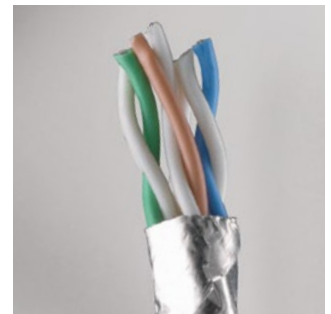
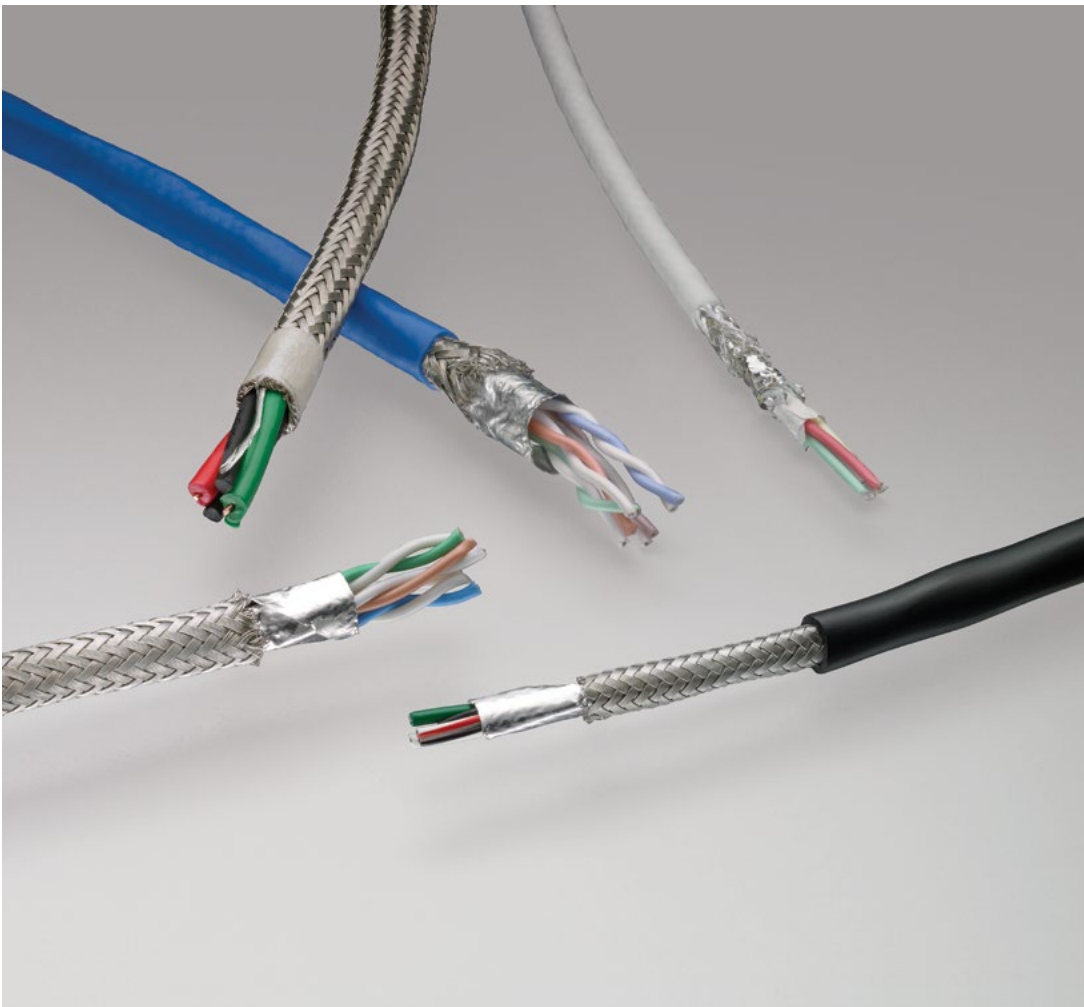


HIGH SPEED COPPER CABLES

Signal Integrity for High-Speed Protocols in Cables Designed to Withstand Harsh Environments



