the end of the cable from the connector manufacturer's recommendation.

Figure 4.

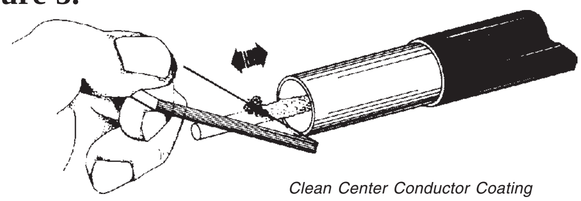


CENTER CONDUCTOR PREPARATION

Cleaning

After coring the cable, a thin layer of dielectric material will remain coating the exposed center conductor. The center conductor is made of copper covered aluminum and can be damaged very easily if care is not taken to clean the conductor. A plastic center conductor cleaning tool (or piece of Plexiglas™) can be used to scrape the coating off the center conductor. See Figure 5.

Figure 5.

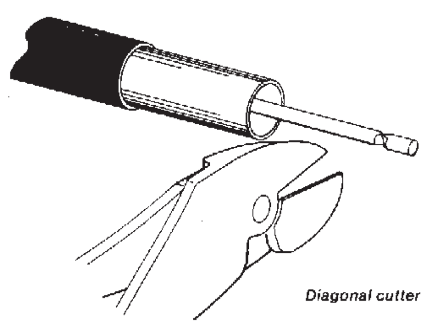


The use of hard materials such as knives, razor blades, or sand paper to clean the coating off may score or abrade the copper clad aluminum center conductor. If the conductor is scored or abraded, it will be weakened and can break in the future after it is exposed to cyclic stress. Another possible problem is that if the aluminum is exposed, a galvanic cell can form and eventually result in the loss of electrical contact due to corrosion.

Trimming

After the center conductor is cleaned, cut the center conductor to its final length. Cut the center conductor with diagonal cutters 1/2 to 2/3 of the way through. Rotate the cutters 90 degrees and cut through completely. This should leave the center conductor with a slightly triangular shaped end. Straighten the center conductor and follow the connector manufacturer's recommendations for installing the connector.

Figure 6.



Caution: The connector should slide into the cable easily. The connector can be damaged if excessive force is used. The connector should never be hammered onto the cable.

DROP CABLE TRANSFER IMPEDANCE

Introduction

Although drop coaxial cable is selected for its electrical, mechanical, and environmental performance, probably the most important factor is shielding. Aside from the strict FCC regulatory requirements, cable signal leakage problems can have a disastrous effect on system performance, especially when upstream communications in the 5 to 42 MHz band are considered. Since shielding controls drop cable cost more than almost any other element, it is important to understand how various shield configurations perform.

Transfer Impedance

The unit of measure that best describes how well a shield performs or how energy transfers through the shield is its transfer impedance. Transfer impedance is the ratio of the voltage in the disturbed circuit to the current in the interfering circuit along an elementary length of the shield. The disturbed circuit for ingressive signals is inside the coaxial cable and the interfering circuit is the environment outside the coaxial cable. The lower the transfer impedance, the better the isolation. A low transfer impedance allows less energy to pass through the shield than a high transfer impedance.

Shield Types

The transfer impedance of solid shields can be calculated with extreme accuracy. The transfer impedance of shields that have holes, like a braid with uniform size, shape, and distribution of the holes, can also be calculated, but with far less accuracy. When the shield is more complex, having multiple braids and tapes, transfer impedance calculations have very questionable accuracy.

Generally, the type of shields used by the cable television industry are complex, often consisting of multiple layers of tapes and braids. In order to determine the transfer impedance of these complex shields, measurements are necessary. The technique generally accepted by the industry employs a terminated triaxial fixture, such as the Radiometer manufactured and used by TFC.

Simulated Aging

Figure 1 shows the transfer impedance of several coaxial cables after simulated aging and a solid tube which is listed for reference only. The simulated aging is based on flexure that degrades transfer impedance by the same amount as drop cables removed from systems after 10 years of actual service in the Northeast U.S. Flexure may simulate cyclic stress from temperature changes, wind, and ice loading. The simulated aging does not take into account other environmental effects, such as corrosion, which can also degrade shielding performance.

Braid Shield

One of the first drop cables used by the cable television industry was a 59-type cable. The earlier designation, “RG59/U”, refers to a cable with a 75 ohm impedance, a 0.146 inch O.D. solid polyethylene dielectric, and a 95 percent coverage copper braid. Although its performance is not affected by the simulated aging tests (i.e., it has no tape shields), even its unaged transfer impedance performance is quite poor by today’s standards, especially at higher frequencies.

Shields With Tape and Braid

An improved version of this cable, from both a cost and a shielding standpoint, consists of a laminated tape over the dielectric and a low coverage aluminum braid. The tape provides 100 percent optical coverage and is composed of three discrete layers (aluminum-plastic-aluminum). Aluminum foil alone is unacceptable because of its tendency to crack even after only moderate flexure; the plastic laminant tends to reinforce the outer aluminum foils.

A sealed version of this laminated tape (with a fourth layer of adhesive) was later introduced to facilitate connector installation and to keep the overlap from separating after flexure, thus creating a gap which would degrade shielding performance. This construction is somewhat more expensive but it had much improved resistance to shielding degradation after flexure, when compared to tape versions without the seal.

Quadshield

Further improvements were made to shielding performance by using multiple layers of tapes and braids. The best available is quadshield, which includes a sealed tape, a braid, an unsealed tape, and a second braid. This construction showed a vast improvement over other available cables, especially after handling and field exposure.

Trishield

Other cables, such as trishield (sealed tape-braid-tape), were developed, which provided a trade-off between cable cost and shielding by avoiding the use of the costly outer braid used on quadshield. The trishield has a lower cost, but it does not afford the shielding level of quadshield.

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Trishield was modified further by replacing the outer tape with a two-layer laminated tape. It has a thicker aluminum foil facing inward and a plastic reinforcement facing outward to prevent radial cracks. In this case, the tape is folded to provide metal to metal contact at the overlap, thus reducing the effect of the gap after flexure. This construction offers improved low frequency performance over the original trishield, but measurements confirm no improvement above 30 MHz unless a much higher coverage braid is used (e.g., 80 percent).

Although these constructions are better than the original tape-braid versions, quadshield remains superior. A headend cable was developed with the quadshield design for applications where extremely good shielding is required.

DISCUSSION OF FIGURE 1.

The best transfer impedance performance that can be achieved is with solid tubes because they contain no holes which would allow electric and magnetic energy to couple to the external circuit. In the case of solid tubes with no holes, leakage is solely a function of fields that diffuse through the metal. Transfer impedance improves (gets smaller) as the frequency increases because the diffusion through the metal decreases.

Braided shields are subject to the same diffusion process, but the braid holes allow magnetic energy to couple through the shield. The transfer impedance is the vector sum of the diffusion and magnetic coupling. Since magnetic coupling increases directly with frequency, at frequencies in the cable television band, the magnetic coupling contribution is the driving force behind the braid’s poor performance.

When a tape is added to the braid, the size and number of holes are substantially reduced, thus limiting the magnetic coupling. However, the overlap defies easy analysis. Gaps that exist at the overlap can vary significantly from one sample to the next. Prior to simulated aging, a tape/braid version performs quite well. After flexure substantial degradation can occur.

Less sensitive to flexure are sealed versions of the tape/braid construction. Apparently the gap at the overlap does not separate as much as unsealed tape versions, thus controlling the amount of magnetic coupling. Additional shields (those beyond the sealed tape and braid) improve the cable’s transfer impedance.

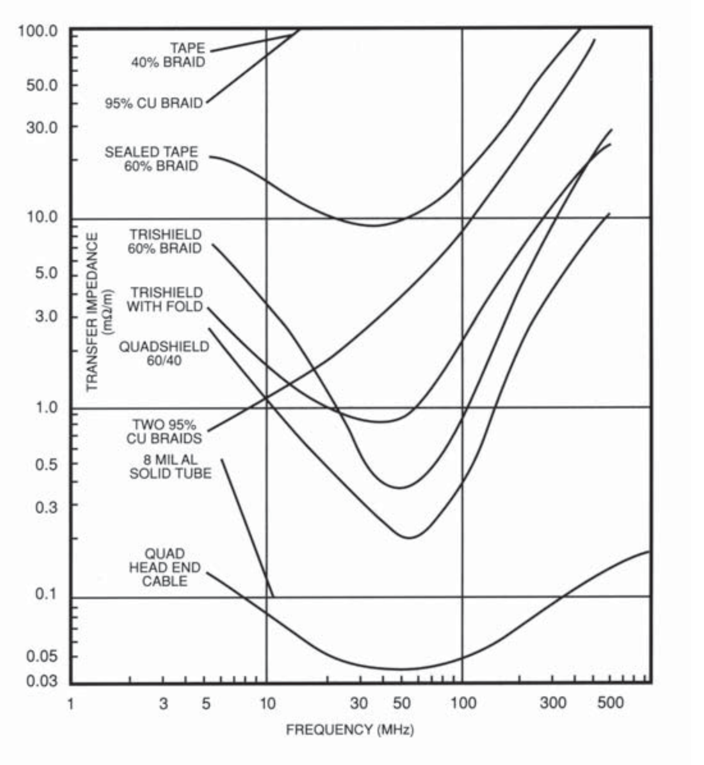
Prior to flexure, the two trishields and quadshields are almost indistinguishable except at low frequencies where the amount of metal is the key factor. Because quadshield has the lowest DC shield resistance, it is clearly superior in this region. The quadshield developed for headend applications provides substantially improved shielding.

After flexure, the multiple-shield types degrade. Quadshield has an advantage in that it keeps the tape overlap from separating and degrading far less than the trishield versions.

In addition, there is an advantage to having the second tape sandwiched between the two braids and the second braid sandwiched between the tapes. This efficiently shorts the tape overlap and optimizes intershield RF electrical contact.

Flexure is only one mode of shielding degradation. Another and probably more important mode is corrosion, especially at the cable-connector interface. This paper has presented the transfer impedance of typical cable constructions used by the CATV industry. Because subtle differences in the geometry of the tape overlap, many samples of the product should be measured to validate the cable design.

Figure 1.
Drop Cable Transfer Impedance Versus Frequency After Flexure.



OVERVIEW

The following discussion has been prepared in response to inquiries about the different types of flooding compounds used in CATV cable. Interest has centered on which compound is appropriate and when flooded cable should be used.

The primary reason to use a flooded cable is for additional corrosion protection. This extra protection is highly desirable in burial applications and also under certain conditions for aerial installations. Currently, TFC uses three types of flooding compounds.

BURIAL FLOODING COMPOUND

Underground Semiflex

For semiflex burial cable, TFC uses a material (flooding compound) with permanent fluid properties which allow it to cold flow underneath the cable jacket. Because of the nature of burial cable installation, jacket damage is always a concern. If the jacket of the cable is damaged, the flooding compound will actually ooze out of the damaged area and provide a seal.

Underground Drop

For drop burial cable, TFC uses a lower molecular weight flooding compound, which is a less viscous material. The lower viscosity allows the flooding compound to flow even more readily within the interstices of the cable's outer braid.

AERIAL FLOODING COMPOUND

Aerial Semiflex

For jacketed aerial applications where additional corrosion protection is required, a flooding compound with limited flow properties is used. A flooding compound with limited flowing properties is necessary to prevent dripping of floodant onto underlying areas.

Aerial Drop

A different flooding compound is needed for flexible drop cable. The limited flow properties of the aerial semiflex flooding compound make connectorization more difficult when using “F” type connectors. A special non-flowing flooding compound was developed which does not flow or drip so that it can be used for aerial applications and is flexible so that connectors can be installed more easily. This non-dripping floodant material is called LifeTime™. The use of LifeTime™ significantly extends not only the life of the flexible drop cable but also extends the life of the drop cable connector junction.

TERMINATION OF FLOODED CABLE

The preparation of a flooded cable for connectorization must be done with some precaution in order to avoid jacket movement. This phenomenon is common to all manufacturers of flooded cable. Because of normal longitudinal stresses that are built into the jacket during the extrusion process, longitudinal shrinkage may occur due to the lubricity of the underlying flooding compound. If unrestrained, the jacket can move several inches leaving the aluminum exposed. To prevent this, TFC recommends securing the jacket with a hose clamp and then installing a heat-shrinkable tube.

REMOVAL OF FLOODING COMPOUND

Semiflex Cable

The installation of the connector on semiflexible cable requires the removal of the flooding compound from the aluminum sheath. TFC has evaluated several removal agents and found that prepackaged cleaner wipes, Scotchcast Brand 4415 manufactured by Telcomm Products Div./3M, worked very well along with HydraSol™ manufactured by American Polywater Corp. The cleaning agent was safe and easy to work with and was not harmful to the cable.

At very cold temperatures other removal materials may be needed because the water based materials freeze.

Drop Cable

In the case of drop cables, removal of flooding compound is not suggested or desired because the floodant enhances the corrosion protection of the connector interface.

ENVIRONMENTAL PERFORMANCE

In addition to required viscosity and flow properties, flooding compounds are chosen for compatibility with the cable materials used and for overall chemical, oxidation and UV resistance. Flooding materials are also compounded for high tackiness to aluminum, polyethylene, and PVC to assure uniform and continuous material protection.

OVERVIEW

The following discussion has been prepared in response to a number of inquiries on the concerns of pulling coax cables into conduits.

FACTORS TO CONSIDER

General Concerns

There are many variables that one must consider in planning a conduit pull. These include the size, strength and number of cables being considered for a given size conduit. The initial payoff tensions on the cables, the coefficients of friction of the surfaces involved, and the geometric layout of the conduit, the calculations for the pulling tension and sidewall pressure on the cables are quite complex. It is not the intent of this discussion to go into the actual methods of these calculations, but rather to give some general recommendations for pulling coax cables in conduits.

Conduit Material

The choice of the conduit material will have a direct relationship on the frictional drag imposed on the cable being pulled in the conduit. High density polyethylene will typically exhibit the lowest coefficient of friction while metal conduit exhibits the highest. If metal conduit is being used, it should be checked for burrs at all joints.

Feeding Cable

In order to keep the pulling tension low in a conduit, it is desirable to have a minimum payoff tension especially when bends will be encountered. In fact, if the run is very difficult it may be necessary to hand feed the cable into the conduit. When conduit must be reached through a manhole, it is important that the cable be guided in with a chute. The liberal use of a pulling compound will reduce the frictional drag between the cable and the inner surface of the conduit. This reduction can have a major effect on pulling tension.

Number of Cables

The number of cables being pulled into a conduit will effect the forces imposed on the cables during the actual pull. The size of the inner diameter of the conduit and the outer diameter of the cables will determine the percentage fill of the conduit. Interference and tangling increases with the number of cables being pulled with three being a practical maximum.

Bend Location

If 45° to 90° bends in a conduit run are located toward one end, it would be advantageous to pull the cable into the conduit from this end. While tension builds linearly in a straight run, tension coming out of a bend increases as a multiple of the tension coming into the bend. To keep this incoming tension low, the bend should be closest to where the cable is being pulled into the conduit. Conversely, the least desirable location for bends would be at the end of a run where pulling tension would be large.

Maximum Allowable Pull Tension

The maximum pull tension imposed on a cable being pulled into a conduit should not exceed the manufacturer's recommended value. If more than one cable of the same size and construction is being pulled together, their maximum allowable pull tensions can be added provided forces can be properly equalized. When actually pulling the cables into the conduit, a dynamometer or similar scale should be employed to assure that maximum tension is not exceeded.

Note: The maximum allowable pulling tension applies to straight pulls, refer to sidewall pressure for pulling around bends.

Jam Ratio

When three cables are pulled into a conduit, their relative position in the conduit, when being pulled around bends can change, causing a condition of "Jamming". The Jam Ratio is defined as the ratio of the conduit I.D. to the single cable diameter. ~~It has~~ been established that if the JR < 2.8 or > 3.0 jamming will not occur or be greatly minimized.

Sidewall Pressure

Sidewall pressure is the radial crushing force exerted on the cable at a bend caused by the tension in the cable and the forced contact with the side of the conduit. The major variables that will affect sidewall pressure are pulling tension entering a bend, the radius of the bend, and the occupancy factor for the cables. All of these variables mentioned should be kept as low as possible.

Pulling Compounds

When pulling cables into a conduit, a pulling compound should always be used to reduce friction and avoid potential cable damage. There are many products that are available, including wax, polymer and soap base lubricants. The lubricant selected should be compatible with the cable jacket. Soap and wax based lubricants are not recommended for use with polyethylene as they may initiate stress cracking at some later date. Commonly available compounds which may be used with polyethylene jacketed cables include:

1. Gel (Ideal Industries, Inc.)
2. Polywater J (American Polywater Corp.)
3. Polywater G (American Polywater Corp.)

Each of the above lubricants was tested to confirm that it is not a stress crack initiator when used with polyethylene jackets. The test procedure was per ASTM D-1693-70, using the lubricant as the test solution. All were found acceptable.

OVERVIEW

CATV semiflex coaxial cable can be easily damaged if the reels of cable are not stored and handled properly. Aside from cable damage, improper handling can also result in personal injury. The following are some points to consider when handling and storing cable.

GENERAL

Reel wrappers play an important role in protecting cable from damage. The wrapping will prevent damage from minor impacts resulting from reels rolling into each other or from rolling the reel over rough surfaces. Once the wrapping is completely removed, the cable is susceptible to damage. The wrapping should not be completely removed until the cable is ready to be installed.

Cable may also be damaged if the reel is dropped. In the event that this occurs, the flange may break, deflect or the hub may collapse and damage the cable, degrading impedance properties (Structural Return Loss). More importantly, personal injury could result.

UNLOADING PROCEDURE

Unloading

While unloading a truck it is important that the reels of cable not be dropped. They should be rolled from the truck onto a receiving platform which is the same height as the tailgate of the truck. If a platform is not available, arrangements should be made to obtain a forklift or lift gate truck so that the reels will not have to be dropped. Also, an inclined ramp could be fabricated locally from commonly available lumber.

Visual Inspection

Aside from making sure that the correct type and quantity of cable was shipped from the factory, it is necessary to inspect each reel for damage. Usually, if there is no sign of damage on the cardboard wrapper or flange, then the cable is probably undamaged. However, if there is any doubt, remove the wrapper and examine the cable thoroughly. If there is any shipping damage, it is the responsibility of the customer to notify TFC's Customer Service Department.

ELECTRICAL INSPECTION

A removable cover marked "REMOVE FOR TEST" is provided near the top end of the cable and on the side of one of the two flanges so that the ends of the cable on the reel can be accessed for electrical testing without having to remove the entire wrapping. After testing, replace the cable end caps.

STORAGE

Reels of cable should remain properly wrapped to prevent damage from minor abuse during storage. The wrapping, however, will not protect the cable from forklift impacts or similar carelessness.

The reels should be left on their rolling edge whenever possible and lined up in rows so that the flanges of the reels touch each other. Care should be taken with the bottom end of the cable (the end of the cable that protrudes through the side of the flange) since it can be easily bent back and kinked making future SRL test results invalid.

After inspection, the wrapping should be replaced to minimize future damage, although it is recommended that the test port portion of the outer wrapper be discarded so as to allow air flow under the wrapper. This will minimize the effects of condensation and staining, discoloration or corrosion of the aluminum surfaces (refer to Technical Note 1050A, Discoloration, Water Staining and Corrosion of Aluminum).

In some cases, storage space is limited and it becomes necessary to stack reels on their sides to conserve room. Once stacked, however, the stack of reels should not be moved, since a stack of reels poses a safety problem if not handled carefully.

Stacking Reels

To facilitate stacking and unstacking with a forklift and to prevent damage of the bottom cable end, spacers should be used to separate the flanges of the stacked reels. Spacers can be made from 2 inch x 4 inch lumber to 2 feet to 3 feet long depending upon the type of reels to be stacked. The idea of the spacers is to provide enough room between the reels for the forks of a forklift to fit without having to tilt the stack of reels which might cause the stack of reels to drop or fall over. Reels should not be stacked on any surface which would allow the reels to be unstable and fall. The spacers should be placed under the bolts of the reel. On 36 inch reels 2 spacers are usually used while on 54 inch reels 3 spacers are used. Generally, 36 inch reels can be stacked 5 high and 54 inch reels, 4 high, but safety must be kept in mind at all times. Stacking large reels is usually a two-man job. While one man controls the forklift by positioning the forks, the other man gently pushes the reel over onto the forks.

ROLLING REELS

With the reel wrapping in place, reels of cable can be rolled on their flanges without damaging the cable. Reels should be rolled at walking speed and should not be left unattended while they are rolling. Reels should not be allowed to bump into each other or any other objects which may cause cable damage. A reel of cable should not be rolled down any grade which could ultimately result in loss of control over the reel.

REEL TRAILER LOADING AND TRANSPORT

In order to get the cable to the actual construction site, it is necessary to load the reel or reels of cable on the reel trailer. The reels should be loaded according to the recommendations of the trailer manufacturer. Once the reels are loaded, the wrapping may be removed and discarded. The wrapping may be reused for partial reel lengths if desired, but the cable end must be securely fastened to the flange to prevent the cable from loosening on the reel as it is transported.

OVERVIEW

Proper care and handling of semiflexible trunk and feeder cable during installation is critical to the long term reliability of a CATV system. The following guidelines are intended to assist CATV operators and construction contractors to help make cable installation safe and trouble free, to avoid cable damage, and to build a cable plant that will provide long term system reliability.

CABLE HANDLING

A separate technical note (1034) is available which covers the proper handling of the cable from the time it is received to the time it is transported to the construction site. The key points are that the cable can be easily damaged and personal injury can result if the cable is not handled properly. Cable reels should not be unloaded by dropping them off the back of the truck. If an unloading dock is not available, a fork lift or ramp should be used. The cable should be visually inspected for damage when it is received and electrically tested before it is sent to the construction site if there is any question of damage during shipment from the manufacturer. The protecting outer wrapper should be left in place as long as possible to avoid cable damage. A visual inspection of the cable at the construction site should be conducted to assure that the cable was not damaged during transport from the warehouse. Cable ends of partial reels should be tightly secured with a staple, string, or nylon filament tape to keep the cable from loosening due to vibration and bouncing during transport to the next location. If the cable is loose, problems such as cross wraps and kinks can result as it is paid off of the reel. Reels with cross wraps should not be used.

CLEARANCE

Before cable installation can proceed, it is necessary to assure that there will be enough clearance between the CATV cable and the other utilities at the pole and between supports. It is also necessary to assure enough clearance between the CATV cable and the ground, roadway, rail, or water surfaces below. The 1997 National Electrical Safety Code (NESC) requires that these clearances be determined under a specific set of conditions. In general, the final sag of the CATV plant must be known to determine the minimum separation at the pole between CATV cable and the other utilities. Forty inches of separation between CATV and power at the support, may not be sufficient to meet clearance requirements (e.g., 30 inches) between supports. The final sag is also needed to determine the minimum CATV cable attachment height on the pole to assure proper clearance above the ground, roadway, etc...

Although final sag can be calculated (See Technical Note 1006-A at www.timesfiber.com), the calculation is rather complex and a knowledge of the materials is required. For this reason, Times Fiber Communications, Inc. provides initial and final sag tables in a separate series of sag tables (Technical Note 1064 at www.timesfiber.com). The requirements of the NESC are invoked by the local authorities, but there may be other, more stringent, requirements that also apply and must be observed. Good communications with the other utilities involved should facilitate the resolution of clearance related problems. At the heart of the clearance requirements is a concern for safeguarding the people that work on the cable and the general public. It is this thought, for safety, that should be kept in mind not only for clearance but during all phases of cable installation.

