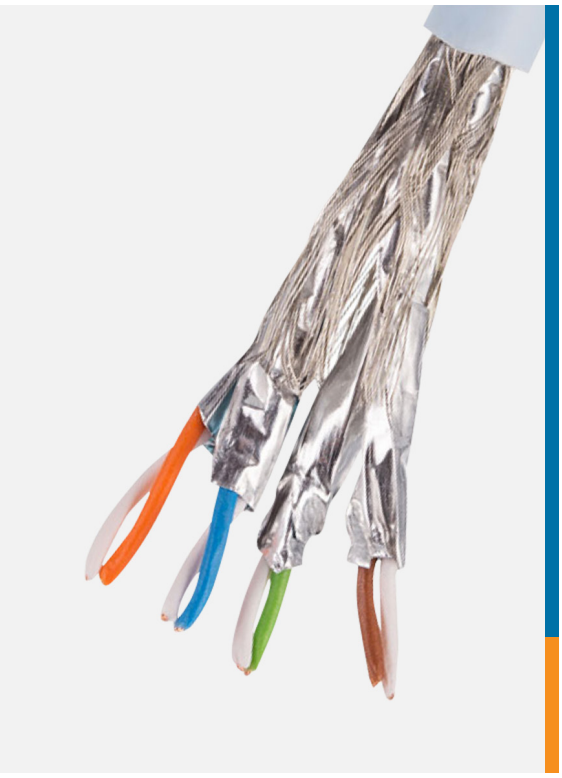


TE CONNECTIVITY HIGH SPEED RAIL DATA CABLES

High Speed Copper Cables in the Rail Environment

THE NEEDS OF THE RAIL ENVIRONMENT

TE Connectivity has worked with the Rail industry in pursuit of greater operational efficiency, to satisfy the desire to be connected to the outside world, regardless of time or place. This desire coupled with the need to produce ruggedised cables capable of resisting contamination from common fluids and providing Limited Fire Hazard properties to ensure passenger safety in case of a fire on board can only be satisfied through the use of cutting edge technology.

In public transport as well as Rail operators, manufacturers are equipping their latest generations of passenger trains, metros and trams with a wide range of products to provide their passengers with a high level of connectivity with maximum safety and the best possible service. Distributing the increased data volumes across the train represents the biggest challenge to operators of modern rolling stock.

The answer lies in establishing new generations of train communication networks based on Internet technology.

APPLICATIONS:

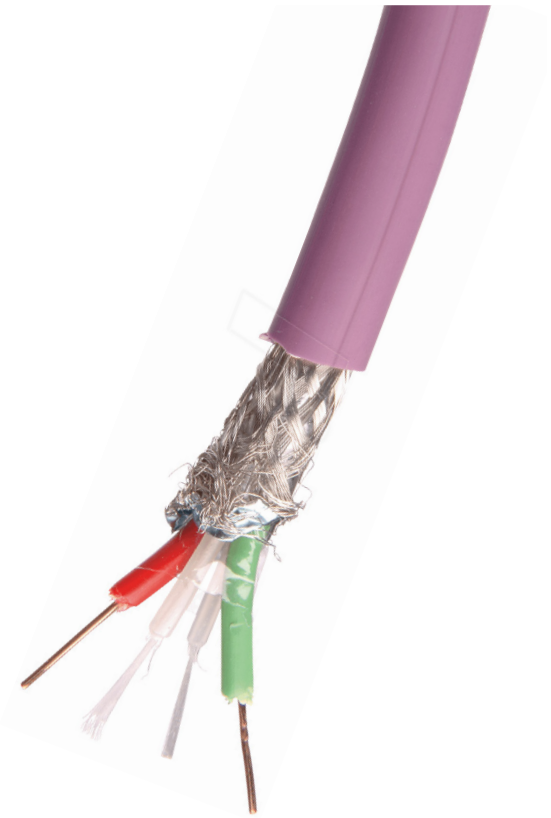
- **Passenger Information:** Itinery of Shedule, Annoucements, Destination Information & Entertainment
- **Internet access:** News, Games, Video, Music & Advertising
- **Train Opreating Systems:** On Board Ticketing, Passenger Counting, Automated Logistics & Train location
- **Staff information Systems:** Fault Reporting, Data Collection, Intranet Access & Diagostics On Train Monitoring & Recording, CCTV, HVAC,
- **Broadband Data Transmission**

Profibus

THE ORIGION OF DATA TRANSMISSION IN RAILWAYS

It has been understood for many years that twisting wires together enables the currents to balance, i.e in one wire the current is moving in one direction, and int he other wire of the pair the current is going in the other, enabling the overall fields around the twisted pair to cancel offering a level of imunity to external electrical interference

Profibus was the first protocol to embrace the need digitise the transfer of information between Rail devices on twisted pairs, the first use of Profibus started in the late 1980's and due to the reduced technology in recovery of data at that time the cable impedance was set as 120 Ohms to reduce the capacitive loading of the cabling system.



The datarate of Profibus was very limited to a low number of Kbps but paved the way to the ethernet System that was lauched around 10 years later and eventually increased the datarates to more than 1,000 times the Profinet capacity.

Today new systems would not be engineered using Profibus networks but there is still a demand generated by maintenance and repair and build to print of older technology devices.

In order to meet this demand TE Connectivity still provides a broad portfolio of Profibus constructions using modern technology insulation systems, providing total electrical compatibility with existing devices and applications but providing significant upgrades in performance and safety, whilst still providing the interconnectivity requirements of the original system design.