HIGH-SPEED COPPER CABLES

Signal Integrity for High-Speed Protocols

HIGH PERFORMANCE

- Increased bandwidth
- EMI protection
- Lightning protection

COMPACT AND RUGGED

- Ruggedized to survive in harsh environments
- Reduced size and weight

LOWER TOTAL INSTALLED COSTS

- Integrated solution
- Reduced engineering time
- Complexity reduction for straightforward installation
- Compatibility with numerous TE contacts and TE termination devices

VERSATILE

- Configurations for a wide range of protocols
- Custom solutions available

TE Connectivity (TE) offers a large and growing range of high-speed copper cables for high-speed protocols, such as Ethernet, IEEE 1394, Fiber Channel, and USB in commercial and military aerospace, ground systems, and marine applications.

TE's high-speed copper cable combine with TE's matched-impedance contacts and connectors can provide a total solution for higher performance and the signal integrity while maintaining robustness in today's Aerospace, Defense and Marine applications.

Our expansive research and development programs in material sciences are continually developing unique polymer solutions that will reduce weight and size while increasing robustness of our products.

APPLICATIONS

- **Military Aerospace:** Situational awareness systems (radar); weapons systems (missiles); communications (radio and intercoms)
- **Commercial Aerospace:** In-flight entertainment; glass cockpit; in-flight wireless
- **Military Ground Systems:** Glass dashboard; integrated computer system; remote weapons system; radio and intercom communications; situational awareness (thermal imaging, vision systems)
- **Smart Soldier Systems:** Live health monitoring; Real Time Soldier Movement; Portable computers

MATERIALS

- **Conductor:** Tin, silver, copper, high-strength alloys

ELECTRICAL

- **Impedance:** Matched impedance connectors and cables
 - 90-Ohm USB
 - 100-Ohm Gigabit Ethernet
 - 100-Ohm DVI
 - 110-Ohm IEEE 1394
 - 150-Ohm Fibre Channel
- **EMC:** Electromagnetic interferences protection

MECHANICAL

- Small size
- Lighter weight
- Reduced complexity

DESIGN FLEXIBILITY

- Custom design capability
- High product performance
- Optimum layout
- Rapid quotations
- Size and weight details



HIGH-SPEED COPPER CABLES

Materials Innovation for Superior Dielectrics

TE has designed a new process for extruding foamed FEP and other jacket materials with relatively uniform bubbles (void spaces) along the entire length of our cables. Such uniformity helps increase electrical performance and signal integrity while maintaining mechanical robustness.

Jacket Materials

Jacket Materials	Temperature Range (°C)	Abrasion Resistance	Flexibility	Typical Industry Use
Thermorad K (Modified PVDF)	-65 to +150	Very Good	Fair	Aerospace, Ground and Marine
Thermorad F & S	-55 to +125	Good	Good	Ground Systems
Modified FEP	-65 to +200	Good	Good	Aerospace
UXL-ETFE	-65 to +150	Good	Fair	Aerospace and Ground Systems
Thermorad HT (XL-ETFE)	-65 to +200	Very Good	Fair	Aerospace
Thermorad FL	-55 to +200	Very Good	Good	Aerospace
Zerohal	-30 to +105	Good	Good	Marine
FDR-25	-40 to +125	Fair	Excellent	Ground Systems
Low Fluoride XL-ETFE	-65 to +200	Very Good	Fair	Aerospace
Laser Markable FEP	-65 to +200	Good	Good	Aerospace
Thermorad NTFR	-55 to +110	Good	Excellent	Ground Systems and Marine
Raythane FR	-65 to +90	Excellent	Excellent	Marine
Thermorad O	-55 to +125	Good	Good	Ground Systems and Marine

Compatible Products

A small sampling of TE connectors and contacts that are compatible is shown below. Consult TE for additional information.