STRAND TENSION

Before the strand can be installed, consideration must be given to tension that will be applied to the strand under various loading conditions and span lengths. Obviously, the size and number of cables are also important.

NESC Heavy Loading District Requirements

The NESC requires that 60 percent of the break strength of the steel support strand not be exceeded at 0°F with 1/2 inch radial ice, 4 pounds per square foot of wind loading and with an added weight constant of 0.3 pound per foot for a Heavy Loading District. In general, tension can be reduced by increasing sag. The sag tables mentioned above assure that the maximum strand tension is not exceeded. A separate set of corresponding tension tables (Technical Note 1065 at www.timesfiber.com) provides the initial and final tension for various span lengths and cable types.

STRAND INSTALLATION

The amount of sag is dictated by clearance and tension requirements. The strand is initially placed loosely in the clamps to allow for adjustment. The strand should be tightened to the proper stringing tension for the ruling span of the run and the suspension clamps tightened. Stringing tension is provided in Technical Note 1065(See Technical Note 1065 at www.timesfiber.com) for various cable types and span lengths. An alternate technique is to adjust the sag to 1.5 percent of the ruling span after the cable is installed and then tighten the suspension clamps.

REEL PLACEMENT

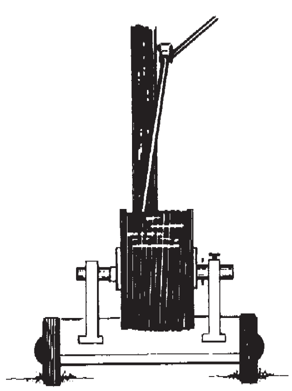
Obstructions

Take the proper safety precautions of checking the trailer and placing the required safety cones. Usually, the reel is unattended, therefore the location of the cable reel in relation to the first pole or roller is extremely important. The first pole location must be clear of obstructions that could interfere with a smooth payout. Potential obstructions include telephone drops, support guys, or tree limbs. If the payout reel cannot be located at the first pole, consideration should be given to moving forward to the next pole. The reel should be loaded on the reel trailer so that cable will feed from the top of the reel so that the cable will straighten properly as it pays out.

Reel Centering

When the payout trailer is set up, the center of the reel should be positioned so that the cable pulls from the center of the reel, directly into the first roller or chute, and along the line of sight of the strand. The flanges should be parallel with the strand - not at an angle. If the cable is pulled at an angle, the cable may catch the flange of the reel and be damaged, causing jacket abrasion or cable kinking. By having the flanges parallel to the strand and the reel centered on line of sight of the strand, the cable will always pull away from the reel flange and no damage will occur. If the payout reel or reel trailer cannot be leveled, a member of the crew should remain at the reel to insure that the cable unwinds without making contact with the flanges. If for some reason the reel can not be properly positioned at the first pole consideration should be given to moving forward to the next pole. Although it should be avoided as much as possible, a mid span take off, which is described below, may be necessary.

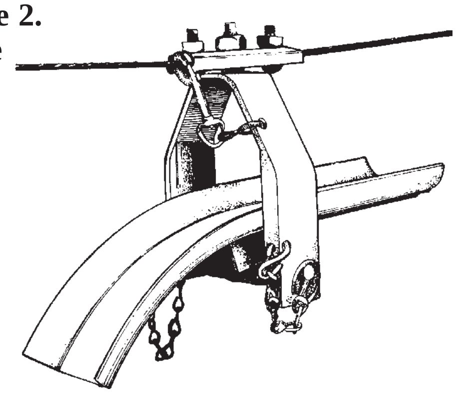
Figure 1.
Cable Reel Centered At Pole



Chute

The purpose of the chute is to guide the cable paying off of the reel onto the cable blocks or rollers. A 45° Corner Block can also be used as a cable chute. A single roller should not be used as a chute because of the small radius of the single roller. The chute bend radius is much larger than a single roller so the cable is not bent too tight. The chute has a surface that has a low coefficient of friction to reduce back tension as the cable is being pulled through the bend. A 45° Corner Block has very low friction. Ideally the chute is securely fastened to the first pole using a pole attachment and adapter.

Figure 2.
Chute

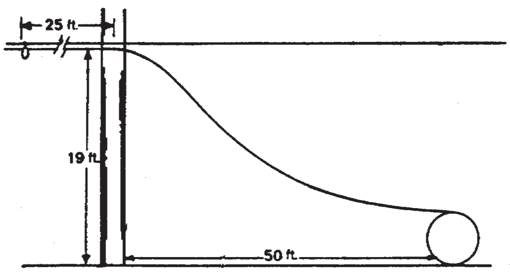


An alternate technique which should be avoided unless absolutely necessary, is the mid span take off which attaches the chute to the strand at some distance from the first pole. The problem with the mid span take off technique is that as the tension on the cable varies as it is being pulled, the first roller or chute tends to jump up and down. An experienced crew that carefully controls tension can successfully make mid span take off pulls. Multiple chutes may be used when multiple cables are pulled.

Distance of the Reel to the Chute

The distance from the payout reel to the chute should be approximately 50 feet (Figure 3). A minimum distance from payout reel to pole should be twice the height of the chute from the ground. The 50 foot distance prevents the cable from being pulled into the strand line at too sharp of an angle. If the cable is pulled over the chute at too great an angle, it is difficult to control pulling tension and the cable will bend and straighten in a non-uniform way. The chute usually can make a transition of 45°. This means that if everything was set up perfectly, the reel could be as close to the chute as the height of the chute or a 1:1 distance to height factor. Also, the greater the angle the cable has to bend, the more force is needed to pull the cable through the bend. Using a minimum 2:1 distance to height factor, will reduce the pull force, will make the set up easier to maintain, will reduce the possibility of cable damage, and will help assure that the cable will straighten as it pays off the reel.

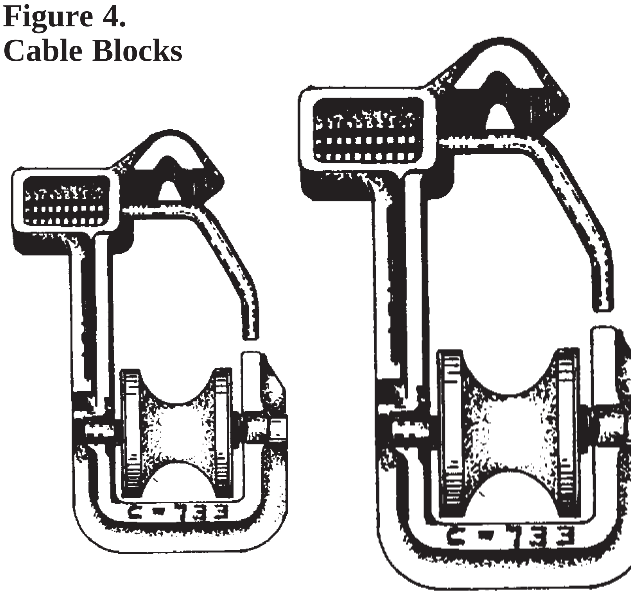
Figure 3.
Location Of Payout Reel In Relation To Pole



CABLE BLOCKS

Cable blocks or rollers should be placed every 25-30 feet to support the cable or cables between poles. Use of cable blocks or multiple cable blocks for multiple cables will reduce pulling tension, keep the cables straight, and reduce the safety hazards such as the cable drooping down when the pull is stopped or whipping up in the power lines if the pull is abruptly started.

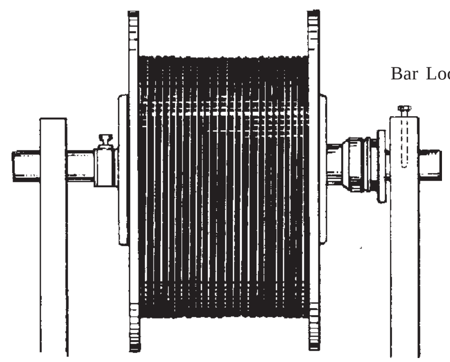
Figure 4.
Cable Blocks



REEL BRAKING

Before pulling the cable onto the strand, the reel should be braked so that as the cable pull is stopped, cable will not continue to pay off the reel and droop down between the reel and chute. The standard reel braking methods use an adjustable friction assembly to prevent over braking or under braking (Figure 5). The brake should be adjusted so that the reel can be turned using the strength of one hand. When the turning of the reel by hand is stopped, the reel should also stop. In some cases the reel weight is not uniformly balanced. Without braking, the reel will make another half turn if no brake is used.

Figure 5.
Adjustable Pressure Brake Assembly



PULLING THE CABLE

Cable Puller

The use of an anti-slack cable puller (Figure 6), which has a locking mechanism that grips the strand, is recommended to prevent slack from pulling back into the strand line when tension is removed from the pull line. As cable is pulled off of a reel it naturally untwists. Swivels are included on the cable puller to accommodate this untwisting so that when multiple cables are pulled, the cables will not cross over and tangle, which can result in flattening or kinking of the cable during lashing.

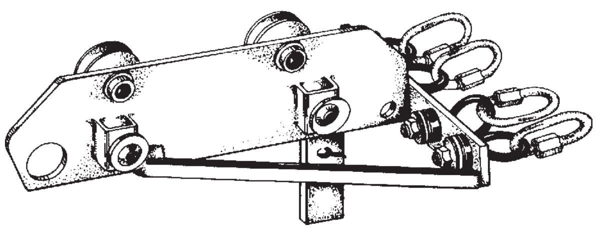
Pulling Tension

While pulling the cable to the strand, it is necessary that the pull begin slowly and smoothly and that a constant pulling force be applied during the pull. Even though the reel is braked, the tension should be slowly reduced as the run is being completed. Maintaining good clearance with overhead power lines is very important during the pull for obvious safety reasons. If the cable has slack between blocks and the cable is pulled too abruptly, the cable can whip up into the power lines.

Pulling Summary

The combination of steady pulling tension, reel braking, using a cable puller equipped with an anti-slack device and swivels, and properly spaced rollers will reduce the possibility of “wee-wahs” occurring, cable drooping down between rollers, and whipping up into power lines.

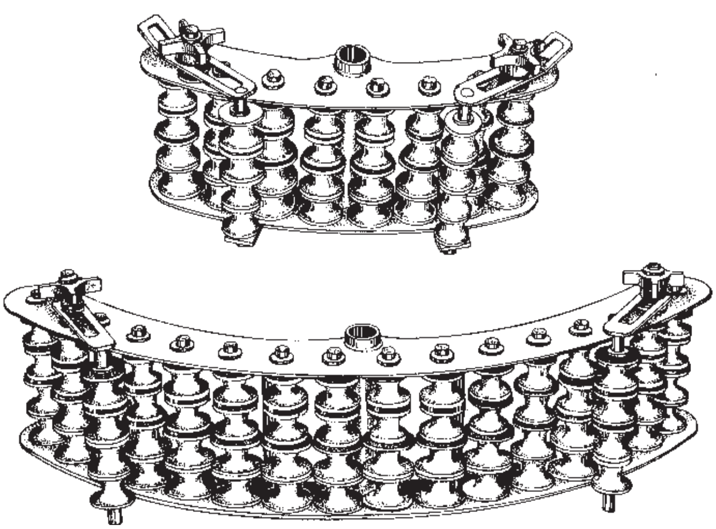
Figure 6.
Cable Puller With Anti-Slack Device



45° AND 90° TURNS

As the cable is pulled along the strand, 45° and 90° turns may be required. In general, such bends require an experienced crew who will pull the cable carefully, and the proper 45° and 90° corner blocks (Figure 7) for the cable to be pulled without being damaged. The corner blocks must be positioned so that the cable is tangent to the bend. If it is not tangent, the cable can be bent to the very small radius of first or last roller in the corner block. Tight bends can cause the cable to wrinkle or flatten as it exits the corner block.

Figure 7.
Typical Corner Blocks



Multiple 45° and 90° bends can be pulled but the true test is to not exceed the maximum recommended pulling force nor should the cable show any signs of flattening or wrinkling as it exits the corner block. If either of these conditions occur, the pull should be stopped and the next run pulled separately. If a 90° bend is anticipated in a run, it is better to have the bend near the start of the run rather than at the end. The reason is that the bend tends to multiply whatever the back tension is rather than simply add to the back tension.

CABLE PROTECTION

When an installation run is completed, any damage at the end of the cable should be removed and 30 inches of undamaged cable left for future use (Figure 8). A plastic cap should be used to protect the cable from moisture exposure both on the line and on the reel so any remaining length can be preserved for future use (Figure 9).

Figure 8.
30 Inches Of Cable Overlap For Future Equipment Installation

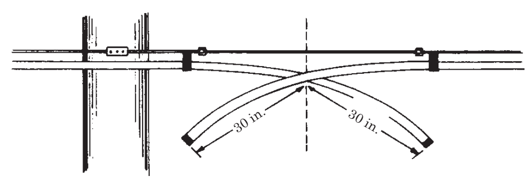
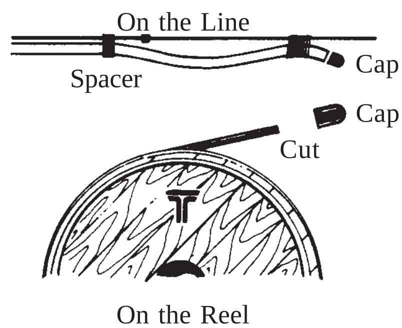


Figure 9.
Sealing Cable Against Moisture



LASHING

Lashing Wire Tension

The lashing machine is put in place and lashing of the individual spans begins. Internal tension of the lashing machine is controlled by routing the lashing wire around one or two wheels inside the lashing machine. The tension should not be adjusted to maximum tension since cable damage has occurred when lashing tension has been too tight. The lashing wire itself is prone to fracture if installed too tight. In addition, the cable expands and contracts more than the steel strand so if the lashing wire is too tight, the cable will undergo cyclic stress that can cause the cable to become brittle and fatigue. Thus, the lashing wire should support the cable but not restrict the cable's movement. Routing the lashing wire around only one wheel in the lasher usually provides sufficient but not excessive tension.

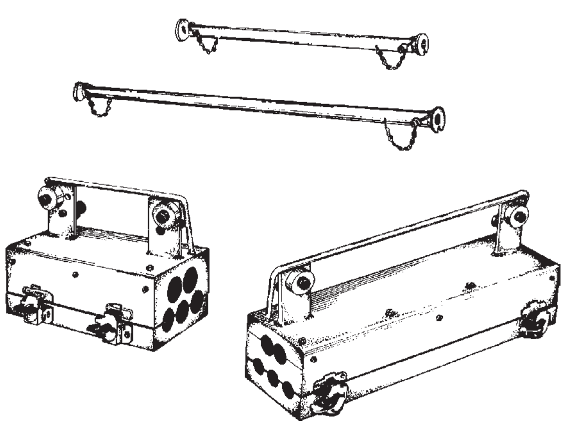
Lasher Pull Angle

The lasher should be pulled in a straight line without changing the angle the lasher is pulled. If the pull angle is changed abruptly, the cable will be pulled off to the same side as the lasher and the cable will appear to have a bend or wee-wah. In many cases obstructions prevent the lasher from being pulled at a constant pull angle over the entire span but smooth transitions in lasher pulling angle can minimize cable bending appearance problems.

Cable Straighteners

Some construction companies use a cable block pusher combined with a straightening box. These devices, which attach to or are pushed ahead of the lashing machine, push the cable blocks and help straighten the individual cables in front of the lashing machine and achieve a clean looking cable span. The lasher should not be allowed to slip backward, nor should the pulling tension be released until the man positioned at the pole has control of the lasher.

Figure 10.
Cable Block Pusher ("Shotgun"), Cable Positioner, Cable Straightener



Double lashing should be used when two or more trunk cables are lashed together. Also, it is a wise precaution to double lash in locations where it would be particularly inconvenient to relash, such as over railroad crossings and highways.

The lashing wire should be wrapped two or three turns around the strand, starting 8 to 10 inches from the clamp, before feeding it through the clamp washers for attachment. To avoid snapping the lashing wire, do not allow it to overlap itself. The tail should be cut off and tucked back into the clamp for future ease of removal.

BANDS AND SPACERS

Spacers are intended to separate the cable from the strand and hardware attached to the strand such as lashing wire clamps and 3 bolt strand clamps. Separation is needed because as the cable expands and contracts it would otherwise abrade against the strand hardware and damage the cable. The band is used to hold the cable and spacers next to the strand. It should not be drawn down tightly on the cable. It should only cradle the cable.

TEMPERATURE EXPANSION AND CONTRACTION

The aluminum sheath of trunk and feeder cables has a linear coefficient of thermal expansion about twice that a steel so the cable expands and contracts twice as much as the strand with temperature. The strand is allowed to expand and contract with temperature as evident by increases and decreases in sag. That is unless the sag is so tight to begin with that the sag can only change a small amount. The expansion and contraction of the strand accommodates some of the change in length of the aluminum cable but the remainder, however, must be taken care of by expansion loops.

The life and reliability of the cable plant are a function of the temperature changes, length of the spans, the amount of sag, and the depth of the expansion loops. Although we have no control over the temperature changes, and only some control over the span lengths, we do have control over the how much sag is installed and the depth of expansion loops. A separate Technical Note (1049) "Performance of Expansion Loops" goes into the details of the importance of expansion loop depth and proper sag. These two factors, more than any others, control the life of the cable.

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Cable Movement

The following table illustrates the net cable movement which must be accommodated for a single 0.750 inch trunk cable lashed to a 0.25 inch steel strand with the pole spacing of 150 feet.

Table 1.

Cable Movement

Initial Sag @ 60°F	@ -40°F	@ +130°F
0.5 percent	- 2.68 inch	+ 1.75 inch
1.0 percent	- 2.40 inch	+ 1.36 inch
1.5 percent	- 2.00 inch	+ 1.19 inch
2.0 percent	- 1.71 inch	+ 1.13 inch

Note that there is substantial cable movement due to temperature. Note also that there is substantially more movement if the sag is tight. If expansion loops are used at every pole location, the cable has a better chance of providing reliable operation.

Cable And Center Conductor Tension

If expansion loops are omitted, or cable movement is restrained, the length changes are translated into relatively severe tension forces at low temperatures. Using the previous table of a single 0.750 inch trunk cable installed at 60°F with zero initial cable tension, the following forces result at -40°F.

Table 2.

Tension at -40°

Initial Sag @ 60°F	Strand (pounds)	Sheath (pounds)	Conductor (pounds)
0.5 percent	1658	1123	387
1.0 percent	954	967	345
1.5 percent	474	712	277
2.0 percent	48	413	202

Table 2 illustrates the problems of installing a cable plant with tight sag and with insufficient or ineffective expansion loops. The tension on the aluminum sheath and center conductor is very high. Predictable consequences of high tension include severe stress on both fittings and electronic devices, center conductors and/or radiation sleeve pullout, broken conductors and housings, intermittent or degraded signal quality, ghosting, and other interference, including complete power failure. It should be noted that thermal expansion as the temperature increases can also cause unsightly cable waves (wee-wahs) and buckling if the sag is too tight, or if the loops are inadequate, or if cable movement is restrained.

Problems with thermal contraction become progressively worse when the initial plant is installed at temperatures higher than 60°F, when pole spacing is increased beyond 150 feet, or the sag is decreased below 1.5 percent.

Figure 11.
1.5 Percent Finished Sag at 60°F

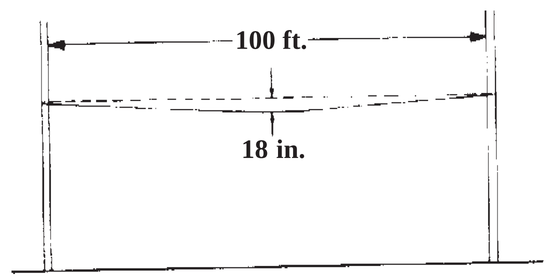

Table 3 illustrates some typical 1/4 inch steel strand tension forces resulting in a 1.5 percent sag at 60°F at various pole spacings with typical cable configurations.

Table 3.

Strand Tension (pounds)

Cable Configuration	100 feet Pole Spacing	150 feet Pole Spacing	200 feet Pole Spacing
Single T10500J Feeder	188	282	377
Single T10750J Trunk	284	426	568
T10750J Plus T10500J	366	549	732
Single T10625J Feeder	228	343	457
Single T10875J Trunk	342	514	685
T10875J Plus T10625J	464	696	928

It is TFC's recommendation, based on field experience, laboratory testing and engineering analysis, that the minimum finished sag in a CATV plant should be 1.5 percent at 60°F. As mentioned above, sag and tension tables are available to help properly install the cable.

EXPANSION LOOP CONSIDERATIONS AND LOCATION

Expansion Loop At Every Pole

TFC recommends the use of properly designed and correctly formed expansion loops at every pole. When multiple trunk and feeder cables are included in the same run, all the cables should have an expansion loop at every pole.

Expansion loops may be located either directly at the pole, or to either side. Advantages of direct pole location include convenient cable spacing away from the strand clamp without requiring spacers, physical protection from severe wind and weather conditions, and handling ease if using a tool for loop formation. Disadvantages are that loops at the pole may be accidentally grabbed by hand which could result in cable damage.

Using a loop forming tool can be convenient if located immediately to one side of the pole or the other. Either location can work reliably, provided an expansion loop is located at or adjacent to each pole.

Expansion Loop On Each Side Of Stationary Equipment

If the cable is connected to equipment that is clamped to the strand, expansion loops should be installed on both sides of the equipment. When a device is located at a pole, the loops at the device are the only ones necessary (Figures 12, 13, 15, 16 & 17). In the case of multiple cables and where equipment is installed, only the cables connected to the equipment require an expansion loop on both sides of the equipment.

Multiple Expansion Loops

In order to handle the increased expansion of long spans over 200 feet or where extreme temperature swings are anticipated, the installation of an additional loop is recommended (Figure 14).

EXPANSION LOOP FORMING TOOLS

There are many expansion loop forming tools available to form flat bottom expansion loops that rpovide long life service in the field. TFC has evaluated the tools to confirm the quality of the exapnsion loops. Two manufacturers that provide tools that have been proven effective for use with T10 and TX10 trunk and feeder cable are listed as follows:

LEMCO Tool Corporation
RR 2 Box 330A
Cogan Station, PA 17728

Jackson Tool Systems
7555 Jack Lane
Clayton, OH 45315

Other loop forming tools may also be used as long as they:

1. do not cause the outer conductor of the cable to be wrinkled,
2. provide at least 6 inch depth, and
3. are at least 42 inches long.

No matter which forming tool is used, proper installation techniques must be employed. If either the expansion loop is not formed properly or a portion of the cable is pulled out after the tool has been removed, the expansion loop may not have adequate depth, and sheath cracking may occur prematurely.

For proper forming, mechanical bending tools should be used instead of loops formed by hand. Flat bottom bending boards are not recommended because the cable must be bent by hand into the bends.

Figure 12.
Typical Expansion Loop Offset From Pole

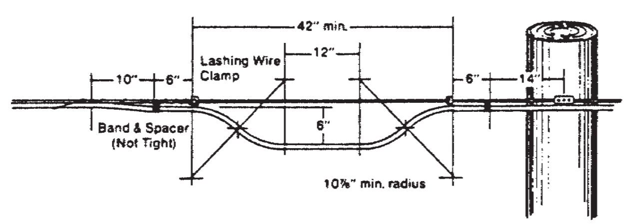

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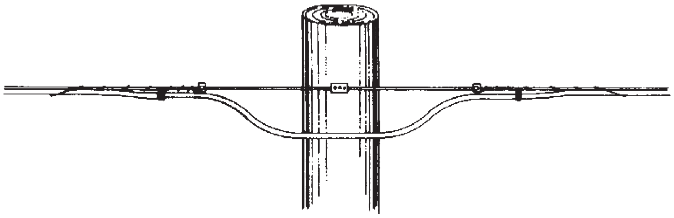
Figure 13.
Typical Expansion Loop Directly On Pole



After the loop is formed, the spacer and band is installed as described above. (See Band and Spacer Section.) The cable is then lashed to the spacer and the lashing wire is secured on one side. The lashing wire should be wrapped around the strand three times and then tied off at the lashing wire clamp. This allows movement during expansion and contraction.

Following completion of one side of the expansion loop, the lasher is moved over to the other side and set up for the next run. The expansion loop forming tool should not be removed until the lasher is about 50 feet from the loop or it may pull some of the cable out of the loop. If cable is removed from the loop, the loop will be shallow and ineffective.

Figure 14.
Double Loop Over 200 Foot Spans

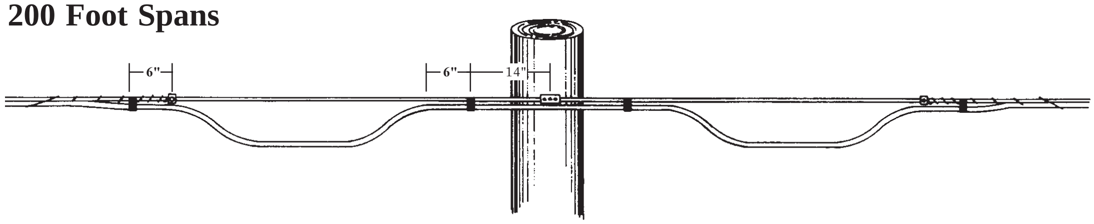


Figure 15.
Double Loop At Tap

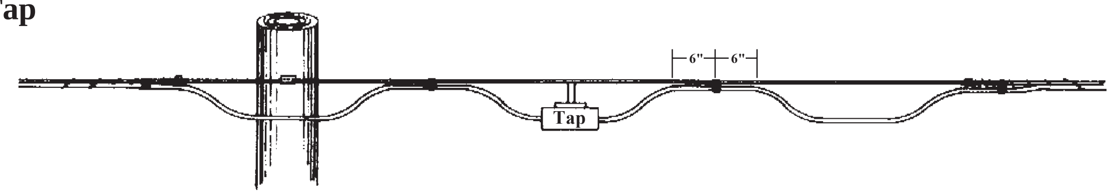


Figure 16.
Double Loop At Amplifier Location

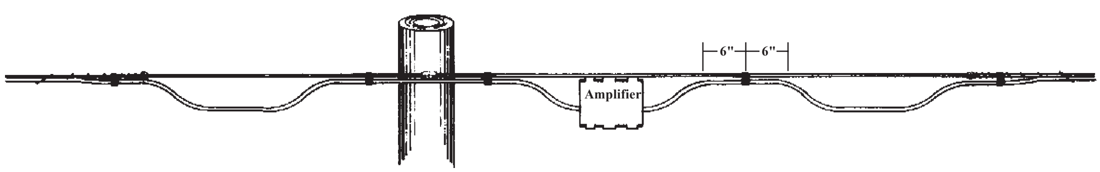
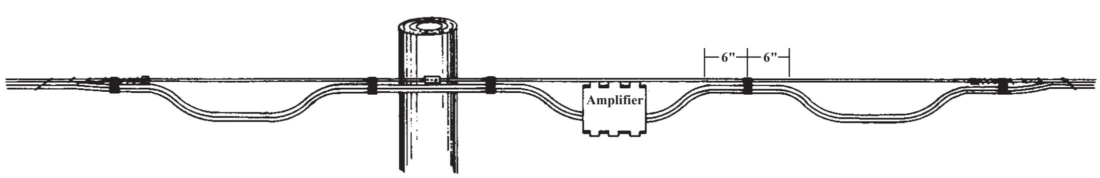


Figure 17.
Dual Cable



CABLE SIZE AND ATTENUATION

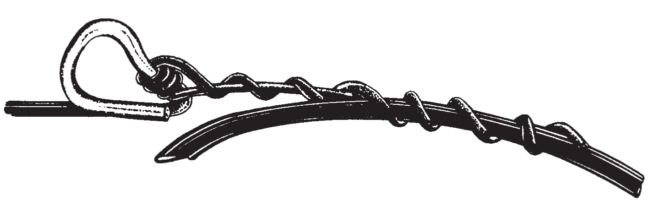
The type of drop cable that should be used for aerial drop installation is determined from several factors. The first has to do with the upper frequency of the system and the attenuation or loss of the cable. The higher the frequency the higher the loss. The larger the cable the lower the loss. The loss of the cable is taken into account during the design stage of the plant and a particular size cable will be required based on the signal levels and the typical distance from the tap to the TV.

MESSENGERED DROP CABLE

If the pole to the house distance is long, typically a larger cable is used to keep the losses down. Even though the span length increases, the clearance requirements still apply and usually a messenger wire is needed to support the long drop span. Typically, spans over 75 feet utilize messengered drop cable. A separate technical note (2015) covers the maximum span lengths for messengered and non-messengered drop cables in various NESC loading districts. The installer should be also familiar with any other clearance requirements that apply.

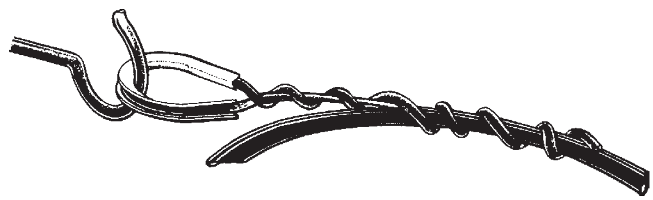
1. Messengered cable is supported by the messenger alone. Several different techniques are used to tie off the messenger wire. One technique is to separate the messenger from the cable, wrap the jacketed messenger wire around the hook three times, next wrap the messenger wire around itself three times, finally wrap it around the cable and messenger three to five times to prevent further cable-messenger separation.

Messenger Termination



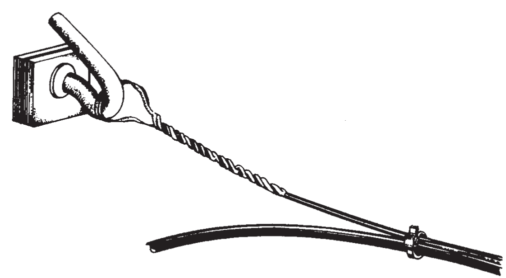
2. A technique which reduces the possibility of the messenger wire from breaking due to the tight bend around the hook is to feed the jacketed messenger through a bail or wire thimble, then proceed as before to wrap the messenger wire around itself three times and around the cable and messenger three to five times.

Messenger Termination With Bail



3. The last technique is to use a dead end grip. In this case the jacket must be carefully removed from the messenger wire and a cable tie installed around the cable and messenger to avoid further separation of the cable and messenger.

Messenger Termination With Dead End



Separation of the cable and jacketed messenger is done by splitting the plastic web at the end with either a knife or diagonal cutter. The web cable and messenger should be separated with a slow steady shearing action rather than quick stretching of the web. At warm temperatures either way works but at extreme cold temperatures, the first technique must be used to avoid zippering the jacket over the coaxial cable.

Separation of Messenger from Cable

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SHIELDING

Another factor is the type of shielding that the cable needs. Generally a single tape and braid will work for most applications but in some cases trishield and Quadshield must be used to improve shielding.

Cable shielding is only part of the solution to shielding problems. The cable-connector interface is another key factor. Since aluminum is a very active metal that forms a resistive oxide, it is difficult to achieve and maintain a low contact resistance between the cable and connector. It was for this reason that lifeTime™ was developed. lifeTime™ minimizes corrosion and RF leakage degradation at the interface which extends the life of the cable and the connection. lifeTime™ is a flooding compound but it does not leak or drip so it can be used aerially or indoors. (Flooded underground drop cable must never be used indoors because the flooding compound leaks and drips.) All new drop installations should require lifeTime™ or its equivalent to reduce the problems associated with RF leakage.

JACKETS

All aerial drop cables use flexible PVC jackets on which it is easy to install “F” connectors. Most outdoor drop cables are black but colored jackets such as beige can also be installed outdoors. All TFC products have UV resistant PVC black and colored jackets which do not crack or split due to sunlight exposure.

Care should be used when fastening the drop cable to the side of the house. The proper cable clips should be used that do not crush the cable or damage the exterior of the house. PVC jackets also have relatively good cold temperature performance which makes bending and connector installation easy but striking the cable at extremely cold temperatures must be avoided. Although the cable can be bent to relatively tight radius (i.e., 1 inch for 6 size cable), the larger the bend radius the better.

INSTALLATION TECHNIQUES

Several different techniques can be used to install drop cable underground: manually with a shovel, with a trencher, with a vibratory plow, or pulled through conduit. Whichever technique is used, care must be used not to over stress the cable, not to bend the cable too tight, and not to rupture the jacket. If these basic guidelines are followed the underground drop cable will provide a long, reliable life.

This technical note does not address the depth the drop cable should be buried or the hazards involved in digging. Aside from the possibility of damaging sprinkler systems, personal injury to the employee and the public can result if care is not taken to locate power cables, gas lines, etc...

FLOODING COMPOUND

The most important part of an underground drop cable is the flooding compound used to protect the outer conductor from corrosion. If the jacket incurs a minor rupture, the flooding compound, because it has good cold flow properties, flows to seal the rupture. The flooding compound reduces the possibility of corrosion due to a direct chemical reaction in soil with high alkaline content. If there are other dissimilar metals in the ground and the soil is moist, a galvanic cell can be setup between the exposed aluminum outer conductor and the dissimilar metal. Because the flooding compound has good dielectric properties, the possibility of developing a galvanic cell is reduced significantly.

The same flowing property that makes flooded cable necessary for underground makes it unacceptable for aerial or indoor applications. If installed aerially, the flooding compound can drip out onto car roofs, pedestrians, etc... In the house, the flooding compound can leak out onto carpets, drapes, etc...

Drop cable without flooding compound should not be used underground.

CONNECTOR INSTALLATION

Connector installation on flooded drop cable is done the same way as with non-flooded drop cable. The flooding compound should not be removed from the braids. In fact, the flooding compound enhances the electrical integrity of the cable-connector junction. The flooding compound protects the cable-connector junction in the same way it protects the aluminum outer conductor.

JACKETS

Two types of jackets are available for underground applications: PVC (polyvinyl chloride) and PE (polyethylene). PVC is flexible which makes connector installation easy. PE is more abrasion and moisture resistant but not particularly flexible which makes connector installation more difficult. Although PE allows less moisture to permeate through the jacket than PVC, the key to protecting the outer conductor is the flooding compound.

During installation, care must be taken not to rupture the jacket. Because the PE has better abrasion resistance, it can withstand more careless installation procedures than can PVC. However, the same care should be exercised on both.

UNDERGROUND SPLICES

In general, underground splices should be avoided and used only as a temporary repair. To avoid future trouble calls, the best approach is to replace the entire underground drop if for some reason it is cut.

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TECHNICAL NOTE / 1044-B

OVERVIEW

The National Electrical Code (NEC) is a set of electrical safety requirements published by the National Fire Protection Association (NFPA). The code covers all types of electrical equipment and apparatus for installations in both residential and nonresidential buildings. The 1999 edition has recently been published and distributed. This technical note describes the type of cables that can be used for various applications per the NEC.

GENERAL REQUIREMENTS INSIDE BUILDINGS

In addition to requirements governing various installations, methods and materials, the code sets forth different levels of fire, flame, or smoke performance for communications cables. These requirements may be adopted by state or local building codes and would then fall under the jurisdiction of local electrical, building, or fire inspectors. Coaxial cables which conform to the code requirements (NEC, Article 820, Community Antenna Television and Radio Distribution Systems) must be marked accordingly after having been listed by an organization such as Underwriters Laboratories which conducts product evaluation and con-formance testing, periodic inspections of production facilities, and publishes lists of those products found to meet the requirements for a specific classification.

In descending order of fire, flame, or smoke performance, the categories are summarized and listed below. All applicable building codes should be reviewed and electrical, building and fire inspection organizations consulted prior to the selection, installation and operation of any cable product.

REQUIREMENTS FOR OUTSIDE BUILDINGS

There are no NEC cable requirements for outside of building applications.

Summary - 1999 NEC Article 820 - Cable Requirements Within Buildings

Notes: When the length of cable within the building does not exceed 50 feet (15.2 m) and the cable enters the building from outside and is terminated at a grounding block (inside the building), no cable requirements apply to the entry cable within the building. However, the ground block shall be located as close to the point of entry as practicable.

Designation	Application
CATVP (Plenum)	Type CATVP, Plenum Cable shall be used in ducts, plenums and other spaces used for Environmental air.
Note:	Types CATVP, CATVR or CATVX cables installed in compliance NEC Section 300-22 of the NEC.
CATVR (Riser)	Type CATVR, Riser cable shall be used in vertical shafts and from floor to floor in multistory buildings.
Note 1:	In one-family and two-family buildings, CATV or CATVX cables may be used.
Note 2:	In commercial and multifamily buildings, CATV or CATVX cables may be used if installed in metallic conduit or noncombustible tubing or if the vertical shaft is fireproof with fire stops between floors.
CATV (V-Rated)	Type CATV cable shall be suitable for general purpose use with the exception of Plenums and Risers.
CATVX (X-Rated)	Type CATVX cable, less than 0.375 inch in diameter shall be limited to use in residential dwellings (not commercial buildings) or where the cable is non-concealed and the internal length of the cable is less than ten feet.

Cable Substitutions

Cable Type	Permitted Substitutes	Cable Type	Permitted Substitutes
CATVP	None	CATV	CATVP, CATVR
CATVR	CATVP	CATVX	CATVP, CATVR, CATV

ALL LISTED CATV CABLES MUST BE MARKED

NOTE: ALL APPLICABLE BUILDING CODES SHOULD BE REVIEWED AND ELECTRICAL, BUILDING AND FIRE INSPECTION ORGANIZATIONS CONSULTED PRIOR TO THE SELECTION, INSTALLATION AND OPERATION OF ANY CABLE PRODUCTS.

OVERVIEW

To increase the bandwidth of cable TV systems beyond their present bandwidth, many factors must be considered. Obviously, amplifiers designed and built for the wider bandwidth must be installed. Taps and directional couplers with wider bandwidth must also be used, but is it necessary to replace the cable? Not only should factors such as the cable's electrical performance, age and maintenance be considered, but recent advances in cable design technology should also be considered to make the optimum economic decision.

ELECTRICAL

A few electrical characteristics of the cable affecting how the system will ultimately perform are of key concern to those upgrading and rebuilding a plant. They are:

- Structural Return Loss
- Attenuation
- Impedance
- Transfer Impedance

Structural Return Loss

The Structural Return Loss (SRL) of the cable is measured in a specific frequency band at the time of manufacture. The measurement band changed several times in the past twenty years to reflect advances in manufacturing technology. Times Fiber Communications began SRL testing from 50 to 108 and 173 to 216 MHz in the mid 1960's with 26 dB as an acceptable level. The band increased to 5 to 300 MHz (which included the midband) in 1972, 5 to 450 MHz in 1980, 5 to 600 MHz in 1988 and 5MHz to 1GHz in 1989 with 30 dB as the current industry standard. Now a question arises: Can older cable which was tested in the lower frequency bands be used at higher frequencies?

Unfortunately, it is not possible to predict cable SRL performance at higher frequencies based on the SRL at lower frequencies. For example, a cable manufactured in 1972 with 30 dB SRL from 5 to 300 MHz could have 12 dB SRL between 300 and 450 MHz, perhaps even worse. In general SRL spikes cause additional narrow bandwidth signal loss. Depending on the severity of the SRL spike, TV channels can be attenuated below acceptable limits through very short lengths of cable. It is necessary to know the SRL of the cable in the frequency that it will be used to assure proper signal transmission. As cascade lengths are decreased, SRL performance requirements are relaxed.

Attenuation

The next factor that affects system performance is attenuation. Although attenuation is more predictable than SRL, many cable designs of the past were susceptible to moisture ingress and absorption which caused their attenuation to increase sharply. Present cables are designed with excellent moisture blocking characteristics and resistance to moisture absorption so that the attenuation will remain stable over time. Cables currently being manufactured are also designed with lower attenuation than many of the previous designs to minimize active equipment and their associated maintenance costs. Drop cable also is now available with the low loss gas injected dielectric. Previous designs with chemically expanded dielectrics are 12% higher in attenuation while solid dielectrics are 36% higher. The problem is compounded by using older cable: higher levels at the taps are required to overcome the higher losses of the cable itself plus the higher losses due to the higher frequency. It may be more economical based on attenuation alone to replace the older cable with the newer, more stable, lower loss cable.

Impedance

Characteristic impedance is another property that should not be overlooked. Although past and present cable plants are designed around 75 ohms, moisture ingress can reduce the impedance of the cable dramatically and cause an impedance discontinuity. Two impedance discontinuities will cause a portion of the signal to be re-reflected which can result in echoes and ghosting. Impedance discontinuities can also be caused by dents and kinks in the cable.

Transfer Impedance

Transfer impedance is another factor that should be considered. Transfer impedance is a characteristic of the cable which describes how much energy will leak out of or into the cable. In the case of drop cable, significant improvements in shielding have been made in recent years. Aside from shielding improvements, a new product, lifeTime™ floodant, is now available which provides continuous longitudinal protection of the outer conductor if there is a minor jacket rupture and minimizes corrosion at the connector junction.

The drop cable to connector junction is the source of most leakage problems in the cable TV industry today. Repair is quite costly and time consuming. Even when the connector is properly tightened, the crimp area can degrade over time due to corrosion. Now with the FCC's

CLI (cumulative leakage index) requirements, the industry is required to repair excessive point source leakage and keep the total system leakage below a specified limit. Serious consideration must be given to leakage before additional frequency bands can be used.

MECHANICAL

Mechanically, the outer conductor of trunk and feeder cable becomes more brittle over time due to cyclic stress. Cyclic stress can be caused by repeated bending of the cable during connector installation and equipment replacement. The more times the cable is bent, the more likely it is to fracture. How long the cable will last depends on the number of times the cable was bent and the radius of the bend.

In expansion loops, cyclic stress is caused by changes in temperature and load conditions. Generally, the age of the cable is one indicator of the total cyclic stress. The expansion loops also have a projected life which depends on the type and shape of the loop and the cable size. Although a good loop in a normal span is expected to last 20 years or more, many factors degrade its life and it can fracture after as few as 1 or 2 years in service.

Repair of expansion loop fractures with splices is time consuming and costly. If the splice is placed at the bottom of the loop, the cable adjacent to the splice is under much higher cyclic stress and will fracture much sooner than the original loop. The reliability of plant becomes more questionable with each splice that is installed. Expansion loop cracks can cause RF leakage and interruption of service. The cracks can also allow moisture ingress and subsequent electrical degradation.

ENVIRONMENTAL

Aerial Installations

During its life the cable is exposed to environmental factors that degrade its mechanical and electrical performance. Cold temperature extremes can cause the cable to be exposed to a great deal of stress, enough in fact, to cause the center conductor to pull out of the connector. Present TFC cable designs minimize or eliminate center conductor pullouts by bonding the center conductor to the dielectric and the dielectric to the outer conductor.

Temperature cycling can cause stress which fatigues the metal components. Differential movement between the cable and the support strand can produce holes in the sheath from the rubbing action. Temperature changes can also cause differential pressure changes inside the cable and equipment housing which will in turn cause moisture to be pumped into the cable unless the connectors and housings are properly sealed. Significant cyclic loading due to trees leaning against the strand, wind, wind gusts, and ice can shorten expansion loop life by excessive cable movement and rapid cycling and vibration. Hail can cause significant damage to the cable. Squirrels can eat the aluminum outer conductor. The cable can be corroded by sea air and automotive and industrial pollution unless the proper jacket and heat shrink tubing are used.

Underground Installations

In the soil, the jacket can be ruptured by rocks and expose the aluminum to water or chemicals in the soil. The jacket may also be ruptured if care is not taken during initial cable installation or during accidental digging by shovels. Burrowing rodents, such as ground hogs and gophers, can eat through underground cable if it is not armored. Ground movement and frost heave can crush the cable. Stray ground currents can rapidly corrode exposed aluminum via galvanic action. In pedestals the cable can be exposed to moisture and condensation; it may even be submersed. The jackets used today are designed with better abrasion resistance. Present jacketed cables with a bonded dielectric can be bent tighter without kinking especially in pedestal applications where the cable may be exposed to repeated tight bends.

During a conduit pull, the jacket may be ruptured and the aluminum exposed. If an improper pulling compound is used it may damage or corrode the aluminum. Again, cables manufactured today have jackets with better abrasion resistance than their predecessors and can aid in resisting kinking during bends. They also have lower friction coefficients to reduce pulling tension.

CONSTRUCTION PRACTICES AND PLANT MAINTENANCE

The condition of the cable also depends to a great extent on how well the cable was installed initially and how well it was maintained over the years. During construction, expansion loop formation is one particularly important factor. If the loops are less than 5 inches deep (6 inch deep loops are recommended), even when it’s very cold the loops are probably not deep enough to accommodate normal cable expansion and contraction. During cable installation, the cable may be pulled around a bend with too much back tension and cause the cable to be flattened. The cable may be exposed to many other adverse conditions during construction which will reduce the cable’s life.

The cable may also be damaged during routine plant maintenance if care is not taken. During connector replacement, both aerially and underground in pedestals, the cable may wrinkle or kink. Replacement of the heat shrink tubing may be forgotten thus exposing the bare aluminum to the environment. Equipment covers and connectors may not be tightened properly thus allowing a path for moisture ingress. A careful examination of the existing plant (how many splices, expansion loop depth, cable kinks, shrink tubing, etc...) is very important in estimating the remaining life of the cable.

CONNECTOR INTERFACE

The cable-connector junction is another possible problem area. During its life, a cable system is continually being modified and in many instances extended. Unless care is taken in the selection of the type of cable, the system may be made up of a number of different types of cable and different types of connectors. With different connectors, maintenance and repair becomes more costly. Naturally, it costs more to have additional connectors in inventory, but the real cost disadvantage may be that the repairs become more time consuming if the technician doesn't have the right connector on his truck. He must return to the shop and find the right connector before he can return to make the repair. The problem of using existing cable may be amplified by the need for different size radiation sleeves. Obviously, having the same type cable throughout the entire system has real economic advantages for continuing maintenance.

ECONOMICS

Due to the higher attenuation of older cables, more amplifiers will be needed than for present cable designs. This problem is further compounded if the bandwidth of the system is increased because cable attenuation increases with frequency. Drop cables manufactured today also have lower losses, better shielding characteristics, and are designed to resist corrosion at the fitting. Additional cable sizes are also available to optimize overall plant cost. Cables designed today can be expected to last longer and increase the rate of return on the investment.

CONCLUSIONS

Obviously, from an electrical view point, the cable should be replaced, just like amplifiers and taps, if it does not have the proper bandwidth. Key factors in determining its bandwidth are SRL, attenuation, impedance, and transfer impedance. From a mechanical view point, factors such as where the cable is in its life cycle, how the cable was initially installed and how it was maintained must be considered. Environmental degradation of the cable should not be overlooked. Even if the cable may be electrically and mechanically acceptable and has not degraded from the environment, an economic analysis should be performed to compare the cost of maintaining the existing cable versus cable replacement.