CeeLok FAS-T Connector



Molded Shapes



Tinel Rings



SolderSleeve Termination Devices



CeeLok FAS-X Connectors



EN4165 Connectors

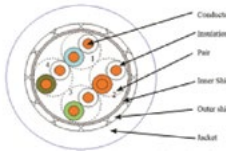


Quadrax Contacts



Twinax Contacts

HIGH-SPEED COPPER CABLES



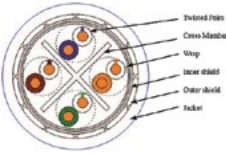
Cat5e Ethernet

Features

- Lightweight, rugged, Gigabit Ethernet cables for reliable 100Mb/s and Gigabit Ethernet data transmission
- Easier to terminate when compared to tape-wrapped designs
- Waterblock capability
- Harness component system compatibility

Markets: Marine, Ground Systems, Military and Commercial Aerospace
Applications: Shipboard, Satellite, Missiles, Weapons Systems, Avionic Systems, IFE

Data Rate: 100 Mb/s to 1Gb/s
Gage Size: 24 AWG
Temperature Range: -65°C to +200°C
Standard Impedance (Nom): 100 Ω



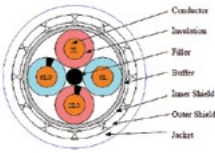
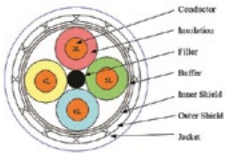
Cat6a Ethernet

Features

- Fully shielded, four-pair cables meeting electrical requirements, while the cables FEP insulation and jacket allow a reduced-diameter when compared to standard Cat6a cables
- Easier to terminate when compared to tape-wrapped designs
- Compatible with most TE CeeLok FAS-T and CeeLok FAS-X connectors
- Pending AS6070/6 [Mil-Spec]

Markets: Marine, Ground Systems, Military and Commercial Aerospace
Applications: IFE, Flight Control, Avionics, Cabin Management Systems, Formula 1 Motorsport, Weapons Systems

Data Rate: 10 Gb/s
Gage Size: 24 and 26 AWG
Temperature Range: -65°C to +200°C
Standard Impedance (Nom): 100 Ω



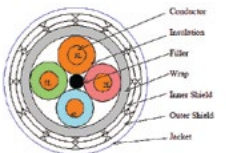
100Base-T Quad Ethernet

Features

- Cable protocol which consists of an outer contact with four defined spaced inner contacts forming a matched impedance, differential pair
- Smaller size and weight than a Cat5e cable
- Tight bend radius

Markets: Marine, Ground Systems, Military and Commercial Aerospace
Applications: IFE, Galley Systems, Radar, Missile Warning Systems, Radio Communication, Smart Weapons, Formula 1 Motorsport

Data Rate: 100 Mb/s
Gage Size: 24 and 26 AWG
Temperature Range: -65°C to +200°C
Standard Impedance (Nom): 100 Ω



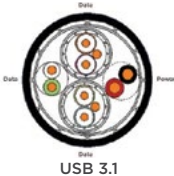
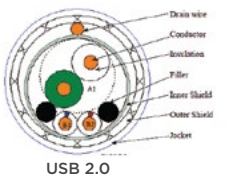
IEEE 1394 (FireWire)

Features

- Offers flexibility in routing through space-constrained environments.
- Standard configurations use a double braid to achieve excellent signal integrity (EMI Protection)

Markets: Ground Systems, Military and Commercial Aerospace
Applications: Mission Systems, Flight Control, Propulsion Control, Avionics,

Data Rate: 100 Mb/s to 3.2 Gb/s
Gage Size: 22 to 26 AWG
Temperature Range: -65°C to +200°C
Standard Impedance (Nom): 110 Ω



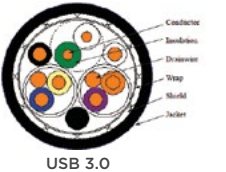
USB 2.0, USB 3.0 and 3.1

Features

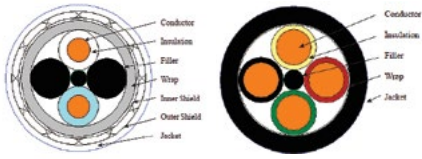
- External bus which supports data rates up to 480Mb/s for USB 2.0, 5 Gb/s for USB 3.0, and 10 Gb/s (USB 3.1)
- Custom Designs Available

Markets: Marine, Ground Systems, Military and Commercial Aerospace
Applications: Radar, Avionics, IFE, Glass Cockpit