OVERVIEW

Several factors affect the performance of expansion loops. The key factors are: temperature changes and span length which directly affect the amount of excursion length of cable into and out of an expansion loop. This technical note also examines the effects of sag and loop depth on the performance of expansion loops. Unlike temperature changes and span length over which you have little or no control, sag and loop depth have a significant effect on loop life and can be controlled.

Reasons For Expansion Loops

Expansion loops are installed to reduce or eliminate tension and compression forces on cable. If these forces are not reduced, center conductor pull-outs, cable kinking, and premature cable fracture can occur as the temperature changes.

FACTORS TO CONSIDER

Temperature Changes

Normal average daily temperature changes can be anywhere from 10°F to 30°F, while normal average yearly temperature changes can be from as little as 15°F to as much as 65°F depending on the location. Extreme yearly temperature changes can be anywhere from 50°F to 140°F.

In addition to cable temperature changes caused by ambient air temperature changes, solar heating and radiative cooling should also be considered. Direct sunlight can elevate bare aluminum cable temperature 24°F over ambient and 45°F over ambient for jacketed cable. On clear nights, bare aluminum cable can drop 4°F below ambient and jacketed cable can drop 8°F below ambient.

The cable, being largely aluminum, has a coefficient of thermal expansion of about 0.000 013 per degree F. Steel's expansion coefficient is about 0.000 007 2 per degree F.

Span Length

Since the expansion length of the cable is directly related to the cable length, the longer the span the more differential movement there will be between the cable and the support strand.

Sag

The effect of sag on cable movement is a bit more difficult to describe and envision than the effects of span length or temperature changes. In a normal plant, as the temperature drops the steel support strand contracts. Its ends are attached to poles so they can not move. The sag of the span decreases to compensate for the reduced length of the steel strand. As the sag decreases the tension increases. The increasing tension causes the steel strand to strain (i.e., get longer) so as to decrease the amount of sag reduction.

The cable length also changes with temperature. As the temperature drops, cable from the expansion loop feeds into the span to make up for the shorter cable length. Also, as the temperature drops the sag is reduced which reduces how much cable is fed into the span and therefore has the opposite effect on cable movement.

The smaller the sag, the less the sag changes as temperature changes. Changes in sag reduce cable movement due to temperature changes. Therefore there will be more cable movement in spans with little sag than there will be in spans with more sag.

Load

Load refers to tension on the steel strand due to not only the weight of the cable but other factors such as ice build up over the cable and wind blowing against the cable.

As the load changes, the steel support strand strains (i.e., its length increases). If the cable has expansion loops and the lashing wire does not restrict cable movement, the cable will have no load on it and it will not strain. If the strand strains and the cable does not strain there will be differential cable movement that the expansion loop must compensate for.

Although changes in load may have a significant effect on the life of an expansion loop, the purpose of this technical note is to focus on the other factors previously mentioned.

DISCUSSION

Temperature Effects

With the above factors in mind, charts can be generated that will show how these factors interact. Fig. 1 quantifies cable movement as a function of temperature for 100 to 400 foot spans. Although it was generated based on 0.500 inch cable and 1.5% initial sag, the principles apply to other cables and sags. In general Fig. 1 shows that larger temperature changes correspond to more cable movement.

As a specific example, consider a 200 foot span of plain cable exposed to sunlight. If the normal daily temperature increases 10°F during the day and drops 10°F during the night, then the cable temperature will increase about 35°F during the day and decrease 15°F on clear nights (if solar heating and radiative cooling are included). From Fig. 1, plain cable will expand about 0.7 inch during the day and contract about 0.3 inch at night for a total excursion of 1.0 inch.

Jacketed cable will have a larger excursion because it can absorb and radiate heat better than bare aluminum. With the same +10°F and -10°F ambient temperature change and sunlight exposure, the jacketed cable temperature increases about 55°F during the day and decrease 20°F during clear nights. This temperature change of +55°F and -20°F corresponds to a total cable excursion of 1.4 inches from Fig. 1.

Effects of Tight Sag

Figure 1.

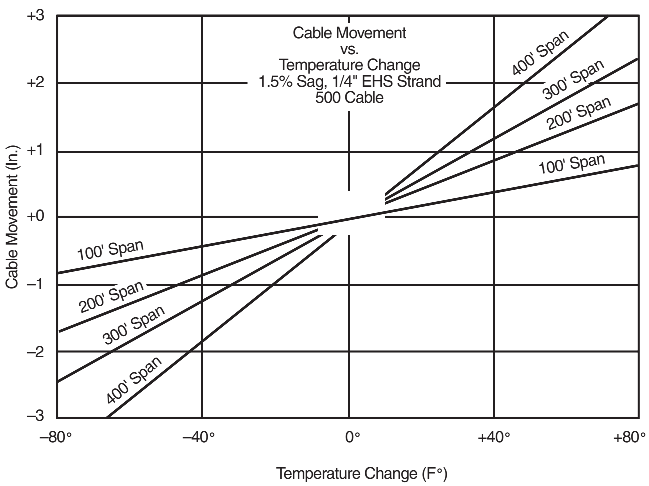
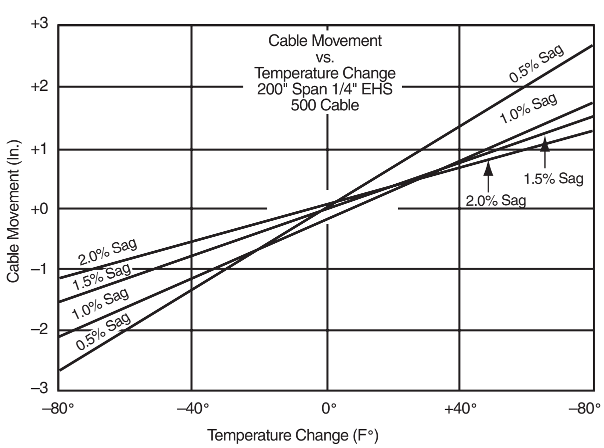


Fig. 2 shows the dramatic effect sag has on cable movement. In general, the tighter the sag the more cable movement there will be as temperature changes. For the same example given above except with 0.5% sag instead of 1.5% sag cable movement would be 1.6 inches instead of 1.0 inch for bare aluminum cable and 2.3 inches instead of 1.4 inches for jacketed cable.

Figure 2.

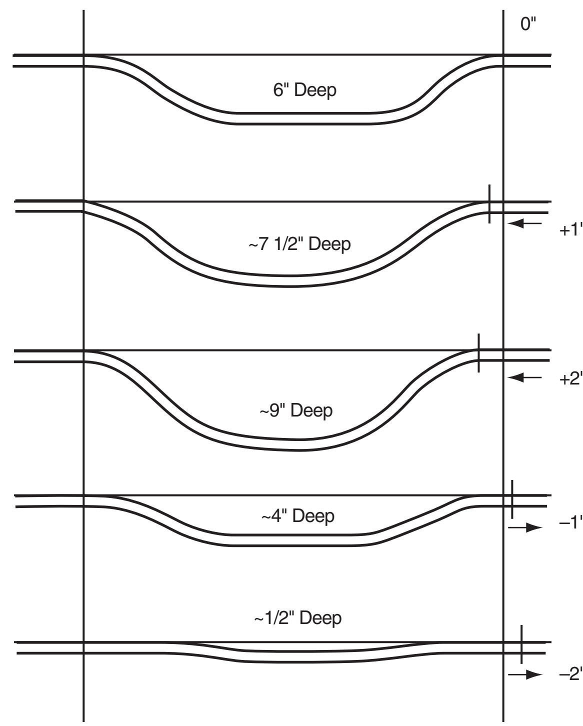


Loop Depth

Fig. 3 pictorially shows how the depth of an expansion loop changes as the cable moves in and out of the loop. The loop is initially 6 inches deep. As the temperature increases the cable expands more than the steel support strand. The excess cable pushes into the expansion loop. One inch movement causes the depth to increase to about 7.5 inches; 2 inches movement causes the depth to increase to about 9 inches.

As the temperature drops the cable contracts more than the steel support strand. One inch of movement results in a loop about 4 inches deep. Two in movement results in a loop only about 0.5 inch deep.

Figure 3.



Strand Creep

As a side comment, if the support strand is strung too tight and is exposed to extreme loading conditions, it may permanently deform or creep. If a 200 foot span was exposed to such extreme loading and the strand was caused to creep 0.09%, the strand would get longer by about 2 inches. The result would be an expansion loop only about 0.5 inch deep. As will be shown, such loops will have practically no life. With enough sag the occurrence of such extreme forces can be minimized if not completely avoided.

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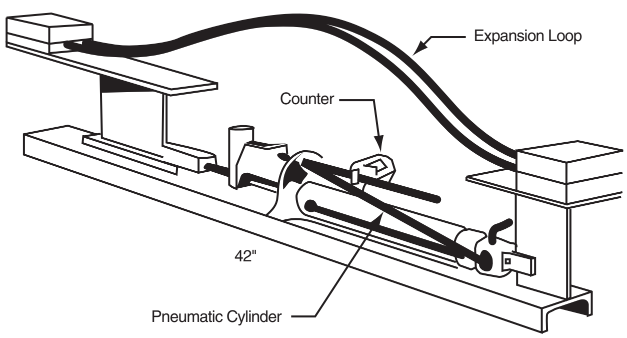
Testing Expansion Loop Performance

A device similar to the one shown in Fig. 4 is used to predict the life of expansion loops. An expansion loop is installed in the device. One end of the loop is fixed in place while the other end is caused to move back and forth a certain distance. The loop is considered to have failed the test when the outer conductor fractures. With this device loop life can be determined as a function of loop depth and excursion distance.

Figure 4.



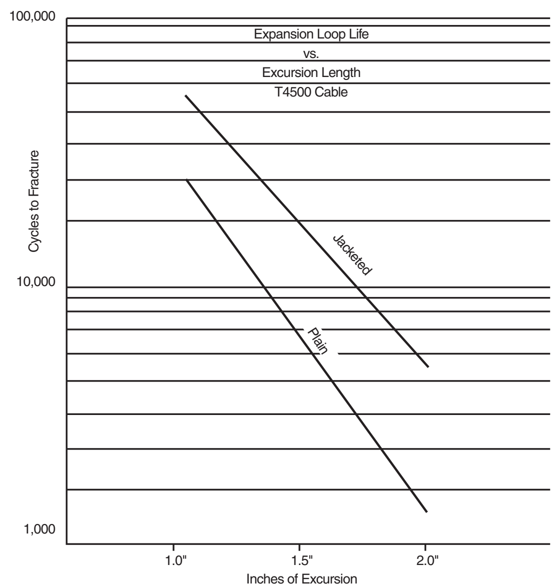
Expansion Loop Flex Tester

Loop Life Versus Excursion Distance

Fig. 5 shows the number of cycles to failure as a function of excursion distance of plain and jacketed 0.500 inch cable. If each cycle represents one day of life due to changes in temperature and other factors such as wind and wind gusting are ignored, then, from Fig. 5, plain 0.500 inch cable will last about 32,000 cycles or about 88 years with a 1 inch excursion. If on the other hand the excursion is 1.6 inches, which simulates a 0.5% sag in a 200 foot span, the life of the loop will drop to about 4,500 cycles or about 12 years. Clearly, excursion distance has a dramatic effect on loop life.

Although jacketed cable seems to perform better than bare cable, the temperature change is greater on jacketed cable due to its heat absorption and radiation characteristics. For the same conditions described above for plain cable, jacketed cable would move 1.4 inches. Its life, from Fig. 5, would be 22,000 cycles or about 60 years. Although not shown on the graph a 2.3 inch excursion would result in a life of about 3,000 cycles or about 8 years.

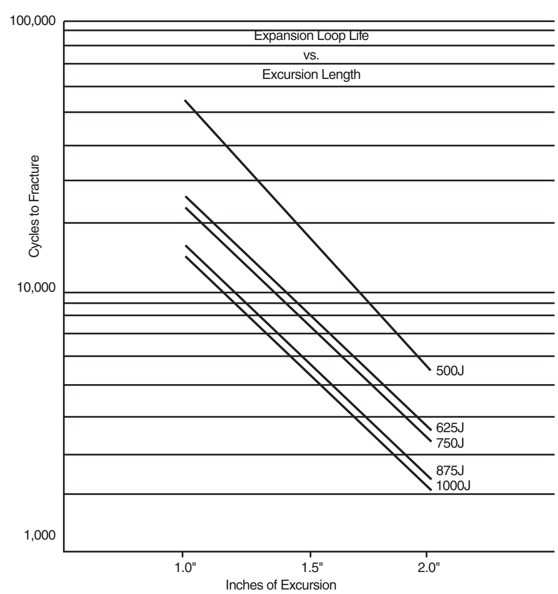
Figure 5.



Cable Size Versus Loop Life

Fig. 6 shows the life of various size jacketed cables versus excursion distance. In general the larger the cable diameter the shorter the loop life. Given a 1.4 inch excursion, jacketed 0.500 inch cable will last 60 years, jacketed 0.750 inch cable would last 27 years, and jacketed 1.000 inch cable would last about 20 years. Again, the effects of wind and wind gusting can cause rapid expansion loop cycling.

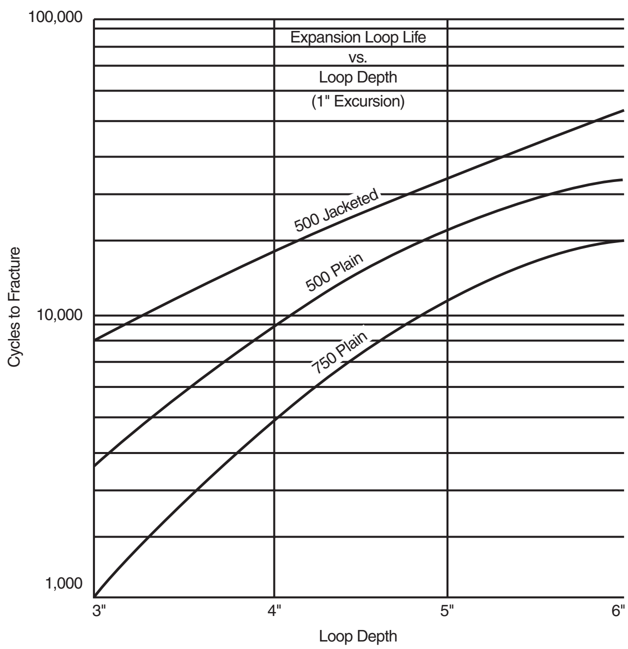
Figure 6.



Loop Depth Versus Loop Life

Fig. 7 shows how loop depth affects the life of expansion loops. Plain 0. 500 inch cable with a 6 inch depth will last about 32,000 cycles or about 88 years, as mentioned before. As shown in Fig. 7, if the depth is decreased to 3 inches, the loop life drops to about 3,500 cycles or about 9.5 years. Under the same conditions 0.750 inch cable will drop from a 55 year life to less than a 3 year life. Clearly, the depth of the loop has a dramatic effect on loop life also.

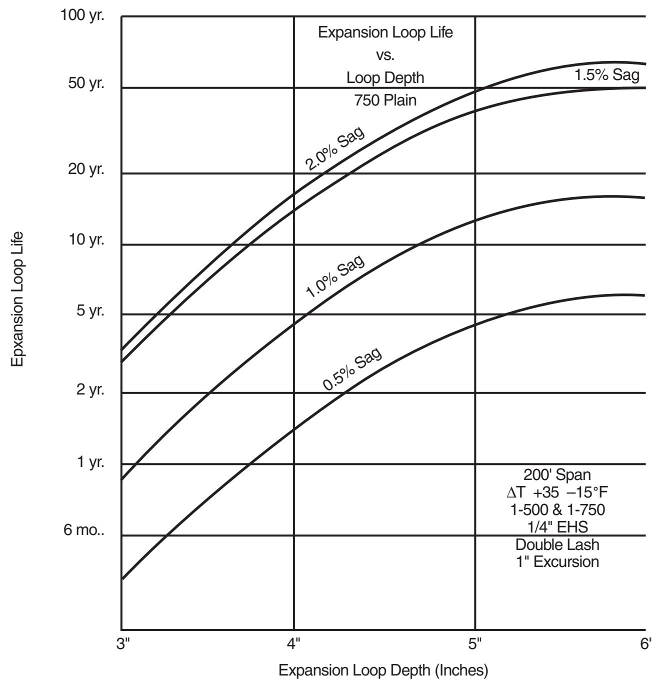
Figure 7.



Loop Life Versus Loop Depth and Sag

Fig. 8 shows the composite effects of loop depth and sag on the loop life of a 200 foot span of plain 0.750 inch cable. Depending on how the cable was installed the loop life can vary anywhere from less than 0.5 year for shallow 3 inch deep loops and tight sags to an excess of 50 years with the proper loop depth and sag.

Figure 8.



CONCLUSION

Several factors affect the life of expansion loops. The obvious factors are temperature change and span length. Unfortunately we have little or no control over these factors. Of significant importance are loop depth and installation sag. Both of these factors can be controlled through the proper installation techniques and can extend cable life. In the example given, the life of 0.750 inch cable was increased from only 0.5 year to an excess of 50 years simply by installing the cable with the proper sag and proper loop depth.

OVERVIEW

This technical note describes the causes of aluminum discoloration, water staining, and corrosion, and makes recommendations for the methods of handling and storage which will minimize these effects.

BACKGROUND

Aluminum Oxide

Aluminum is one of the most chemically active elements and has a strong affinity for oxygen. However, the presence of oxygen is what makes aluminum so widely used. Unprotected in almost every common environmental situation, a newly produced aluminum surface reacts almost immediately with oxygen, forming a thin oxide layer which effectively protects the pure surface from further oxidation and from the effects of many forms of chemical activity.

The oxide coating tightly adheres to the aluminum in a very thin, transparent coating which is hard and relatively stable. Generally, the oxide is unaffected by chemicals in the range of pH 4.5 to 8.5 but is susceptible to concentrated acids and alkalies.

Discoloration From Oxides

The corrosion of any material can be broadly defined as the destruction or deterioration of a material due to a reaction with its environment. This takes different forms depending on the nature of a material. For aluminum, corrosion generally takes the form of a reaction with the atmosphere and aqueous solutions.

Water is the third most common component of the atmosphere. Water may be in solid form (ice, snow), liquid form (rain) and in the form of humidity (vapor). Aqueous corrosion is an electrochemical relation in which liquid water is the key ingredient of the electrolyte necessary for the corrosion process.

Water dissolves different materials from the gases and solid particulate matter present in the atmosphere. When it falls on a metal surface or condenses on it, that surface becomes coated with what could be a strong electrolyte depending on proximity to coastal areas, industrial processes or a weaker electrolyte if in more rural areas. As an oxidation reaction occurs corrosion progresses and the metal surface is discolored, stained or corroded by the formation of oxides.

COAXIAL CABLE WATER STAINING, DISCOLORATION AND CORROSION

Aerial Cable

Except for areas near the coast or with significant pollutants, bare aluminum coaxial cables have been aerially installed for years with no reported operational problems caused by oxidation or corrosion. Jacketed cables are used in underground applications and where there is close proximity to coastal areas and areas of heavy industrialization. In normal exposed environments the aluminum surface does not experience atmospheric related problems if the surface is naturally washed clean of any potential electrolyte or contaminant. Aluminum's natural resistance to corrosion also offers protection. However, if the aluminum surface is covered and free air movement is restricted, contaminants may accumulate in a concentrated manner and electrolytic corrosion is accelerated.

Sheltered Corrosion

Sheltered corrosion of this type has been observed on coaxial cable which has been stored for a period of time while still tightly enclosed in the shipping wrapper. Although outdoor storage will certainly aggravate the situation, this type of corrosion starts as moisture, condenses on the aluminum surface under the wrapper and is not free to dry out. In the presence of high humidity the surface temperature of wrapped cable can be lower than the dew point temperature. Vapor will begin to condense, leaving the surfaces of the aluminum under the wrapper covered with condensation (aqueous electrolyte).

The resulting electrochemical action on the aluminum takes the form of shallow pits which generally do not degrade mechanical properties. With time, the luster of the aluminum surface will fade as it roughens and is covered with a gray layer of these corrosion products.

PREVENTION

The Aluminum Association, 818 Connecticut Avenue, N.W., Washington, D.C. 20006 has available a publication entitled "Guidelines for Minimizing Water Staining of Aluminum'' in which they set forth some guidelines for the handling and storage of aluminum products. These guidelines are applicable for the loading, storage and movement of aluminum materials where particular care and attention can be given to the prevention of condensation by controlling conditions of temperature and humidity.

Alumimum Discoloration, Water Staining and Corrosion

For the storage of coaxial cable, water and condensation may cause staining, discoloration or corrosion under certain conditions, and it is recommended that cable be stored in a dry location if at all possible. To minimize condensation and staining, discoloration or corrosion, allow air to flow into and through the area under the reel wrapper by removing part of the wrapper such as the test port and allow the cable under the wrapper to come into closer temperature and relative humidity equilibrium with the surrounding air. If using outdoor storage, position the opened portion of the wrapper so that the opening will not collect water.

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Sunlight Resistance Of PVC Drop Cable Jacketing

OVERVIEW

The purpose of this technical note is to discuss the ultraviolet (UV) stability of black and colored PVC jacketing compounds.

BACKGROUND

Polyvinyl chloride jacketing compound is susceptible to degradation under ultraviolet radiation unless suitable additives are incorporated in the finished compound. The mechanism of degradation due to exposure to sunlight is the deterioration of polymer bonds. The useful life of a PVC jacketing drop cable depends on the efficiency of the UV blocking agents used and the intensity and duration of sunlight to which the cable will be exposed. The most effective UV stabilizer is carbon black, which provides black PVC with its outstanding weathering and UV resistance. Natural PVC which would be used to make various colored jacketing requires different stabilizers to achieve similar UV resistant characteristics as black PVC. Compatible color concentrates, which are also UV resistant and acceptable for outdoor use, and not reactively destabilizing to PVC formulations, must be used to manufacture UV stable acceptable colored jacketing.

UV TEST METHOD

The most common test used to evaluate UV resistance of cable jackets is UL 1581, paragraph 1200. This test generates high intensity UV light via carbon arc illumination and also incorporates a water spray at 60°F to simulate weather conditions. The test is continued for a period of 30 days (720 hours) and the criteria of 80 percent minimum retention of initial tensile and elongation are considered acceptable for cable television and other outdoor applications.

CONCLUSION

Times Fiber Communications uses only UV stabilized PVC on their drop cable products with black and colored jackets. All color pigment systems employed to color the end product are also UV stable and acceptable for outdoor use.

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April,1999

The following grounding wire sizes are based on the minimum calculated DC resistance of the outer conductor of semiflex cable and the resistance of the closest copper wire size that does not exceed the calculated resistance.

Cable Type	Outer Conductor				Closest Copper Wire Size Resistance		
	Max. OD (inches)	Max. Wall (inches)	ID (inches)	Resistance (Ohms/kft)	AWG	(Ohms/kft)	OD (inches)
412	0.414	0.026	0.362	0.4216	6	0.3952	0.1620
500	0.502	0.026	0.450	0.3437	5	0.3135	0.1819
625	0.627	0.032	0.563	0.2234	3	0.1971	0.2294
750	0.752	0.037	0.678	0.1608	2	0.1563	0.2576
875	0.877	0.040	0.797	0.1270	1	0.1239	0.2893
1000	1.002	0.056	0.890	0.0803	2/0	0.07793	0.3648
565	0.567	0.025	0.517	0.3139	5	0.3135	0.1819
700	0.705	0.027	0.651	0.2323	3	0.1971	0.2294
840	0.842	0.032	0.778	0.1641	2	0.1563	0.2576
1160	1.162	0.053	1.056	0.0724	3/0	0.06182	0.4096

Calculations based on dimensions and aluminum resistivity of 2.828 microhm-cm.

Note: The above copper wires do not apply to the cable in general because the center conductors of the cables are significantly smaller with correspondingly high resistance.

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T10 and TX10 semiflex and T10 drop cables are sweep tested to 1 GHz. However, these cables are commonly used for satellite down link applications from 950 MHz to 2150 MHz. The following table provides the attenuation of T10 cables for such applications.

T10, TX10 Semiflexible Coaxial Cables and T10 Coaxial Drop Cables

Product	Typical Maximum Attenuation									
	dB/100 Feet @ 68°F					dB/100 Meters @ 20°C				
	950MHz	1200 MHz	1450MHz	1750MHz	2150MHz	950MHz	1200MHz	1450MHz	1750MHz	2150MHz
T10500	2.46	2.83	3.12	3.47	3.92	8.07	9.28	10.2	11.4	12.86
T10625	2.05	2.32	2.61	2.92	3.24	6.73	7.61	8.56	9.58	10.63
T10750	1.69	1.96	2.16	2.41	2.75	5.54	6.43	7.09	7.91	9.02
T10875	1.48	1.72	1.90	2.13	2.43	4.86	5.64	6.23	6.99	7.97
T101000	1.40	1.55	1.81	2.03	2.21	4.59	5.09	5.94	6.66	7.25
TX10565	2.11	2.45	2.66	2.96	3.41	6.92	8.04	8.73	9.71	11.19
TX10700	1.70	2.00	2.13	2.36	2.81	—	6.56	6.99	7.74	9.22
TX10840	1.48	1.72	1.90	2.13	2.44	4.86	5.64	6.23	6.99	8.00
TX101160	1.17	1.33	1.52	1.71	1.91	3.84	4.36	4.99	5.61	6.27
T10 Series 59	7.90	8.91	9.82	10.92	12.10	25.9	29.23	32.2	35.8	39.70
T10 Series 6	6.39	7.18	7.89	8.74	9.69	21.0	23.56	25.9	28.7	31.79
T10 Series 7	5.11	5.77	6.34	6.93	7.68	16.8	18.93	20.8	22.7	25.20
T10 Series 11	4.10	4.71	5.29	5.95	6.60	13.5	15.45	17.4	19.5	21.65
TX Flexible Feeder	3.03	3.43	3.84	4.27	4.77	9.94	11.25	12.60	14.01	15.65

Note: Values above 1000 MHz are calculated.

Maximum Span Lengths For Semiflex Messengered Cables

OVERVIEW

Times Fiber Communications manufactures CATV integral messengered semiflex cables available with several different size messenger wires. The purpose of this technical note is to help select the proper messenger size for the application.

CLEARANCE

The intention of the messenger wire is to support the cable and equipment in aerial applications between utility poles under worse case loading conditions without having to lash the cable to a separate support wire. The cable is usually separated from the messenger and cut so that a tap or other equipment can be installed. Because the cable is cut, the steel wire must be capable of sustaining the full load. According to the 1997 National Electrical Safety Code (paragraph 261K2), the steel support messenger shall not be stressed beyond 60% of its rated break strength. Vertical clearance requirements are also provided in the 1997 NESC. A typical requirement is 15.5 feet above roads and driveways under worse case sag conditions (paragraph 232A). If the minimum clearance above the road is 15.5 feet and assuming that the cable is attached to the utility pole 21 feet above the ground, the sag must not exceed 5.5 feet. The following table shows the maximum span length for heavy loading districts if the above clearance and tension requirements are met.

Cable Size	Messenger Size and Type (inch)	Maximum Span (feet)
500	0.109 solid	150
500	0.134 solid	175
500	(3/16) 0.1875 stranded	225
565	0.109 solid	150
565	0.134 solid	175
565	0.1875 stranded	225
625	0.109 solid	150
625	0.134 solid	175
625	(3/16) 0.1875 stranded	200
750	(3/16) 0.1875 stranded	200
750	(1/4) 0.250 stranded	250
875	(3/16) 0.1875 stranded	175
875	(1/4) 0.250 stranded	225

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ABSTRACT

CATV system bandwidths are increasing to 750 MHz and 1 GHz. New measurement techniques are needed to facilitate testing to these higher frequencies. One problem with the higher frequencies is the increased mismatch problems due to the shorter wavelengths. Testing the basic properties of long 75 ohm coaxial transmission lines at these higher frequencies, such as insertion loss, structural return loss (SRL), and impedance is more difficult. This paper will discuss the concept of vector error correction using a fixed bridge for these measurements and will compare this technique to the variable return loss bridge technique currently being used by the CATV industry. The theoretical basis for this fixed bridge technique is covered in detail. Data is presented from the results of an automatic transmission line testing program to 1 GHz and is compared to variable bridge measurements. These new testing procedures are important for measuring 75 ohm transmission lines especially as system bandwidths increase to 1 GHz, as new HDTV requirements unfold, and as hybrid fiber/cable systems become commonplace.

INTRODUCTION

As the CATV industry moves forward, we must be continually looking out for better ways of doing things. This is the case with cable measurements as we push the frequency range up to 1 GHz. What is proposed requires the next generation of test equipment for making measurements on the next generation of cable. The advantages are numerous. With the past technique, measurements to 1 GHz are difficult, tedious, and prone to errors. With the proposed technique, these problems are virtually eliminated, with the result, a cable that will enhance the value of the system in which it is used.

ELECTRICAL PROPERTIES OF CABLE

Insertion Loss

The insertion loss or attenuation of the cable describes how a signal loses energy as it travels through the cable. This loss is usually described in terms of a power ratio in dB and increases with the signal frequency. For coaxial cables these losses are attributed to the conductors and to the dielectric. The electrical properties of these materials are well known; thus the insertion loss is predictable from DC to well over 1 GHz.

The attenuation of typical CATV cables at 1 GHz is shown in Table 1. The cable must be measured in long production lengths (greater than 2000 feet) so the total loss per reel is also given in Table 1.

Many of the cables have losses in excess of 60 dB for normal reel lengths, but up to 96 dB of loss per reel is possible. The challenge for measuring attenuation is that the test equipment must have sufficient dynamic range to measure the losses through these long lengths of cable.

Impedance

The cable characteristic impedance is the ratio of the voltage to current for a wave traveling in the cable. Ideally coaxial cable impedance appears purely resistive across the frequency band and CATV coaxial cables are designed to have 75 ohm impedance, the standard used by the CATV industry. Seventy five ohms is nearly the optimum impedance for the lowest attenuation. For higher frequencies, greater than 5 MHz, the coaxial cable impedance is related to the ratio of inner to outer conductor dimensions and the dielectric material between them. Unfortunately, the cable impedance is not exactly 75 ohms across the frequency band and is generally within ± 2 ohms from 75 for trunk and feeder cable and within ± 3 ohms from 75 for drop cable.

Table 1.

Attenuation at 1 GHz								
Trunk Cables			Feeder Cables			Drop Cables		
Cable Size	Attenuation dB/100 feet	Attenuation dB/reel	Cable Size	Attenuation dB/100 feet	Attenuation dB/reel	Cable Size	Attenuation dB/100 feet	Attenuation dB/reel
T10-750	1.74	43.5	T10-412	3.10	96.1	59 Series	7.92	79.2
T10-874	1.53	38.3	T10-500	2.53	63.3	6 Series	6.42	64.2
T10-1000	1.44	36.0	T10-625	2.11	52.8	7 Series	5.41	54.1
TX10-840	1.53	38.3	TX10-565	2.17	54.3	11 Series	4.31	43.1
TX10-1160	1.20	30.0						

Return Loss

When the cable impedance is not exactly 75 ohms, there will be an impedance mismatch and a reflection of energy if it is connected to an ideal 75 ohm signal source. This reflection can be quantified in terms of the return loss:

$$RL = 20 \text{ LOG} \left[\frac{Z_{DEVICE} - Z_0}{Z_{DEVICE} + Z_0} \right] \quad (1)$$

where Z_{DEVICE} is the complex characteristic impedance of the device (ohms) and Z_0 is 75 ohms for CATV systems.

Since the cable impedance is within a few ohms of 75, the return loss, as opposed to the cable's structural return loss, is very good and usually better than 37 dB. The structural return loss, which deals with return loss at particular frequencies, will be discussed next.

Structural Return Loss

As coaxial cable is manufactured, a number of variables can cause the impedance to change. Recall, the cable's impedance is a function of the cable's physical properties (conductor diameters, insulation's dielectric constant), and if any of these properties change, the impedance will change. For example, the dielectric material is extruded over the center conductor during the manufacturing process. As the dielectric is extruded, its diameter or dielectric constant can change and cause the impedance to change. This impedance change is extremely small and difficult to measure. If only one of these impedance changes occurs in the cable or if they occur at random intervals, the return loss will be good; but due to manufacturing processes, there may be many evenly spaced impedance changes and return loss problems will arise. Reflections from these evenly spaced impedance changes add together at a frequency corresponding to a half wavelength spacing. Although, each impedance change may be very small, when they all add together, they cause a return loss "spike". These spikes can be narrower than 200 KHz. The return loss from these impedance changes is called the structural return loss because the impedance variations are due to structural nonuniformities in the cable. Although structural return loss measurements are described below, the challenge for measuring cable to 1 GHz is that the test equipment must have extended bandwidth (greater than 600 MHz) without sacrificing the ability to resolve and accurately measure these sharp SRL spikes.

Test Techniques

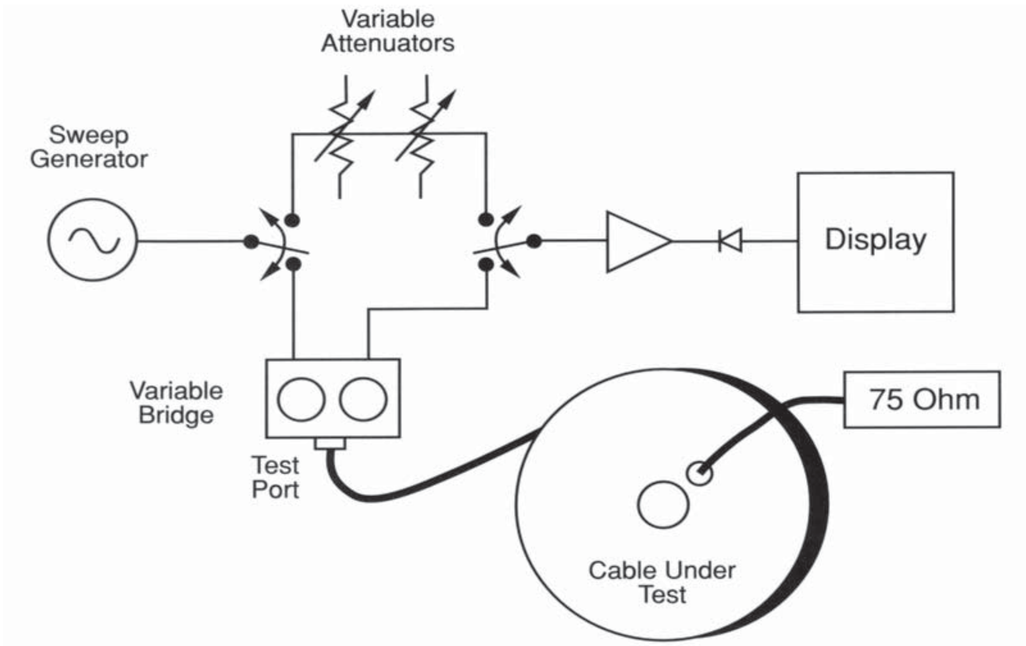
Testing the insertion loss, impedance, and return loss of 75 ohm cable requires defined test techniques for making repeatable and accurate measurements. This section of the paper will present two test techniques for making impedance and structural return loss measurements. The first technique involves the use of a variable bridge and is the currently accepted method for doing this type of cable testing. The second technique involves a fixed bridge, a network analyzer, a set of calibration standards, and a technique for simulating a variable bridge with calculations to perform these cable tests.

Variable Bridge Technique

The variable bridge testing technique block diagram for measuring SRL is shown in Figure 1. This block diagram shows that one end of the cable under test is connected directly to the variable bridge while the other end is connected to a 75 ohm load. To perform a measurement, the tester connects the top of the cable under test to the variable bridge and the bottom to the 75 ohm load, adjusts the variable bridge for the best match (i.e., CRT trace is adjusted for the lowest possible baseline without regard to "sharp spikes" when looking at return loss), and takes the measurements. An RMS voltmeter is sometimes used as a null indicator to help balance the bridge and improve repeatability. The connections are switched and the process is repeated for the bottom of the cable under test. During the measurements the tester is required to locate the worst case structural losses and report their amplitudes and frequencies. This requires the tester to locate these spikes with the help of the frequency markers in the sweep generator and determine their magnitude with an external variable attenuator. In order to see very narrow bandwidth return loss spikes, the sweep generator's sweep time must be increased or the sweep generator's frequency bandwidth must be decreased. This method of testing is currently an industry practice and is widely accepted for making SRL measurements.

In the variable bridge technique, there are three references that are used when making these cable measurements. The first involves the variable bridge. This bridge is used to determine the cable impedance and is calibrated to read out in ohms. This measurement requires a calibration process for determining the impedances for several variable bridge positions. By tuning this bridge to achieve the lowest trace on the CRT, the cable impedance can be read off the bridge directly. The variable return loss bridge has one disadvantage with broadband measurements, it is difficult to find a

Figure 1.



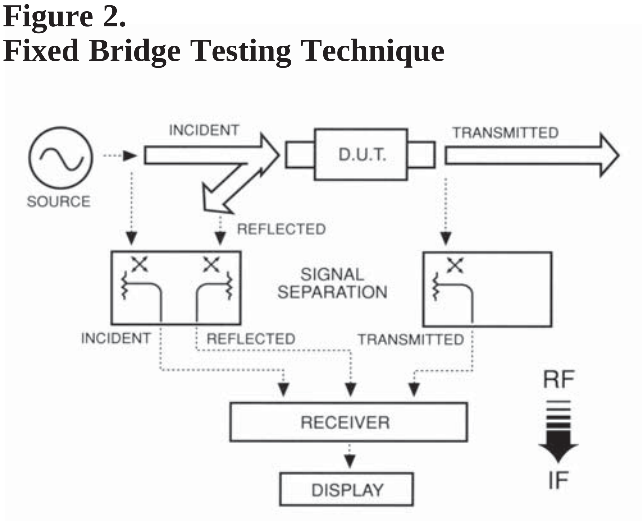
variable bridge with good directivity from 5 MHz to 1 GHz. The second reference used is the frequency markers on the sweep generator. These markers typically have a frequency accuracy of 0.005% and are used to find the location in frequency of the worst case accuracy loss spikes. The third reference is the variable attenuator. This attenuator determines the level of the return loss spikes and the insertion loss. The ability to know the level of this attenuator is critical, because it is the attenuator level that determines whether a cable passes or fails the structural return loss specification. All three of these references must be calibrated periodically so that the measurements can be made with confidence. The variable bridge technique relies heavily on operator interaction and the three references (bridge impedance, sweep markers, attenuator).

The measurement errors associated with the variable bridge technique can be attributed to three items: frequency tracking, mismatch, and directivity. The errors associated with the measurement system frequency response, otherwise known as frequency tracking, can be reduced to less than 0.5 dB by properly balancing the passive losses of the test set and the reference legs. The errors associated with cable mismatch can also be virtually eliminated by balancing the variable bridge for the best match between the bridge and the cable. The directivity errors are not easily eliminated and are due to the connector and the bridge itself. The directivity errors can be significant when measuring cables since the return loss of the cable is generally greater than 30 dB. The best solution has been to specify a bridge that has a very low directivity specification for the test system. In the 5 to 600 MHz range, a bridge with 55 dB or better can be achieved. Above 600 MHz it is difficult to obtain a broadband variable bridge with much better than 45 dB directivity. Typically a directivity of 50 dB is desirable. In general, a directivity error of +2.5/-1.9 dB can be expected from a bridge whose directivity is 12 dB better than the measurement and a directivity error +1.2/-1.0 dB accuracy can be expected from a bridge with a directivity of a 18 dB better than the measurement.

Fixed Bridge Technique

The fixed bridge technique for measuring SRL is shown in Figure 2. This measurement technique has several advantages for measuring cable. The first advantage is the cable can be tested from both the top and bottom without being disconnected. This allows the measurement to be taken faster now that only one set of connections needs to be made. The other benefit of only one connection is reduced connector wear. The second characteristic of this technique is that the source is now a synthesized source. This allows for a much more repeatable measurement not only from sweep to sweep but from test stand to test stand. This synthesized source has a frequency accuracy of 10 KHz at 1 GHz and is phase locked to a 10 MHz frequency reference. The third characteristic is that no tuning need be done to get the measurements. There is no variable bridge to tune, and no sweep generator to vary. This eliminates many of the operator errors and frees up

Figure 2.
Fixed Bridge Testing Technique



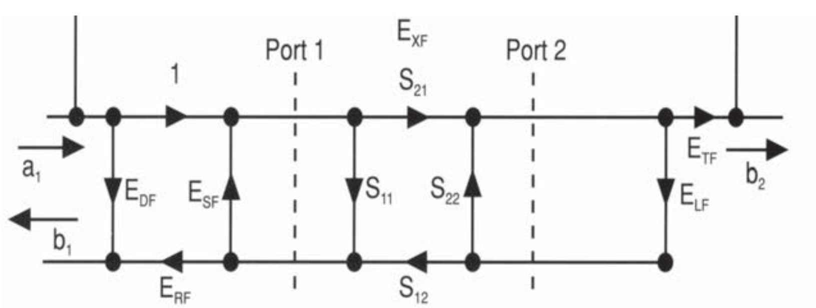
the operator to do other tasks. The fourth characteristic, not shown in the block diagram, is the ability of this system to correct for the systematic errors that occur in the test system with calibration standards. These calibration standards are used to correct for the fixed bridge directivity, the measurement system frequency response, and the measurement system port matches. This calibration is done by measuring known standards and comparing the measured results to the theoretical results and calculating error vectors to correct the measurement. This fixed bridge technique can easily measure return loss, impedance, and intersion loss for the cable under test.

The process used to correct the measurements is known as vector error correction. Vector error correction is the process of measuring the magnitude and phase of defined standards, comparing these measurements to theoretical results and computing complex error vectors. The standards used for this calibration are an open, a short, a load, and a thru. Each standard is machined to tight tolerances and is traceable to the National Institute of Standards (NIST). This means that the measurements taken with a calibrated system are traceable to national standards.

Figure 3 shows the error model for the test system. The cable under test is represented with S-parameters, where S11 and S22 are the input and output return loss (top and bottom) while S21 and S12 are the forward and reverse insertion loss for the cable. Around the S-parameters for the cable are the 6 forward error terms. These are the error terms for stimulating the cable from port 1, there are another 6 error terms for when the stimulus comes from port 2. In looking at Figure 3, the first three error terms have to do with port 1. Error term Edf has to do with the imperfections in the directional coupler, i.e., the directivity. This term is corrected for with the load calibration standard. Ideally, the directivity should be infinite. Error term Esf is the source match error. This error is corrected for with both the short and open calibration standards. The source match error has to do with how well the test set is matched to 75 ohms. Ideally, the source at port 1 would be exactly 75 ohms and there would be no mismatch between the test set and the cable under test. Error term Erf is the frequency tracking error. This term is also corrected for with both the short and open calibration standards. The frequency tracking error has to do with the frequency response of the test system including the loss through the test lead from the test port and back. Ideally, the frequency response of the test system should be zero and flat versus frequency. Error term Exf is the isolation error. This error has to do with the rf leakage inside of the test set and becomes important for accurate measurements on cables with high loss. Ideally, this error is zero. Error term Elf is the load match. This error term is corrected for by measuring the match of port 2. This error term is especially important at low frequencies when the loss thru the cable is less than 6 dB and the match of the cable is better than the match of port 2. Ideally, port 2 would look like a perfect 75 ohm load. Error term Etf is the frequency tracking term for the transmission measurement. This error term is corrected for with the thru measurement, which includes the loss through both test leads. Ideally, this transmission frequency response should be zero and flat versus frequency. It is typically the first three error terms that are needed when making the return loss measurements of the cable,

Figure 3. Forward Flowgraph

Forward Coefficients		Reverse Coefficients
E_{DF}	Directivity	E_{DR}
E_{SF}	Source Match	E_{SR}
E_{RF}	Reflection Tracking	E_{RR}
E_{XF}	Isolation	E_{XR}
E_{LF}	Load Match	E_{LR}
E_{TF}	Transmission Response	E_{TR}



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unless the insertion loss of the cable is less than 6 dB then Elf must be taken into account.

1 GHZ TEST SETUP

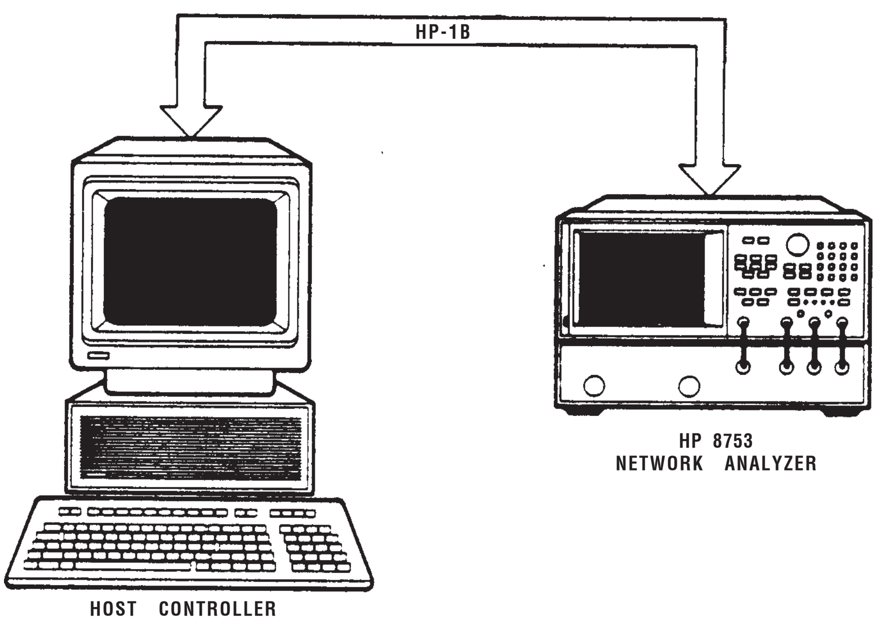
Figure 4 shows the test setup used to make measurements on Times Fiber Communications semiflex cable. In Figure 4 the host controller is an HP Vectra. The HP 8753C RF Vector Network Analyzer is used to perform the measurements. This instrument has the capability to measure all four S-parameters, the input and output return loss, the insertion loss as well as do the necessary error corrections for making accurate measurements. The HP Vectra is a DOS based computer and is used to extract the data from the HP 8753C, perform some calculations, and store the data into a database. For structural return loss, the measurements are taken over the 5 MHz to 1 GHz frequency range in 5 measurement bands. In each one of these bands there are 1601 data points taken, which gives a frequency resolution of 125 KHz. This 125 KHz frequency resolution helps to locate the extremely narrow SRL spikes that can occur due to the periodic discontinuities in the 2000 plus feet of cable. The return loss data is normalized to the average impedance of the cable to give the reading of structural return loss. This information is representative of the largest variation of impedance from the average impedance of the cable rather than 75 ohms, which is the data obtained from the network analyzer. The mathematics to do this calculation simulates the action of balancing the variable bridge with a fixed bridge format. The mathematics are shown below.

$$Z_{CABLE} = 75 \left[\frac{1 + G_M}{1 - G_M} \right] \quad (2)$$

$$G_{SRL} = \frac{Z_{CABLE} - Z_{AVG}}{Z_{CABLE} + Z_{AVG}} \quad (3)$$

In equation (2), Z_{CABLE} is the impedance of the cable and G_M is the reflection coefficient from the network analyzer as measured at each frequency. In equation (3) Z_{AVG} is the average impedance of the cable over the frequency range and G_{SRL} is the structural reflection coefficient for the cable. G_M is measured by the network analyzer and Z_{CABLE} is calculated. Z_{CABLE} is put in eq (3) and the value G_{SRL} results.