Data Rate: Up to 480 Mb/s (USB 2.0), 5Gb/s (USB 3.0), and 10 Gb/s (USB 3.1)
Gage Size: 22 to 28 AWG
Temperature Range: -65°C to +200°C
Standard Impedance (Nom): 90 Ω



HIGH-SPEED COPPER CABLES



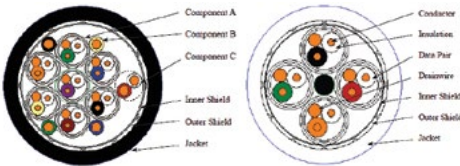
CANbus

Features

- Provides wide range of AWG availability for signals needed at 1Mb/s
- Easier to terminate when compared to tape-wrapped designs
- Designs that meet J1939 requirements

Markets: Marine, Ground Systems, Military and Commercial Aerospace
Applications: Radar, Missiles, Avionic Systems, Modern Soldier Equipment, IFE

Data Rate: Up to 480 Mb/s
Gage Size: 18 to 26 AWG
Temperature Range: -65°C to +200°C
Standard Impedance (Nom): 120 Ω



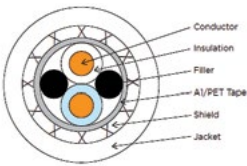
Digital Video Interface (DVI)

Features

- Primarily used for video displays and uni-directional data transfer
- HD Video Coaxial Cables Available
- Custom designs available

Markets: Marine (contact for drawing), Ground Systems, Military and Commercial Aerospace (contact for drawing)
Applications: Video Displays, Video Systems

Data Rate: 3.96 Gb/s to 7.92 Gb/s
Gage Size: 24 to 28 AWG
Temperature Range: -65°C to +200°C
Standard Impedance (Nom): 100 Ω



Single Pair Ethernet (SPE)

369 Series Shielded Connectors

- 100Base-T1 standard
- 15 m link with four connector breaks
- Reduces termination complexity
- (369) 2-5 minutes vs. (Quadrax) 6-10 minutes

Molded Parts

- Molded part shape designed specifically for use with 369 connector and Single-Pair Ethernet cable
- Flexible polyolefin (-4) material provides strain relief, environmental sealing, and abrasion resistance
- High temperature adhesive (/86) for bonding with cable jacket or heat shrink tubing
- Low profile desing and 2:1 heat shrink ratio for ease of installation



Shield Types

Shield Type	Standard	Optimized	M24640 or M24643 Optimized
Braid or Spiral			
Braid	1	K	V
Flat braid	2		
Braid + braid	3	L	W
Flat braid + braid	4		
Spiral shield	5		
Foil			
Al/PET	6		
Al/PET + drain wire under wrap	7		
Al/PET + drain wire under braid	G	H	
Other			
Braid + PET wrap + braid	E	P	
Braid + PET wrap + PET wrap + braid	F	Q	
Braid + mumetal + braid		R	

Shield Type	Standard	Optimized	M24640 or M24643 Optimized
Foil and Braid			
Al/PET under braid	8	M	Y
Al/PET over braid	J		
Al/PET/al under braid	9		
Al/PET/al over braid	A		
Al/polyimide under braid	B		
Foil and Double Braid			
Al/PET + braid + braid	C	N	
Al/PET + braid + PET + braid		T	
Al/polyimide + braid + braid	D		
Unshielded			
No shield or foil wrap	U		

HIGH-SPEED COPPER CABLES

HSC - PART NUMBERING SYSTEM High-Speed Copper

Example:

C5E - 26 B 1 2 4 - 7 1 4 * - 9X

Variation Code (3-characters):

3EA IEEE1394a	C7A CAT7a	DVI DVI	TGX 1000B-T Quad
3EB IEEE1394b	C7E CAT7e	FBC Fiber Channel	THX 100B-T Quad
3EQ IEEE1394b Quad	C7X CAT7	HDM HDMI	UB2 USB 2.0
C5E CAT5e	CBS Canbus	LVD LVD	UB3 USB 3.0
C6A CAT6a	DSP Display Port	SPW Space Wire	U31 USB 3.1
C6X CAT6			

Conductor AWG Size (Data Pair):

Conductor Stranding (Data Pair):

A Solid	C 19 Strand	E Rope Lay
B 7 Strand	D 37 Strand	F High-Strand Count

Conductor Material (Data Pair):