Figure 4.
Times Fiber Communications Measurement Setup



The other two measurements, impedance and insertion loss, are read directly from the network analyzer. The average impedance is measured by taking a single sweep from 5 MHz to 1 GHz with 101 points. The average is calculated from these data points and used in calculation of structural return loss. The insertion loss is measured at a number of specified frequencies.

TEST RESULTS

Structural Return Loss

Table 2 summarizes the results of test data collected on full reels of cable. These reels were tested with both a variable return loss bridge and a vector network analyzer (VNA) and then the results were compared. A large test sample consisted of T10500, 0.500 inch feeder cable, and T10750, 0.750 inch trunk cable, which were specially manufactured for 1 GHz applications. Table 2 shows the average of the worst case SRL spike.

Table 2.

Average Structural Return Loss	
Variable Bridge	33.99 dB
Network Analyzer	33.92 dB
Difference Avg	0.07 dB
Diff Std Dev	2.10 dB

The variable bridge structural return loss measurements were performed by a production tester. The network analyzer return loss measurements, being automated, required only the tester to connect the test leads to the cable reel. Once connected, the network analyzer test system performed all the measurements and recorded the data. After each reel was measured, the results were compared. Differences of approximately 2 dB were expected since the directivity of the variable bridge was only approximately 45 dB from 600 MHz to 1 GHz. This corresponds quite well with the difference standard deviation of 2.10 dB. With the exception of some small changes in the test leads, the directivity error on the VNA system is virtually eliminated while the directivity error of the variable bridge is left as an uncertainty.

In some cases a difference significantly greater than 2 dB was detected. Further analysis of these cases showed that the tester had missed an SRL spike. The tester missed these spikes because the display is linear and most of the cable is better than 32 dB; thus the operator had to adjust the display sensitivity to more accurately measure these lower levels. With this increased display sensitivity, the top of 28 dB spikes go just beyond the top of the screen. Although the system had enough resolution to catch the spike, it is necessary to reduce the display sensitivity after each cable is measured. Since most of the cables are better than 32 dB, it is a challenge for the tester to continually reset the display sensitivity after each measurement is made when the cables with sharp SRL spikes occur only a few percent of the time. No significant change in the SRL average in Table 2 was noticed when the samples with the measurement errors were removed.

Impedance

The impedance measured from the variable return loss bridge compared favorably to the vector network analyzer, in light of the fact that the impedance is read off a dial indicator.

Table 3.

Average Impedance	
Variable Bridge	75.50 Ohms
Network Analyzer	75.70 Ohms
Difference Avg	-0.20
Diff Std Dev	0.54

Attenuation

Because two groups of cable (500 and 750) were measured, it is appropriate to compare only the difference between the two attenuation measurements rather than their averages because the 500 has significantly different attenuation than 750. Combining them into one group would not be meaningful and perhaps misleading. The average difference in total attenuation was 0.20 dB (0.60%) at 400 MHz with a standard deviation of 0.15 dB. This type of correlation is quite good, given that the smallest increment on the variable attenuators for the variable bridge technique is 0.5 dB.

DISCUSSION

The accuracy of the variable bridge technique can be significantly improved by using a vector network analyzer and error correction. The variable bridge technique also requires a great deal of operator intervention which can add to the errors. The VNA mathematically corrects for the cable impedance and eliminates the possibility of missing sharp spikes. The vector network analyzer frees the operator to do other tasks while it does the actual measurements. Listed below are some other considerations that are made when using a VNA to make cable measurements.

Lump Impedance Discontinuities

There are a few factors that need to be addressed with a vector network analyzer that are not as critical with the variable bridge measurement. The operator's ability to recognize problems associated with test connectors and the cable is lost to some extent with an automated system. If the cable is kinked or damaged in some way, it will have a lumped impedance discontinuity and the structural return loss trace will have a very distinct characteristic or pattern. Pattern recognition is difficult to do quickly with a computer, while the human eye can recognize patterns in a fraction of a second. Since test time is crucial, the operator's intervention is still needed when this type of problem occurs.

Test Connectors and Time Domain Capability

At 1 GHz, test connectors can introduce errors into the measurement because the system calibration is performed on the "N" type port at the end of the test lead. When a test connector is installed on the end of the test port, its impedance variations are introduced into the measurement. In order to minimize these problems, good connectors must be used. Over a period of time, the performance of the connectors degrade. Since the operator is no longer involved with the measurement, it is important for the system to recognize when problems with the connector arise. The automated VNA has such capability. By switching into the time domain mode, the VNA can measure the reflection coefficient of the interface. A program is written to analyze the data and notify the operator if a problem does arise. Use of the time domain mode can also be used to identify problems in the reels being tested.

Test Leads

The stability of the test leads must also be considered. In the case of the variable return loss bridge, the test leads are not part of the test circuit. In the case of the VNA system, they are. Small changes in the test leads after the calibration is performed can introduce errors into the measurement. It is therefore necessary to perform regular checks of the system performance. Special test leads that can endure repeated flexure and crushing forces from the operator walking on them or reels rolling over them limit the changes in impedance and phase that can degrade the system performance.

CONCLUSION

It has been shown that measurements of structural return loss, impedance, and insertion loss can be performed using a vector network analyzer and are in substantial agreement with the current industry accepted standard technique. Some factors are more critical with the new measurement technique, but with the proposed system, measurement errors are reduced in numerous ways including vector error correction. Although some human intervention is still necessary, the measurements are made and recorded directly by the automated system so most errors introduced by human intervention are eliminated. As the CATV industry moves forward toward the enhanced value of 1 GHz systems, the vector network analyzer technique using vector error correction and impedance normalization should be accepted as the new standard by which other techniques are compared.

REFERENCES

[1] Doug Rytting, "Advances in Microwave Error Correction Techniques", Hewlett-Packard, RF & Microwave Symposium, 1987.

[2] J. Fitzpatrick, "Error Models for Systems Measurement", Microwave Journal, May 1978.

OVERVIEW

This procedure describes techniques which can be utilized to prepare the telephony portion of TeleDrop Cables for termination.

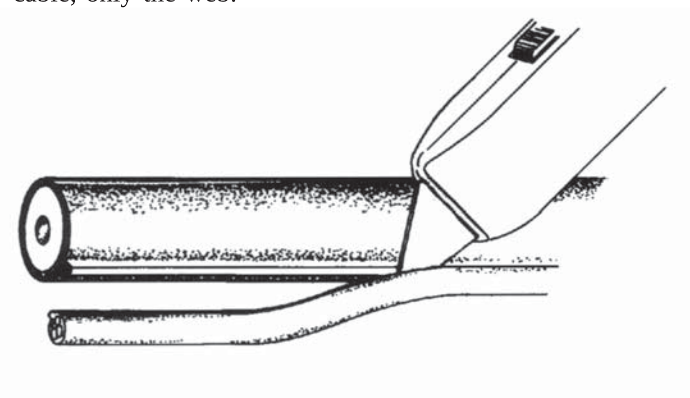
TeleDrop Cables combine standard flexible high frequency coaxial CATV drop cables with telecommunications wire pairs in a Figure-8 profile with an overall jacket and inter-connecting web of black weather resistant polyethylene. A ripcord is provided under the jacket of the telephony cable to facilitate removal of the overall jacket.

Two TeleDrop telephony pairs are provided fully color coded and with different twist lengths to minimize crosstalk couplings. Pairs are available in wire sizes AWG 22, AWG 24, or AWG 26. Optional interstitial filling and an overall telephony shield (screen) with a drain wire are available.

SEPARATION OF COAXIAL CABLE AND TELEPHONY PAIRS

The distance of separation of the coaxial cable from the telephony pairs is determined by the location of the points of termination for the two cable components. It is desirable to retain the jacket covering the telephony component for most of the distance from the point of separation to the point of termination.

Having determined the distance of separation required by a specific installation, separate the coaxial cable from the telephony component by cutting the web between them with a sharp knife or razor blade tool. Be careful not to cut into the jacket of the CATV coaxial cable or the telephony cable, only the web.



Caution: The two components should not be torn apart by hand as the forces involved may result in the tear migrating out of the web area into the jacket around one or the other of the two components.

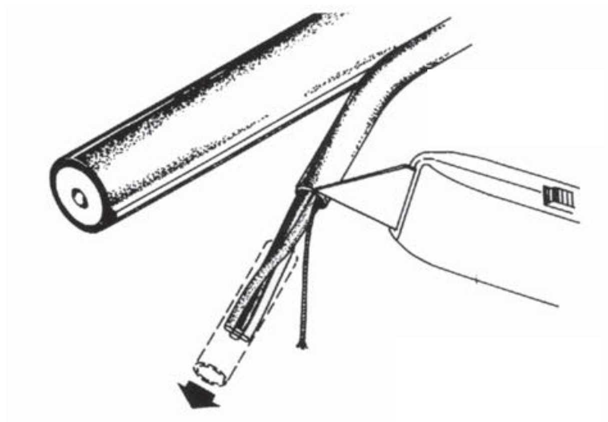
ACCESSING THE RIPCORD

To access the ripcord under the telephony component jacket it is necessary to either remove the jacket for a short distance or to slit it so the rip cord can be accessed.

Method 1:

At a distance of approximately 1.5 inches from the end, score radially completely around the jacket of the tele-phony component with a sharp knife or razor blade. The cut should be deep, but not so deep as to cut the ripcord or cable underneath. After cutting, bend the cable back on itself at the cut line, causing the polyethylene jacket to fracture and the jacket to separate cleanly.

Remove the jacket exposing the ripcord underneath.



Method 2:

From a point approximately 1.5 inches from the end, care-fully make a longitudinal cut along the cable axis to the cable end, cutting completely through the polyethylene jacket. If the insulation of the pairs is inadvertently nicked or cut, it can be cut off and discarded later, after the pairs are exposed for the desired distance.

Pull the telephony pairs, including ripcord, through the slit in the jacket to access the ripcord.

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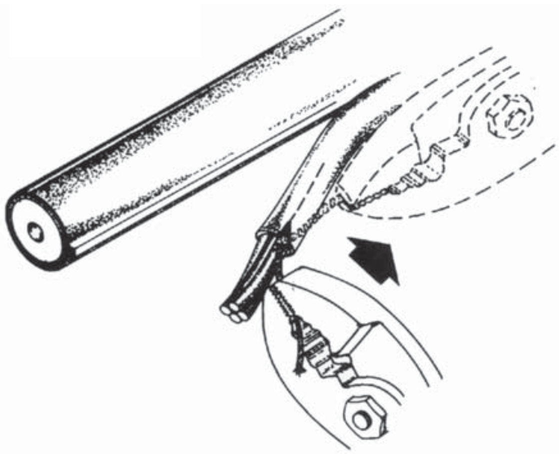
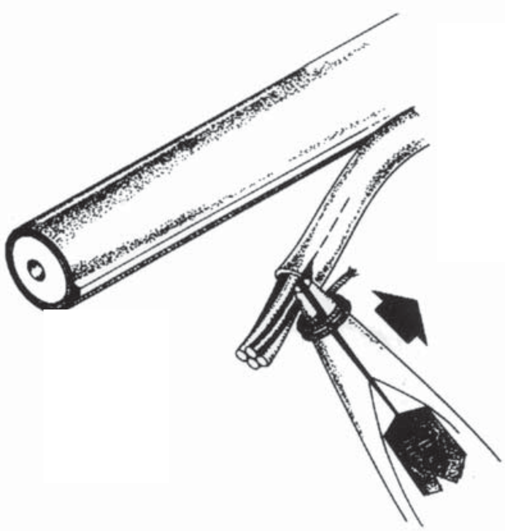
OPENING THE JACKET WITH THE RIPCORD

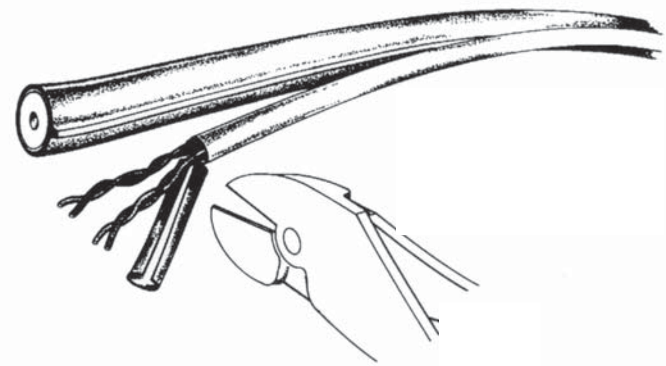
If Method 1 (above) was used to access the ripcord, make a short longitudinal cut in the cable jacket with a sharp knife, a razor blade tool or diagonal side cutter pliers. This serves as a starting point for the ripcord to be pulled longitudinally along the axis of the cable, cleanly slitting the jacket. If Method 2 was used, the ripcord can be pulled into the existing cut.

Using a pair of pliers, grip the ripcord and pull it into the jacket cut. Slice through the jacket longitudinally along the axis of the cable by pulling on the ripcord for whatever distance is desired for exposure of the telephony pairs.





Pull the telephony pairs through the slit in the jacket and then remove the cut-through jacket by folding the pairs back and cutting the jacket free with diagonal side cutters. If the telephony pairs were nicked or cut during the step to access the ripcord, cut off and discard the first 1.5 inches of the pairs at this time.



The telephony pairs are now ready for termination procedures.

The preparation and termination of the coaxial drop cable portion should be undertaken utilizing specialized tools and with specific reference to the instructions furnished by connector manufacturers.

ABSTRACT

The power or current carrying capacity of a cable is commonly referred to as the AMPACITY. The term is simply a contraction of the two words AMPere and capACITY.

The most recognized method of determining the ampacity of power cables is Article 310-15(b) of the National Electrical Code (NEC). Currently, the NEC does not publish the ampacity of CATV cables.

The basis of the NEC ampacity formula is the IEEE (formerly AIEE) paper titled "The Calculation of the Temperature Rise and Load Capability of Cable Systems" published in 1957 by J.H. Neher and M.H. McGrath. Utilizing the concepts developed by Neher/McGrath this paper will detail ampacity formulas and, appended to this paper, the resulting calculated ampacity tables for the range of products offered by Times Fiber Communications.

INTRODUCTION

The Neher/McGrath paper considers thermal circuits applicable to cables. Those thermal circuits include sources of heat and the thermal paths through which the heat flows. Since any coaxial cable has physical characteristics that limit the amount of temperature it can be exposed to, the temperature of the conductor carrying current is limited so as not to exceed the maximum allowable insulation temperature. That is, the heat generated in the cable must be equal to or less than the heat dissipated by the cable.

THERMAL CIRCUITS

Thermal circuits are analogous to electrical circuits with the qualification that changes in thermal circuits always occur much more slowly than changes in electrical circuits. The results outlined herein, therefore, are given only for steady state. Other methods should be employed to evaluate cable temperature rise due to transient, or sudden application of, currents.

ELECTRICAL FORMULA (Ohms law)	THERMAL FORMULA
$E = I * R$	$\Delta T = W * R_{th}$

Where:

- E = Potential difference (voltage)
- ΔT = Temperature difference between t_a, the ambient temperature, and t_c, the conductor temperature or $\Delta T = t_c - t_a$
- I = Current (amperes)
- W = Heat (watts)
- R = Conductor resistance (ohms)
- R_{th} = Thermal resistance (^{o}C-cm/watt)

SOURCES OF HEAT

The primary sources of heat that apply to CATV cables are the current carrying conductors (inner and outer conductor) and solar radiation.

The heat generated in the inner and outer conductor when current is flowing can be calculated as follows:

For the inner conductor

$$W_{IC} = I^2 * R_{IC}$$

and for the outer conductor

$$W_{OC} = I^2 * R_{OC}$$

Where:

- W_{IC} = Heat created in inner conductor due to current (I) flowing. (watts/ft)
- W_{OC} = Heat created in outer conductor due to current (I) flowing. (watts/ft)
- I = Current flowing in conductor. (amperes)
- R_{IC} = Resistance of inner conductor. (W/ft at operating temperature of conductor)
- R_{OC} = Resistance of outer conductor. (W/ft at operating temperature of conductor).

Heating due to exposure to solar radiation must be considered as an interfering heat source. In the development of formulas for outdoor (in air) ampacity a factor is introduced for added heating due to the solar radiation.

Other interfering heat sources, such as steam lines or other nearby cables operating at temperatures in excess of ambient temperature must be accounted for in a similar manner.

THERMAL RESISTANCE

In the thermal circuit, heat generated by current in the cable conductors will flow from the conductors through the insulation and jacket into the ambient air surrounding the cable. While the insulation and jacket are electrically insulating, they are also thermal insulators. That is, the insulation and jacket and any other thermal insulators (such as ducts, soil, etc.) will retain heat according to their thermal resistance.

Cable flooding compounds also introduce added thermal resistance to the cable. However, sensitivity studies have shown that the effect of cable flooding compound on cable ampacity is largely insignificant and can be safely disregarded.

A metallic object within the cable construction and in the thermal path, such as a cable armor, is considered to be an isotherm, or having an equal temperature on both sides of the armor. Certainly this assumption is not appropriate if there is air space in the thermal path, like the instance when cable is installed in metallic ducts.

The thermal resistivities (r) of materials in CATV cable are as follows:

Foamed polyethylene insulation

ρ_i = 1300 (°C-cm/watt)

Polyethylene (PE) jacket

ρ_j = 400 (°C-cm/watt)

Polyvinylchloride (PVC) jacket

ρ_j = 350 (°C-cm/watt)

The resulting thermal resistance, in °C/watt/ft, can be calculated as follows:

For the insulation

$$R_i = 0.00522 * \rho_i * \ln\frac{C}{d}$$

and for jackets,

$$R_j = 0.00522 * \rho_j * \ln\frac{D}{D_s}$$

The total thermal resistance of the circuit is:

$$R_{th} = R_i + R_j$$

Where:

- ρ_i = Thermal resistivity of the insulation material
- ρ_j = Thermal resistivity of the jacket material
- R_i = Thermal resistance of insulation
- R_j = Thermal resistance of jacket
- R_{th} = Total thermal resistance of thermal circuit
- ln = Natural logarithm
- C = Insulation diameter (inches)
- d = Center conductor diameter (inches)
- D_s = Outer condutor diameter (inches)
- D = Jacket diameter

GENERAL AMPACITY EQUATION

Using the thermal equation $\Delta T = W_{OC} * R_{th}$, assuming only the outer conductor is carrying current, and replacing

ΔT with $t_c - t_a$ (see DT definition) and

W_{OC} with $I^2 * R_{OC}$

results in

$$t_c - t_a = I^2 * R_{OC} * R_{th}$$

Before solving the equation for (I) it may be useful to solve first for the conductor temperature, t_c, which will allow illustration of those factors which control maximum conductor temperature.

$$t_c = I^2 * R_{OC} R_{th} + t_a$$

It is now apparent that the toal watts ($I^2 * R_{OC}$), the thermal resistance (R_{th}), and the ambient temperature (t_a) determine the conductor operating temperature. Since the ambient temperature and the thermal resistance are determined by given cable installation conditions, it can be seen that the conductor temperature must be controlled by the total watts ($I^{2)} R_{OC}$). Since the conductor temperature must not exceed the rated insulation or jacket temperature it is necessary to limit the total watts ($I^2 * R_{OC}$) by limiting the current (I) or the ampacity.

Returning to the thermal equation and solving for (I), in amperes, yields:

$$I = \sqrt{\frac{t_c - t_a}{R_{OC} * R_{th}}}$$

It should be noted that this equation is nearly identical that defined in NEC 310-15(b) and is used as a general formula for calculating cable ampacity.

INDOOR CABLE AMPACITY

The ampacity of indoor cables are the assumed worst case conditions for CATV installations since cables typically run from outdoors (where wind helps to cool the cable) to indoor or enclosed installations.

Like in the general equation, indoor cable ampacity is based on an assumed maximum allowable conductor temperature. The heat for cables installed indoors will flow from the conductor through the cable insulation (for inner conductor) and jacket to the cable surface where it is radiated away from the cable.

The indoor cable ampacity with the outer conductor carrying current is found by solving the following simultaneous equations:

$$I=\sqrt{\frac{t_c-t_s}{R_{oc}*(R_{th}-R_i)}}$$

and

$$I=\sqrt{\frac{0.182*\varepsilon*D*(t_s-t_a)+0.0714*D^{0.75}*(t_s-t_a)^{1.25}}{*R_{oc}}}$$

For indoor cable ampacity with both outer and inner conductors carrying current the simultaneous equations are modified as follows:

$$I=\sqrt{\frac{t_c-t_s}{(R_{ic}+R_{eoc})*R_{th}}}$$

and

$$I=\sqrt{\frac{0.182*\varepsilon*D*(t_s-t_a)+0.0714*D^{0.75}*(t_s-t_a)^{1.25}}{n*(R_{ic}+R_{eoc})}}$$

R_{eoc} is the effective increase in the center conductor resistance due to the effects of the outer conductor and is calculated as follows:

$$R_{eoc}=\frac{R_{th}-R_i}{R_{th}}*R_{oc}$$

Where:

- I = Ampacity (amperes)
- t_c = Conductor operating temperature (°C)
- t_a = Ambient temperature (°C)
- t_s = Cable surface temperature (°C)
- R_{ic} = Inner conductor resistance (Ω/ft at t_c)
- R_{oc} = Outer conductor resistance (Ω/ft at t_c)
- R_{eoc} = Increase in R_{ie} due to outer conductor
- R_{th} = Thermal resistance of circuit (°C/watt/ft)
- R_i = Thermal resistance of insulation (°C/watt/ft)
- ε = Emissivity of cable surface
  - Jacketed = 0.95
  - Bare = 0.35
- n = Number of cables
- D = Cable Diameter (in.)

OUTDOOR CABLE AMPACITY

Ampacities for cables installed outdoors are calculated using simultaneous equations very similar to the those for indoor cables. Outdoor equations, however, include a term to account for heating due to solar radiation and additional cooling from forced convection (wind) rather than natural convection.

The ampacity of outdoor cable with the *outer conductor carrying current* is found by solving the following **simultaneous equations**:

$$I=\sqrt{\frac{t_c-t_s}{R_{oc}*(R_{th}-R_i)}}$$

and

$$I=\sqrt{\frac{0.182*\varepsilon*D*+(0.237*(p*v)^{0.7}*D^{0.5})*(t_s-t_a)-8.77*\varepsilon_{cs}*D}{n*R_{oc}}}$$

For outdoor cable ampacity with both outer and inner conductors carrying current the simultaneous equations are modified as follows:

$$I=\sqrt{\frac{t_c-t_s}{(R_{ic}+R_{eoc})*R_{th}}}$$

and

$$I=\sqrt{\frac{0.182*\varepsilon*D+(0.237*(p*v)^{0.7}*D^{0.5}(t_s-t_a)-8.77*\varepsilon_{cs}*D}{n*(R_{ic}+R_{eoc})}}$$

The nomenclature used for the variables in this section are the same as those used for indoor cables with the following additions:

- ε_{cs} = Absorptivity of the jacket surface = 0.33
- p = Atmospheric pressure (atmospheres)
- v = wind speed (feet/second)

SUMMARY

It is not the intent of this paper to instruct on the use of techniques developed in the Neher/McGrath paper, or to derive the formulas and constants that resulted from that paper.

In summary, this paper is intended to introduce to the CATV industry ampacity tables, similar to those in the NEC for power cables, utilizing a well known and proven method for determining the current carrying capability of cables.

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REFERENCES

The Calculation of the Temperature Rise and Load Capability of Cable Systems", J.H. Neher and M.H. McGrath, AIEE, March 1957

The Current-Carrying Capacity of Rubber Insulated Conductors, S.J. Rosch, AIEE, April 1938

The National Electrical Code Handbook, 1993 National Fire Protection Association, Sixth Edition, 1993

CRC Handbook of Chemistry and Physics, CRC Press, Inc., 62nd Edition, 1981

The Cable Book, Times Fiber Communications Inc., December 1993

APPENDIX I.

AMPACITY CALCULATIONS FOR 500 SERIES TFC CABLE WITH BOTH INNER & OUTER CONDUCTORS CARRYING CURRENT.

$d = 0.109"$ $\quad C = 0.450"$

$D_s = 0.500"$ $\quad D = 0.560"$

$t_a = 20^oC$ $\quad t_c = 65^oC$

$R_{oc} = 0.3581 \times 10^{-3}\,\Omega/ft@20^oC$

$R_{IC} = 1.3456 \times 10^{-3}\,\Omega/ft@20oC$

$\varepsilon = 0.95$

$n = 1$

$\rho_i = 1300\ ^oC\text{-cm/watt}$

$\rho_j = 400\ ^oC\text{-cm/watt}$

Since the conductors will be operating at 65ºC, the resistances, R_{ic} and R_{oc} must be corrected from 20ºC to 65ºC. The correction factor is calculated to be 1.181 and the resulting resistances at 65ºC are:

$R_{oc} = 0.4229 \times 10^{-3}\Omega/ft @ 65^oC$

$R_{IC} = 1.589 \times 10^{-3}\Omega/ft @ 65^oC$

$$R_i = 0.00522 * 1300 * \ln \frac{0.450}{0.109} = 9.622$$

$$R_j = 0.00522 * 400 * \ln \frac{0.560}{0.500} = 0.237$$

$$R_{th} = 9.622+0.237=9.859$$

$$R_{eoc} = \frac{9.859-9.622}{9.859} * 4.229 * 10^{-3} = 0.1017 * 10^{-3}$$

Substituting these values into the simultaneous equations for indoor cables yields:

$$I = \sqrt{\frac{65-t_s}{(0.4229*10^{-3}+0.1017*10^{-3})*9.859}}$$

and

$$I = \sqrt{\frac{0.182*0.95*0.560*(t_s-20)+0.0714*0.560^{0.75}*(t_s-20)^{1.25}}{1*(0.4229*10^{-3}+0.1017*10^{-3})}}$$

which, when solved simultaneously results in:

I = 43.084 or 43 amperes

APPENDIX II.

DERATING FACTORS FOR TWO SINGLE, CURRENT CARRYING CABLES JOINED BY AN OVERALL JACKET (SIAMESE)

If the number of cables (n) in Appendix I is changed from n=1 to n=2 the resulting ampacity would be 38 amperes. This equals a derating factor of 88.3% to account for the mutual heating of another cable in the proximity of the original single cable. Sensitivity studies have shown that a derating factor of 85% can be safety used for Siamese drop cables with current in both the inner and outer condutors and 70% can be used for Siamese drop cables with current in the outer conductor only.

Alan J. Amato, Senior Application Engineer
Times Fiber Communications, Inc.

Appendix III
TFC Semiflexible Cable Ampacity

TFC Semiflexible Cable Ampacity (Amperes)				
Cable Type	Current in Both Conductors		Current in Outer Conductors	
	20°C (68°F) Ambient	40°C (104°F) Ambient	20°C (68°F) Ambient	40°C (104°F) Ambient
T10 Series Semiflex Cable				
T10412	33	25	125	90
T10500	43	32	148	107
T10625	54	40	201	145
T10750	67	50	254	184
T10875	81	60	304	220
T101000	94	71	404	293
TX10 Series Semiflex Cable				
TX10565	50	38	158	115
TX10700	66	49	201	146
TX10840	79	59	257	187
TX101160	117	87	436	317

Notes:

1) Conductor operating temperature = 65 °C (149 °F)
2) Center conductor material - Copper clad aluminum
3) Outer conductor material - Aluminum

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Drop Cable Ampacity

TFC Drop Cable Ampacity (Amperes)				
Cable Type	Current in Both Conductors		Current in Outer Conductors	
	20°C (68°F) Ambient	40°C (104°F) Ambient	20°C (68°F) Ambient	40°C (104°F) Ambient
59 Series Drop Cable				
Standard Shield (53%)	6	4	18	13
Standard Shield (67%)	6	4	20	14
Premium Shield (95%)	6	4	24	17
Trishield (53%)	6	4	22	15
Trishield (80%)	6	4	24	17
Quadshield (53%-34%)	6	5	25	18
6 Series Drop Cable				
Standard Shield (60%)	8	6	21	15
Premium Shield (90%)	8	6	27	19
Trishield (60%)	8	6	26	18
Trishield (80%)	8	6	28	20
Quadshield (60%-40%)	8	6	30	22
7 Series Drop Cable				
Standard Shield (53%)	10	7	24	18
Trishield (80%)	10	8	32	23
Quadshield (60%-36%)	10	8	34	25
11 Series Drop Cable				
Standard Shield (53%)	13	10	28	20
Premium Shield (60%)	13	10	29	21
Trishield (60%)	13	10	35	25
Quadshield (53%-32%)	13	10	38	28
Quadshield (60%-40%)	13	10	41	29
TX Flexible Feeder				
Standard Shield (60%)	41	30	42	30
Trishield (60%)	42	31	50	36
Quadshield (60%-40%)	42	31	58	42

Notes:

1) Conductor operating temperature = 65ºC (149 °F)
2) Derating factors (multiply derating factor by value selected above):
   Siamese, outer conductor of both components carrying current = 0.85
   Siamese, both conductors of both components carrying current = 0.70
3) Center conductor material - Copper clad steel
4) Outer conductor material - Combination of aluminum/polypropylene/aluminum tape(s) and aluminum alloy wire braid(s) as applicable.

OVERVIEW

The following technical note discusses the natural tendency of flooded, semiflexible, polyethylene jacketed cables to shrink back, a phenomenon common to all manufacturers of flooded cable.

Reason for Jacket Shrinkage

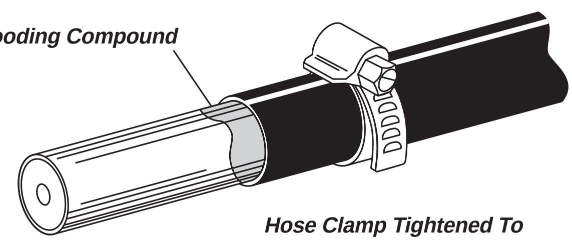
The cable jacket is applied to the cable core by heating pellets of polyethylene to the melting point in an extruder. The melted material is routed through the extruder as melted polyethylene onto the unjacketed cable core. After exiting the extruder crosshead, the now jacketed cables immediately quenched in cold water. This quench operation is necessary for several reasons. First, in order to prevent the cable core from being exposed to excessive heat and next to the cool the jacket so it will not deform and will maintain the wall thickness and dimensions defined by industry specifications.

This rapid cooling locks longitudinal stresses into the polyethylene jacket and are relieved, in the field, by daily environmental heating and cooling of the jacket. This process of stress relief manifests itself by longitudinal shrinkage of the jacket material relative to the cable outer conductor. Shrink back is most pronounced when the jacket is directly exposed to heating by the sun. In extreme cases, where no action has been taken to secure the jacket against movement, up to 12” of outer conductor may be exposed.

Preventing Jacket Movement Due To Shrinkage

Prevention of jacket movement due to shrinkage takes place during the preparation of the cable for connectors. All strip dimensions remain the same as indicated in the manufacturer’s instructions for the connector being used and a general description of the preparation process can be found in TFC Technical Note 1022-H.

After stripping back the cable jacket secure hose clamp approximately 1/2” from the end of the cable jacket to prevent shrink back (see figure 1). When the job is complete heat shrink tubing should cover the hose clamp, cable and connector.



Caution: The hose clamp must not be overtightened, deformation of the outer conductor and signal degradation may result.

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Drop Installation

When installing drop cable (i.e., from the pole to the home, to the ground block, through the wall, and to the television set), there are many points where the cable is subject to tight bends. The tightness of each bend should be controlled in order to avoid compromising cable performance. The key areas of concern are:

1. The stiff copper clad steel conductor should not be bent so tightly that it's forced against the softer foamed polyethylene. Excessive forces could result in an impedance drop, causing signal reflections. In very extreme conditions, the conductor could eventually make contact with the shield, resulting in a short.

2. The laminated shielding tapes should not be stressed so severely that the coating develops fissures and cracks, compromising shielding performance.

In order to assure that excessive internal mechanical stresses are not developed, a minimum bend radius is recommended below for each of our basic drop cable designs.

Flexure

The radii shown are not intended for applications where the cable will be continually flexed or subjected to severe tension or sidewall pressure. If the cable were being installed in densely packed electronic equipment bend radii as large as 10 times the cable diameter would be recommended. If the cable were subject to moderate or even slight continuous flexing, radii as large as 25-100 times the cable diameter might even be required for long life freedom from material degradation due to fatigue.

One Time Bends

For conventional cable TV home wiring, bends are put in as part of the drop installation which will not be subject to subsequent flexure as part of their normal use. There may also be small stress relieving loops, where applicable, and the cable will not be subject to high tension forces or severe sidewall crushing, while being bent.

Under these typical cable TV installation conditions, the minimum bend radius can be as small as 3.0-3.5 times the cable diameter as shown below:

Recommendations

TFC drop cable utilizes a gas injected dielectric, containing a significant proportion of high density polyethylene. Therefore, the dielectric is tough and capable of withstanding relatively high levels of abuse. The bend radii provided are conservatively selected and are based on a rugged drop cable design. Therefore, these represent the smallest bend radii applicable to drop cable regardless of the source.

Minimum Recommended Bend Radius inches (millimeters)

	Series 59	Series 6	Series 7	Series 11	TX Flexible Feeder
Tape/Braid	0.750(19.050)	1.000(25.400)	1.1250(28.580)	1.375(34.930)	2.000(50.800)
QuadShield	0.875(22.230)	1.000(25.400)	1.250(31.750)	1.500(38.100)	2.500(63.500)

OVERVIEW

Trunk and feeder cable are available in a variety of construction options, from plain aluminum to jacketed, flooded jacketed and armored flooded jacketed. While the plain aluminum version is the most economical, the jacketed versions may be preferred depending on anticipated field conditions. In addition to the increased economy of the plain version, there are also some product advantages which should be considered, before assuming that jacketed cable is preferable.

This technical note summarizes the features of plain versus jacketed cable in order to help customers be aware of all the pertinent factors.

JACKETED CABLE

Advantages

1. Significant improvement in corrosion resistance for areas near salt water, acid rain, industrial and automotive pollution.
2. Improved handling due to the additional support provided by the jacket to the aluminum.
3. Longer cable life due to the jacket's ability to more fully support and protect the aluminum against long term fatigue resulting from expansion, contraction, wind, vibration, etc.
4. The jacket provides reduced surface friction compared to the bare aluminum surface, reducing drag when pulling around blocks, rollers and through conduits.
5. The jacket provides an opportunity for extensive cable identification. This includes extruded and monofilament multicolor striping, which is far more durable than available paints and stains that can be provided over bare aluminum. The option of sequential footage marking is also provided by jacketed cable.
6. The jacket provides improved abrasion resistance, which protects the aluminum against surface degradation. This is helpful during installation and during service, especially if the cable passes through tree branches or other abrasive environments.
7. During emergency conditions, high voltage power lines can fall onto plain cable, resulting in catastrophic transients which can seriously damage system electronics. Jacketed cable can insulate the aluminum against high voltage during these situations, providing short term protection until the problem is repaired.

PLAIN CABLE

Advantages

1. The reflective surface of plain cable absorbs far less heat from the sun than standard, black jacketed cable. Thus, plain cable will tend to be cooler during the summer and in the warmer parts of the country, resulting in lower attenuations and reduced demand on AGC circuits.
2. The reduced weight and diameter of plain cable reduces the load on the strand wire, especially during high wind and heavy icing situations.
3. While jacketed cable provides some improved mechanical protection for the seamless aluminum sheath, if damage does occur, the jacket may make it difficult to detect visually. During installation, when pulling cable around multiple 90° bends or other difficult turns, slight flattening or kinking of the aluminum may be more difficult to detect with jacketed cable. Thus, plain cable has the advantage of avoiding the problem of concealed damage. (It should be pointed out that jackets bonded to the aluminum sheath also avoid concealed damage.)
4. Termination is quicker with plain cable since the jacket removal step is eliminated.
5. Of course, plain cable is more economical than jacket cable, which is always a key factor.
6. The intimate contact between the aluminum on the plain cable and the lashing wire provides improved grounding for the entire length of the run. This uniform grounding effect can be important under lightening, power company transients or other emergency situations.

BONDED CORE CABLE

Advantages

TFC's bonded core, bonded jacket cable offers greatly improved handling and cold weather performance. With bonded plain cable, one can obtain all of the advantages of plain cable, indicated above, but also several advantages usually found only with jacketed cable. The bonding of the dielectric allows the cable to exhibit handling approaching jacketed cable along with the improved life resulting from fatigue resistance. The bonded core also provides improved insurance against moisture ingress, further improving long term reliability.

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OVERVIEW

T10 is a full wall seamless aluminum trunk or feeder cable with a bonded composite construction. With the continuous bond of the center conductor to dielectric, dielectric to aluminum sheath and aluminum sheath to jacket, T10 cable exhibits enhanced mechanical properties.

ENHANCED PERFORMANCE

T10 Specifications

As a result of the composite construction, T10 has increased pull strength and sidewall pressure resistance. With the additional aluminum sheath support, T10 better resists kinking and flattening during installation. T10 can also be bent to a smaller radius (8x rather than 14x for non-bonded cable diameter).

Multiple bends and difficult installations both aerially and underground are more reliable with T10.

Initial core to sheath adhesion and retention of adhesion at cold temperatures has been significantly improved.

T10 offers the same basic electrical specifications as non-bonded cables, but extends the upper frequency of the cable to 1GHz. There is no compromise in shielding or sheath and loop resistance.

For the exact values on electrical and mechanical properties see the TFC's product catalog.

Increased Cable Life

Based on test results obtained in our laboratory evaluation, T10 offers significant improvements over non-bonded cable in fatigue protection both before and after aging. In all cases, the flexural performance of T10 actually improved rather than degraded after thermal aging.

While non-bonded cable offers firm support of the aluminum from its hard dielectric, T10 bonding supplies additional support even at cold temperatures.

Since T10 utilizes the same full wall seamless sheath as conventional non-bonded cable, there is no compromise in the corrosion life of the cable. In addition T10's bonded jacket will prevent moisture from travelling under the jacket.

CONNECTOR INSTALLATION

Since T10 is an enhanced version of the standard non-bonded cable line, the basic dimensions are unchanged. Therefore, standard connectors and coring methods can be used.

OVERVIEW

Cable Television systems provide service to their subscribers by means of a small coaxial cable called a drop cable. Where aerial cable plant is usually suspended between utility poles, the drop cable is usually sus-pended between the pole or support strand and the house. This technical note covers the maximum span over which a drop cable can be suspended.

MAXIMUM SPAN LENGTH

Clearance Requirements

For normal application, the maximum span is limited by two key factors. The first is the maximum allowable sag. The sag is controlled by clearance requirements. For purposes of this technical note a 7 foot sag is assumed which would allow a 14 foot clearance above the ground if the attachments are 21 feet high. It should be emphasized that clearance requirements usually depend on the location of the installation and are dictated by the National Electrical Safety Code, and state and local safety codes.

TENSION REQUIREMENTS

The second factor that limits the maximum span is the maximum tension that the cable can reliably withstand during its service life. This, of course, assumes that the attachment hardware is capable of supporting the tension, which may not be the case. A typical 0.1875 (3/16) inch woodscrew “P” hook can pull out at less than 100 pounds depending on the type of wood used. For purposes of this technical note, it is assumed that non-messengered drop cable can withstand approximately 100 pounds of tension and messengered drop can handle 80% of the messenger’s minimum break strength.

Span Length (feet)

Drop Cable Type	Messenger Size (inches)	Messenger Break Strength (pounds)	NESC Loading District		
			Heavy	Medium	Light
59 Series					
Non-Messengered			75	110	160
Messengered	0.051	200	90	125	160
6 Series					
Non-Messengered			75	100	145
Messengered	0.051	200	90	120	155
7 Series					
Non-Messengered			75	100	135
Messengered	0.072	365	120	160	195
11 Series					
Non-Messengered			75	100	130
Messengered	0.083	485	130	175	205
TX Flexible Feeder					
Non-Messengered			90	115	140
Messengered	0.109	1800	150	200	240

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T10 SEMIFLEX CABLE SERIES

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WEIGHT MATRIX-Approximate Shipping Weights (including reel)

TYPE	NOMINAL FOOTAGE PER REEL	WEIGHT PER REEL	(LBS.) PER										5000 LBS FOOTAGE
			1000'	2000'	3000'	4000'	5000'	6000'	7000'	8000'	9000'	10000'	
T10412	3000	252	84	168	252	336	420	503	587	671	755	839	59594
T10412J	3000	301	100	201	301	402	502	603	703	804	904	1004	49781
T10412MS	3000	479	160	319	479	638	798	957	1117	1277	1436	1596	31336
T10412JB	3000	310	103	207	310	414	517	621	724	828	931	1035	48325
T10412JBF	3000	311	104	207	311	415	518	622	726	830	933	1037	48219
T10412JBA	3000	577	192	384	577	769	961	1153	1346	1538	1730	1922	26010
T10412JX	3000	372	124	248	372	496	620	744	868	992	1116	1240	40320
T10412JBX	3000	382	127	255	382	510	637	765	892	1020	1147	1275	39216
T10500	2450	269	110	220	330	439	549	659	769	879	989	1098	45521
T10500J	2450	319	130	261	391	522	652	782	913	1043	1174	1304	38343
T10500MS	2450	479	196	391	587	782	978	1174	1369	1565	1761	1956	25559
T10500JB	2450	328	134	268	402	536	670	804	938	1072	1206	1340	37314
T10500JBF	2450	329	134	269	403	537	671	806	940	1074	1208	1343	37237
T10500JBA	2450	588	240	480	720	960	1200	1440	1680	1920	2160	2400	20833
T10500JX	2450	409	167	334	501	669	836	1003	1170	1337	1504	1671	29915
T10500JBX	2450	419	171	342	514	685	856	1027	1198	1370	1541	1712	29207
T10500SC	2450	325	132	265	397	530	662	795	927	1060	1192	1325	37749
T10500JSC	2450	375	153	306	459	612	765	918	1071	1224	1377	1530	32677
T10500MSSC	2450	535	218	436	655	873	1091	1309	1528	1746	1964	2182	22911
T10500JBSC	2450	384	157	313	470	626	783	940	1096	1253	1410	1566	31926
T10500JBFSC	2450	384	157	314	471	628	784	941	1098	1255	1412	1569	31870
T10500JBASC	2450	643	263	525	788	1050	1313	1576	1838	2101	2364	2626	19039
T10500JXSC	2450	465	190	380	569	759	949	1139	1328	1518	1708	1898	26350
T10500JBXSC	2450	475	194	388	581	775	969	1163	1357	1550	1744	1938	25799
T10625	2450	399	163	326	489	652	815	977	1140	1303	1466	1629	30693
T10625J	2450	461	188	377	565	753	942	1130	1318	1507	1695	1883	26551
T10625MS	2450	758	309	619	928	1237	1547	1856	2165	2475	2784	3093	16164
T10625JB	2450	472	193	385	578	771	964	1156	1349	1542	1734	1927	25946
T10625JBF	2450	473	193	386	579	772	965	1158	1351	1544	1737	1930	25900
T10625JBA	2450	803	328	655	983	1310	1638	1966	2293	2621	2948	3276	15263
T10625JX	2450	587	240	479	719	959	1198	1438	1678	1918	2157	2397	20860
T10625JBX	2450	599	245	489	734	978	1223	1467	1712	1956	2201	2445	20447
T10750	2500	578	231	463	694	925	1157	1388	1619	1851	2082	2313	21615
T10750J	2500	669	268	535	803	1071	1338	1606	1874	2141	2409	2676	18681
T10750MS	2500	1255	502	1004	1506	2008	2510	3012	3514	4016	4518	5020	9959
T10750JB	2500	682	273	546	819	1092	1365	1637	1910	2183	2456	2729	18321
T10750JBF	2500	683	273	547	820	1093	1367	1640	1913	2187	2460	2733	18294
T10750JBA	2500	1121	449	897	1346	1794	2243	2691	3140	3588	4037	4485	11148
T10750JX	2500	752	301	601	902	1203	1503	1804	2104	2405	2706	3006	16631
T10750JBX	2500	766	306	613	919	1225	1531	1838	2144	2450	2757	3063	16324
T10750SC	2500	709	284	568	851	1135	1419	1703	1986	2270	2554	2838	17620
T10750JSC	2500	800	320	640	960	1280	1600	1921	2241	2561	2881	3201	15620
T10750MSSC	2500	1386	554	1109	1663	2218	2772	3327	3881	4436	4990	5545	9017
T10750JBSC	2500	813	325	651	976	1301	1627	1952	2278	2603	2928	3254	15368
T10750JBFSC	2500	814	326	652	977	1303	1629	1955	2280	2606	2932	3258	15348
T10750JBASC	2500	1252	501	1002	1503	2004	2505	3006	3507	4008	4509	5010	9981
T10750JXSC	2500	883	353	706	1059	1412	1765	2119	2472	2825	3178	3531	14161
T10750JBXSC	2500	897	359	717	1076	1435	1794	2152	2511	2870	3229	3587	13938
T10875	2450	800	327	653	980	1306	1633	1959	2286	2613	2939	3266	15310
T10875J	2450	901	368	736	1103	1471	1839	2207	2574	2942	3310	3678	13596
T10875JB	2450	916	374	748	1121	1495	1869	2243	2617	2991	3364	3738	13375
T10875JBF	2450	917	374	749	1123	1497	1871	2246	2620	2994	3369	3743	13358
T10875JBA	2450	1364	557	1113	1670	2226	2783	3340	3896	4453	5010	5566	8983
T10875JX	2450	994	406	811	1217	1622	2028	2434	2839	3245	3650	4056	12327
T10875JBX	2450	1010	412	824	1236	1648	2060	2472	2884	3296	3708	4121	12134
T101000	2300	1049	456	912	1368	1824	2280	2736	3192	3648	4104	4560	10965
T101000J	2300	1201	522	1044	1566	2088	2610	3133	3655	4177	4699	5221	9577
T101000JB	2300	1217	529	1058	1588	2117	2646	3175	3705	4234	4763	5292	9448
T101000JBF	2300	1219	530	1060	1589	2119	2649	3179	3709	4238	4768	5298	9438
T101000JBA	2300	1822	792	1585	2377	3169	3962	4754	5546	6338	7131	7923	6311
T101000JX	2300	1286	559	1118	1677	2236	2795	3354	3913	4472	5031	5590	8945
T101000JBX	2300	1303	566	1133	1699	2266	2832	3399	3965	4532	5098	5665	8827