1 Tin-coated copper	A Silver-coated ultra high-strength copper alloy
2 Silver-coated copper	E Silver-coated high-strength copper alloy (80-microinch min, ESA compliant)
3 Nickel-coated copper	N Silver-coated high-strength copper alloy (non-RoHS)
4 Silver-coated high-strength copper alloy	
6 Nickel-coated high-strength copper alloy	
9 Bare copper	
0 Other	

Dielectric Material (Data Pair):

1 Rayfoam L (or Foamed XLPE)	4 Modified FEP	8 Rayfoam FS
2 Rayfoam H (or Foamed FEP)	5 UXL-ETFE	9 Rayfoam HS
3 * Rayolin F (or XL-LDPE), or Rayolin L (or XL-HDPE)	6 XL-ETFE	0 Other
	7 Flexible XL-ETFE	L Low Fluoride XL-ETFE

Number of Data Pairs:

1 - 10 (designator for 10 pairs = 0)

Construction (P-Line = Power Line):

- Standard	C 24 AWG (P-Line)	F 18 AWG (P-Line)	W Waterblocked
A 28 AWG (P-Line)	D 22 AWG (P-Line)	G 16 AWG (P-Line)	X *Special construction
B 26 AWG (P-Line)	E 20 AWG (P-Line)	S Space rated	

Shield Type:

See page 2.

Shield Material (each, when more than one shield):

1 Tin-coated copper	4 Silver-coated high-strength copper alloy
2 Silver-coated copper	6 Nickel-coated high-strength copper alloy
3 Nickel-coated copper	U Unshielded

Jacket Material (each, when more than one jacket):

1 Thermorad K	8 Zerohal	L Low Fluoride XL-ETFE
3 Thermorad F or S	9 None	M Laser Markable FEP
4 Modified FEP	0 Other	N Thermorad NTFR
5 UXL-ETFE	C Zerohal SHF1	R Raythane FR
6 Thermorad HT	D Zerohal SHF2	T Thermorad O
7 Thermorad FL	F FDR-25	W PET wrap

* Sequential Alpha Code for Dielectric Material "3" and Special Construction "X":

A sequential alpha code (A-Z, excluding I and O) shall be used only for Dielectric Material code "3" and /or Special Construction code "X" to allow for multiple special constructions.

Outer Jacket Color (code per MIL-STD-681, except as noted):

(For translucent colors, an "X" is added to the end of the color.)

Example: 9X = Translucent White)

0 Black	3 Orange	6 Blue	9 White
1 Brown	4 Yellow	7 Violet	X Clear
2 Red	5 Green	8 Gray	

Rayfoam, Rayolin, Raythane, Thermorad, and Zerohal are trademarks.

HIGH-SPEED COPPER CABLES

HSC - PART NUMBERING SYSTEM High-Speed Copper

Example:

C5E - 26 B 1 2 4 : 7 1 4 * - 9X

Shield Type	Standard	Optimized	M24640 or M24643 Optimized
Round braid	1	K	V
Flat braid	2		
Round braid + round braid	3	L	W
Flat braid + round braid	4		
Spiral shield	5		
Aluminum/PET	6		
Aluminum/PET + drain wire under wrap	7		
Aluminum/PET + drain wire under round braid	G	H	
Aluminum/PET under round braid	8	M	Y
Aluminum/PET over round braid	J		
Aluminum/PET/aluminum under round braid	9		
Aluminum/PET/aluminum over round braid	A		
Aluminum/polyimide under round braid	B		
Aluminum/polyimide + drain wire under round braid	S		
Aluminum/PET + round braid + round braid	C	N	
Aluminum/PET + round braid + PET + round braid		T	
Aluminum/polyimide + round braid + round braid	D		
Round braid + PET wrap + round braid	E	P	
Round braid + PET wrap + PET wrap + round braid	F	Q	
Round braid + mumetal + round braid		R	
Round braid + drain wire + round braid	Z		
No shield or foil wrap	U		

Connect With Us

We make it easy to connect with our experts and are ready to provide all the support you need. Visit te.com/support to chat with a Product Information Specialist.

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