TX10 SEMIFLEX CABLE SERIES T10

WEIGHT MATRIX-Approximate Shipping Weights (including reel)

TYPE	NOMINAL FOOTAGE PER REEL	WEIGHT PER REEL	(LBS.) PER										5000 LBS FOOTAGE
			1000'	2000'	3000'	4000'	5000'	6000'	7000'	8000'	9000'	10000'	
TX10565J	2450	384	157	313	470	626	783	939	1096	1253	1409	1566	31936
TX10565MS	2450	656	268	536	803	1071	1339	1607	1875	2143	2410	2678	18669
TX10565JB	2450	393	161	321	482	642	803	964	1124	1285	1445	1606	31135
TX10565JBX	2450	494	202	403	605	806	1008	1209	1411	1612	1814	2015	24809
TX10565JBF	2450	394	161	322	483	644	804	965	1126	1287	1448	1609	31075
TX10565JBA	2450	681	278	556	833	1111	1389	1667	1944	2222	2500	2778	18001
TX10700J	2500	528	211	423	634	845	1056	1268	1479	1690	1901	2113	23667
TX10700MS	2500	811	324	649	973	1297	1622	1946	2270	2594	2919	3243	15417
TX10700JB	2500	540	216	432	649	865	1081	1297	1513	1729	1946	2162	23129
TX10700JBX	2500	631	253	505	758	1010	1263	1515	1768	2021	2273	2526	19796
TX10700JBF	2500	541	217	432	649	865	1081	1297	1513	1729	1946	2162	23129
TX10700JBA	2500	850	340	433	650	866	1083	1299	1516	1733	1949	2166	23087
TX10840J	2450	769	314	628	942	1256	1569	1883	2197	2511	2825	3139	15929
TX10840MS	2450	1437	587	1173	1760	2346	2933	3520	4106	4693	5279	5866	8524
TX10840JB	2450	783	320	639	959	1279	1599	1918	2238	2558	2878	3197	15638
TX10840JBX	2450	936	382	764	1146	1528	1910	2291	2673	3055	3437	3819	13092
TX10840JBF	2450	784	320	640	961	1281	1601	1921	2241	2562	2882	3202	15616
TX10840JBA	2450	1218	497	994	1491	1988	2485	2982	3479	3976	4473	4970	10061
TX101160J	2100	1391	662	1324	1987	2649	3311	3973	4635	5297	5960	6622	7551
TX101160JB	2100	1407	670	1340	2011	2681	3351	4021	4691	5362	6032	6702	7460
TX101160JBF	2100	1409	671	1342	2013	2683	3354	4025	4696	5367	6038	6708	7453
TX101160JBA	2100	1840	876	1752	2629	3505	4381	5257	6134	7010	7886	8762	5706

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T10 DROP CABLE SERIES

WEIGHT MATRIX-Approximate Shipping Weights (including reel)

DESCRIPTION	(LBS.) PER Part Number	1000'	2000'	3000'	4000'	5000'	5000 LBS FOOTAGE
SINGLE CABLES							
59 PLAIN							
53% SEALED	T5953-VB	26	52	78	104	130	192,308
67% SEALED	T5967-VB	26	52	78	104	130	192,308
95% SEALED	T5995-VB	27	54	81	108	135	185,185
TRISHIELD	T59T53-VB	25	50	75	100	125	200,000
80% TRISHIELD	T59T80-VB	26	52	78	104	130	192,308
QUADSHIELD	T59Q53/34-VB	30	60	90	120	150	166,667
59 MESSENGERED							
53% SEALED	T5953-VB-051M	40	80	120	160	200	125,000
67% SEALED	T5967-VB-051M	40	80	120	160	200	125,000
95% SEALED	T5995-VB-051M	41	82	123	164	205	121,951
TRISHIELD	T59T53-VB-051M	39	78	117	156	195	128,205
80% TRISHIELD	T59T80-VB-051M	40	80	120	160	200	125,000
QUADSHIELD	T59Q53/34-VB-051M	44	88	132	176	220	113,636
59 FLOODED							
53% SEALED	T5953-FVB	25	50	75	100	125	200,000
67% SEALED	T5967-FVB	25	50	75	100	125	200,000
95% SEALED	T5995-FVB	26	52	78	104	130	192,308
TRISHIELD	T59T53-FVB	26	52	78	104	130	192,308
80% TRISHIELD	T59580-FVB	27	54	81	108	135	185,185
QUADSHIELD	T59Q53/34-FVB	29	58	87	116	145	172,414
SIAMESE CABLES							
59 PLAIN							
53% SEALED	T5953SIAM-VB	51	102	153	204	255	98,039
67% SEALED	T5967SIAM-VB	53	106	159	212	265	94,340
95% SEALED	T5995SIAM-VB	51	102	153	204	255	98,039
QUADSHIELD	T59Q53/34SIAM-VB	60	120	180	240	300	83,333
59 MESSENGERED							
53% SEALED	T5953SIAM-VB-072M	73	146	219	292	365	68,493
67% SEALED	T5967SIAM-VB-072M	73	146	219	292	365	68,493
QUADSHIELD	T59Q53/34SIAM-VB-072M	81	162	243	324	405	61,728
59 FLOODED							
53% SEALED	T5953SIAM-FVB	49	98	147	196	245	102,041
67% SEALED	T5967SIAM-FVB	50	100	150	200	250	100,000
QUADSHIELD	T59Q53/34SIAM-FVB	58	116	174	232	290	86,207
SINGLE CABLES							
6 PLAIN							
60% SEALED	T660-VB	31	62	93	124	155	161,290
90% SEALED	T690-VB	32	64	96	128	160	156,250
TRISHIELD	T6T60-VB	31	62	93	124	155	161,290
77% TRISHIELD	T6T77-VB	33	66	99	132	165	151,515
QUADSHIELD	T6Q- VB	38	76	114	152	190	131,579
6 MESSENGERED							
60% SEALED	T660-VB-051M	45	90	135	180	225	111,111
90% SEALED	T690-VB-051M	46	92	138	184	230	108,696
TRISHIELD	T6T60-VB-051M	45	90	135	180	225	111,111
77% TRISHIELD	T6T77-VB-051M	47	94	141	188	235	106,383
QUADSHIELD	T6Q-VB-051M	50	100	150	200	250	100,000

WEIGHT MATRIX-Approximate Shipping Weights (including reel)

DESCRIPTION	MI	(LBS.) PER Part Number	1000'	2000'	3000'	4000'	5000'	5000 LBS FOOTAGE
SINGLE CABLES								
6 FLOODED								
60% SEALED	02386	T660-FVB	31	62	93	124	155	161,290
90% SEALED	02586	T690-FVB	32	64	96	128	160	156,250
TRISHIELD	02624	T6T60-FVB	32	64	96	128	160	156,250
77% TRISHIELD	02629	T6T977-FVB	33	66	99	132	165	151,515
QUADSHIELD	02286	T6Q-FVB	37	74	111	148	185	135,135
SIAMESE CABLES								
6 PLAIN								
60% SEALED	02396	T660SIAM-VB	64	128	192	256	320	78,125
QUADSHIELD	02296	T6QSIAM-VB	73	146	219	292	365	68,493
6 MESSENGERED								
60% SEALED	02384	T660SIAM-VB-072M	84	168	252	336	420	59,524
QUADSHIELD	02284	T6QSIAM-VB-072M	96	192	286	384	480	52,083
6 FLOODED								
60% SEALED	02353	T660SIAM-FVB	62	124	186	248	310	80,645
QUADSHIELD	02253	T6QSIAM-FVB	71	142	213	284	355	70,423
SINGLE CABLES								
7 PLAIN								
60% SEALED	02358	T760-VB	42	84	126	168	210	119,048
TRISHIELD	02680	T7T77-VB	43	88	129	172	215	116,279
QUADSHIELD	02258	T7Q60/36-VB	47	94	141	186	235	106,383
7 MESSENGERED								
60% SEALED	02371	T760-VB-072M	63	126	189	252	315	79,365
QUADSHIELD	02271	T7Q60/36-VB-072M	69	138	207	276	345	72,464
7 FLOODED								
60% SEALED	02372	T760-FVB	41	82	123	164	205	121,951
QUADSHIELD	02272	T7Q60/36-FVB	46	92	136	184	230	108,696
11 PLAIN								
53% SEALED	02362	T1153-VB	65	130	195	260	325	79,923
60% SEALED	023T2	T1160-VB	65	130	195	260	325	79,923
QUADSHIELD	02262	T11Q53/32-VB	65	130	195	260	325	76,923
QUADSHIELD (60/40)	022T2	T11Q-VB	65	130	195	260	325	76,923
11 MESSENGERED								
53% (0.083)	02369	T1153-VB-083M	93	186	279	372	465	53,763
53% (0.109)	02366	T1153-EB-109M	96	192	288	384	480	52,083
60% (0.083)	023V2	T1160-VB-083M	94	188	282	376	470	53,191
QUADSHIELD (0.083)	02269	T11Q53/32-VB-083M	93	186	279	372	465	53,763
QUADSHIELD (0.109)	02266	T11Q53/32-EB-109M	97	194	291	388	485	51,546
11 FLOODED								
53% SEALED	02382	T1153-FVB	64	128	192	256	320	78,125
60% SEALED	023W2	T1160-FVB	64	128	192	256	320	78,125
QUADSHIELD	02282	T11Q53/32-FVB	63	126	189	252	315	79,365

DROP CABLE SERIES

TIMES FIBER COMMUNICATIONS, INC.®
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ORDERING

When placing an order for T10 Drop Cable, refer to the part numbers provided in the individual cable size section, or the numerical index on pages 58 thru 62.

There are two description codes included in the Drop Cable part number; the prefix “3” to indicate **lifeTime™** protectant; the suffix “V” to indicate our NEC listed, **CATV** Rated cable.

EXAMPLE:

	Description	Part Number
1.	6 Series Drop Cable, Standard Coverage	T660-VB
2.	6 Series Drop Cable, Standard Coverage with **lifeTime™**	T660-LTVB
3.	6 Series Drop Cable, Standard Coverage, **CATV** Rated	T660-VBV
4.	6 Series Drop Cable, Standard Coverage, with **lifeTime™** and **CATV** Rated	T660-LTVBV

COLOR CODING: To aid the visual identification of each cable, colored stripes can be added to a cable jacket.

PACKAGING

Standard drop cable reel lengths are 1000 feet (305 meters) , ± 10%. 2000 feet (610 meters) ± 10% reel lengths are available on most configurations.

Not more than 10% of each shipment will be other than standard lengths with no lengths shorter than 400 feet (122 meters) on 1000 feet (305 meters) reels, or shorter than 1000 feet (305 meters) on 2000 feet (610 meters) reels.

For convenient handling, we use 3 different methods of packaging:

1) The standard reel*

2) The Timesaver, which is a weatherproof cardboard construction box with 1000 feet (304.8 m) of cable inside. (Add -7 suffix to part number for 1000 ft. in Timesaver box).

3) The Timesaver II**, a reusable high density polypropylene dispenser case with integral latches to house a stretch wrapped coil. (Add -8 suffix to part number for cable in Timesaver II pack).

* all drop cable can be ordered with this packaging. (add -1 suffix to part number for 1000 ft. lengths on a reel)
** any single 59 or 6 series can be used with this.

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SEMIFLEX CABLE SERIES T10-TX10

ORDERING

To simplify and clarify our Semiflex Cable product numbering system, a description part numbering system is used. Refer to the matrix below to understand how to read and build a semiflex part number and to assist in the order process.

	PRODUCT CHARACTERISTICS								
	CABLE TYPE	SIZE	Plain (P)	Jacketed (J)	Messen-gered (MS)	Jacketed Burial (B)	Armored (A)	Special CODE *	PART NUMBER
1.	T10	500		J		B			T10 500 JB
2.	T10	750						SC	T10 750 SC
3.	TX10	565		J	MS				TX10 565 MS

Cable Type / Size / Characteristics

*Special Codes include:
SC: Solid Copper Center Conductor
F: Flooded notation usually following JB to indicate asphalt flooding compound
VI: Visual identification, indicating color coded cable

Example 1: To order T10 semiflex cable in the 1/2" size with a protective flooding compound, the part number would be built as shown in line 1.

Example 2: To order plain 3/4" T10 semiflex cable with a solid copper center conductor (instead of our standard copper-clad aluminum center conductor), the part number would be built as shown in line 2.

Example 3: To order TX10 cable of .565" size, messengered, the part number is as shown in line 3.

A FEW RULES TO REMEMBER

1. TX10 cable is not available in plain construction.
2. A selection for the burial (flooded) or armored features always require a jacket.
   * Note: a selection for messenger cable also requires a jacket, but the “J” notation is not required.
3. Plain cable requests do not require the insertion of a “P” notation.

PACKAGING

Times Fiber packages all T10 semiflex and TX10 semiflex cable on reels. Refer to chart below for nominal lengths per reel by cable size.

SERIES	NOMINAL LENGTH (FT PER REEL)
412	3000
500,565	2450
625,840, 875	2450
700,750	2500
1000	2300
1160	2100

*Unjacketed only

Shipping lengths will be of published nominal lengths, +/-10%. No more than 10% of any shipment will be other than nominal lengths, with no lengths shorter than:
A: 1000 feet for 412, 500, 565, and 625
B. 1200 feet for 750, 875, 700, and 1000
C. 1800 feet for 840 and 1160

COLOR CODING: To aid the visual identification of each cable, colored stripes can be added to a cable jacket.

UNJACKETED CABLE: A single color stripe is available in red, green, blue or yellow for visual identification on unjacketed aluminum cables.

JACKETED CABLE: A maximum of two colors may be used in any stripe combination. Stripe combinations may not exceed two stripes per side.

To specify the arrangement of the colors for a total of four stripes, for example, select two color choices.

COLOR CODE TABLE

Red - R	Yellow- Y	White - W	Green - G
Slate - S	Blue - B	No Stripe - N	

Example 1: To order cable with a color arrangement with red and green stripes on both sides, specify RG/RG

A slash (/) in the middle of the four letters is used to distinguish between the two sides of the cable.

Example 2: To order cable with a co-extruded red stripe, one on each side, specify RN/RN.

The N is used to indicate that no color (or Black) is one of two stripes.

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COAXIAL CABLES

TFC Amphenol

WARRANTY AND STANDARD TERMS AND CONDITIONS OF SALE

Supersedes and cancels all previous terms and conditions sheets. Prices, discounts, terms and conditions subject to change without notice.

1. The acceptance of Customer's order is expressly limited to and made conditional upon the terms and conditions herein stated.

THE TERMS STATED HEREIN SHALL CONSTITUTE THE FINAL, COMPLETE AND EXCLUSIVE AGREEMENT OF THE PARTIES PERTAINING TO THIS SALE. No Course of prior dealings between the parties and no course of performance or usage of trade shall be relevant to explain any terms staed herein. No statement, promise, understanding, usage of trade, course of performance of dealing or acceptance, of or acquiescence in any course of performance or dealing shall be effective to rescind, waive, modify or add to the agreement as set forth herein, or any term hereof, or any right or claim arising out of a breach or default by Customer, unless such rescission, waiver, modification or addition is expressly approved by Times Fiber Communications, Inc. (TFC) in writing.

No inconsistent terms or conditions stated by Customer in any purchase order or otherwise shall be binding upon TFC unless specifically accepted in wrting by TFC.

2. Quoted prices are based on existing conditions and costs, and are subject to adjustment by TFC, upward or downward, consistent with changes in material costs and wage levels. Customer will pay **all** invoices Net 30 days from the date of invoice. This includes any invoice that represents product sent by TFC to Customer as part of a larger order. An irrevocable Letter of Credit from a U.S. Bank is required to International Transactions.

3. Federal or state taxes now or hereafter imposed affecting the prodution, treatment, manufacture, sale, delivery, transportation or proceeds of the products specified herein, shall be for Customer account, and if paid or required to be paid by TFC the amount thereof shall be added to and become part of the price payable by Customer hereunder.

4. DOMESTIC SHIPMENTS: Shipments to destinations with the United Sates shall be F.O.B. TFC's plant. Notwithstanding this, if TFC prepays the transportation charges, Customer will be obligated to reimburse TFC upon receipt of invoice for the prepaid transporation charges. Any special or abnormal packaging required will be included in the unit price of the item to be delivered or as a separate line item. SHIPMENTS OUTSIDE THE UNITED STATES: Unless otherwise specified by TFC in writing, shipments to destinations outside the United States shall be delivered according to Delivered Ex Ship (DES) terms as modified below (hereinafter referred to as modified D.E.S.) at the port of destination named in this Purchase Order Acknowledgement or quote if no destination is named in the acknowledgement. TFC shall bear the risks invlolved in bringing the products to the named port of destination as agreed in writing. **TFC shall prepay and bill Customer all of TFC's out of pocket costs for transportation including freight and insurance**. TFC fulfills its obligations to deliver when the prdoucts have been made available to Customer on board the ship, not cleared for import, at the named port of destination. TFC shall retain the title to the products and bear all risks of loss of or damage to the products until such time as the products have been delivered per modified D.E.S. terms. Customer shall be responsible for the importation of the product, as well as payment of all tariffs, value added tax, importation taxes, cost of putting product through customs, and for related fees and expenses. Any special or unusual packaging required may be included in the unit price of the item to be delivered or as a separate line item.

5. Partial shipments shall not be subject to rejection for defects in quantity. Remittances with respect thereto must be made in accordance with invoices rendered in connection therewith.

6. TFC will assume no liability or risk of loss after products are delivered.

7. No liability will be assumed by TFC for delays due to conditoins beyond TFC's control.

8. Orders accepted by TFC are not subject to cancellation except with TFC's written consent and upon terms which will indemnify TFC for all loss or damage.

9. Unless otherwise stated, orders will be considered complete when footage shipped is within 10% of quantity ordered.

10. TFC's liability hereunder is expressly limited to repair or replacement of product, at TFC's facility, determined to be out of compliance with the agreed upon product specifications within one (1) year of delivery to Customer, provided TFC receives written notice of such non-compliance with such one (1) year period. Any claim for breach of these warranties shall conclusively be deemed to be waived unless written notice of such claim is given to TFC with thirty (30) days after the date on which the claimed defect is discovered.

These warranties shall be voided if the original buyer/transferee transfers ownership of the warranted product for use, unless TFC is notified in writing of the name and address, within fifteen (15) days after the date on which the transfer is made. This restriction on ownership transfer is not applicable if the original buyer is an authorized distributor of TFC.

These warranties shall not apply to any product which has been subjected to any misuse, neglect, accidental damage or that contains defects which are in any way attributable to improper storage, installation or to alterations or repairs made by any party no under the authority of TFC.

Continued...

WARRANTY AND STARDARD TERMS AND CONDITIONS OF SALE

TFC'S LIABILITY FOR ALL CLAIMS, WHETHER BASED ON BREACH OF CONTRACT, NEGLIGENCE, PRODUCT LIABILITY, OR OTHERWISE, RELATING TO THE PRODUCTS SHALL NOT EXCEED THE PRICE PAID BY CUSTOMER FOR THE PRODUCTS IN QUESTION, IN NO EVENT WILL SELLER BE LIABLE FOR ANY SPECIAL, INCIDENTAL, PUNITIVE, EXEMPLARY OR CONSEQUENTIAL DAMAGES (INCLUDING WITH LIMITATION, LOSS OF USE, LOSS OF PROFIT AND CLAIMS OF THIRD PARTIES), HOWSOEVER CAUSED, WHETHER BASED IN CONTRACT, TORT OR OTHERWISE.

TFC shall not be liable nor be in default for delays or inability to perform which are occasioned by causes beyond TFC's control. Cause beyond TFC's control may include, but are not limited to, Acts of God or of the public enemy, Acts of Government in its sovereign capacity, fires, floods, epidemics, quarantine restrictions, strikes, freight embargos and unusually severe weather.

Customers are reminded that they are solely responsible for confirming that all products are properly installed and used in accordance with all applicable laws, codes, and regulations.

11. THE WARRANTIES SET FORTH HEREIN ARE TFC'S SOLE AND EXCLUSIVE WARRANTIES. TFC DOES NOT ASSUME ANY WARRANTY OF MERCHANTABILITY, ANY WARRANTY OF FITNESS FOR ANY PARTICULAR PURPOSE OR ANY OTHER WARRANTY OF ANY KIND EXPRESSED, IMPLIED OR STATUTORY. TFC DOES NOT ASSUME OR AUTHORIZE ANY THIRD PARTY AGENT, OR EMPLOYEE OTHER THAN ITS PRESIDENT TO CHANGE THE TERMS OF THIS WARRANTY OR ASSUME FOR IT ANY OTHER LIABILITY OR OBLIGATION IN CONNECTION WITH THE SALE OR USE OF ITS PRODUCTS. THERE ARE NO ORAL AGREEMENTS OR WARRANTIES COLLATERAL TO OR AFFECTING THIS SALE.

12. Permission must be obtained from TFC before any materials are returned and shipments must bear our Return Authorization Number. Returend material without a Return Authorization Number will not be accepted. If the return of the material is made necessary through any fault of TFC's and permission is granted for its return, TFC will give full credit including all transportation charges. Permission to return material for any other reason may be granted at TFC's discretion. Such return will reflect a 15% restocking charge on the credit issued and TFC will not be responsible for transportation charges. All requests for return must be made in writing within 30 days from the date of invoice.

All returned material must be in first class, resalable condition. No used, damaged or out-of-date material will be accepted. If any such material is received, TFC reserves the option to return it at Customer's expense and risk or to deduct the sales price of the material from any credits which may be due to Customer. Products must be securely and carefully packaged so as to reach us in good condition. We reserve the right to deduct for any damage sustained in transit.

Transit damaged material must be signed for as damaged at the time of delivery, or TFC will assume no responsibility for issuing credit for transit damaged material.

Reels are non-returnable and no credit will be allowed if they are returned.

13. Customer will indemnify TFC for infringement claims or other claims resulting from TFC's compliance with Customer's designs, processes, formulas, or use of the products in a manner which causes them to become infringing or use of the products alone or in combination with other equipment where the use is the subject of the claim. Any charges that TFC becomes obligated to pay due to the above provision may be added to quoted prices in TFC's sole discretion.

14. If payment is not received by TFC within the agreed upon time frame a late charge of 1.5% per month (18% per annum), or the highest rate allowed by law, will be assessed on the unpaid balance and added to the total invoice due.

15. Any conficts or disputes shall be governed by and construed in accordance with the laws of the State of Connecticut, regardless of its conflict of laws provisions.

15. The possession of the Terms and Conditions Sheet or the applicable price sheet by any person or entity is not to be construed as an offer to sell that person the products listed at the prices stated.