ETHERNET CABLE BASICS IEEE 802.3

All cables are defined by their category number which is measure of their electrical performance only all other considerations need to be addressed seperately:

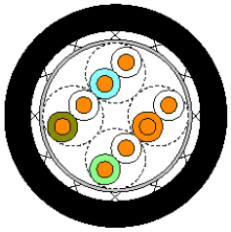
The electrical requirements are are a given and specified in the IEEE spec to ensure the systems function and interface with each other, but other serious issues such as Fire Hazard, mechanical toughness, Fluid resistance High and Low temperature performance, handling and termination and in general suitability for the environment of the application have to be addressed before deciding on the cable to choose.

The superior knowledge of Polymer Chemistry and Radiation Crosslinking positions TE Connectivity in a position of supplying reliable and high performance products for these applications along with more than 60 years of experience of the manufacturing of high performance cables

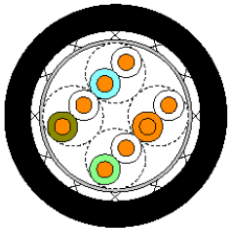
High Speed Rail Data Cables

DATA RATES HAVE INCREASED SIGNIFICANTLY DUE TO ETHERNET

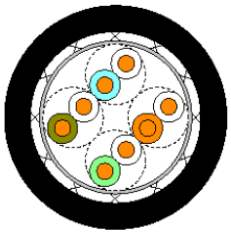
Cat 5e: Bandwidth of 100Mbps over a distance of 100m and intended for transmission of dataspeeds of up to 1Gbps available in 4 pair confuguration. Cat 5e is also available in Quad format (2 pair) but only delivers about half the datarate. Cat5e is the simplest Ethernet cable construction but with a relatively low level of screening and and datarate



Cat 6: Bandwidth of 250Mbps over a distance of 100m and intended for transmission of dataspeeds of up to 10Gbps only available in 4 pair construction, relatively low level of screening and the simplest cable to cope with dataspeeds of 10Gbps



Cat 7: Bandwidth of 600Mbps over a distance of 100m and intended for transmission of dataspeeds of up to 10Gbps only available in 4 pair construction but with additional shielding against external interference/crosstalk and with more than double the Bandwidth providing better signal quality especially over longer cable runs



CHOOSING THE RIGHT ETHERNET CABLES: WHAT TO LOOK FOR

It is important to select the right Ethernet cable to ensure the best performance is obtained for the application now and through the life of the installation: Cat 5e, Cat 6 Cat 7 what is the best choice?

It is important to choose the right cable, underspecify and the performance and future proofing will be impaired, over specify and there may be some cost implications

Some areas for consideration:

- **Data Rate:** The different catagories in Ethernet offer different data rates and the demand for ever higher rates of data transfer in Rail should be a primary considration when chosing the correct cable. If a relatively low speed cable is chosen it may have the bandwith to support the datarate required in the initial design but will offer very little future proofing as the demand for data increases with time. The primary choice should be Cat 7 unless some aspect of the cable construction procludes its use
- **Stranded Conductor Cable:** This type of wire has a higher flexural endurance and it is more applicable to the Rolling Stock Rail environment for Ethernet cables where the cable may be subjected to vibration and movement. In this environment solid conductor cables would probably work harden and fracture in a relatively short period of time making the choice of stranded conductors essential
- **Solid Conductor Cable:** Solid conductor cable do not have the flexural endurance as the stranded type cables so are generally only suitable for use in permanent static installations. Applications on Rolling Stock are uncommon and tend to be limited to stations and other fixed structures.
- **Choice of Dielectric materials:** In terms of Limited Fire Hazard Cables there are only two Choices of Dielectric materials PE/ Foamed PE. TE Connectivity is able to produce both types but favours the foamed Dielectric because it reduces the overall size of the cable and minimises the amount of flammable material reducing Smoke/ Toxicity and Flammability

- **Shielding:** Cat5e and Cat 6 cables only have one shield against the external environment, the twisting of the pairs offers some additional protection but depends on the receiving device being able to reject the electrical interference being carried on the conductors of the pairs. Cat 7 has additional shields, a foil wrap over each pair, this foil wrap has two functions to reduce the pair/pair crosstalk and to add one extra level of shielding from external electrical interference. This higher shielding level means that the cable is more likely to work first time but offers a level of future proofing against changes in the architecture of the installation where an additional source of interference may be introduced in proximity to the cable
- **Fire Hazard:** Whilst Fire Hazard is not addressed in the IEEE specification safety is a major concern for any installation. The key specification written to control fire hazard in the Railway industry is EN 45545-2 R15/R16 – Hazard Level 3 these requirements should be applied to any Ethernet cables destined for Rail applications
- **Environmental Compatibility:** Data transmission is the primary role for Ethernet cables but it is necessary to ensure that the cable will function for the lifetime of the vehicle and not fail due to a lack of capability in some aspect of environmental performance. This is a consideration mainly for the cable jacket. In the CENELEC specs written for wires and cables the key requirement for cable jackets is covered by EM-104 this should be used to describe the minimum performance of any cable used in Rail applications

DATA CABLE FAMILIY;

TE Connectivity (TE) has a complete portfolio of Rail data cables ranging from high speed CAT 7 4 pair, CAT 5 quad to 120 ohm, profibus cables

All cables jackets are Halogen-free, flame-retardant meeting EN45545-2 HL 3

On most designs TE offers both a standard cable jacket to EN45545-2, and a cross-linked ruggadizied version to EM-104 also available

TE not only has a large list of standard parts but can also has the design capabilities to create custom designs to meet individual customer requirements

TE CONNECTIVITY KEY CORE COMPETANCIES FOR DATA CABLE

- Industry Leaders in the Polymer Chemistry of insulation materials for the Cable Industry
- Industry Leaders in Electron Beam Crosslinking
- Compliant to modern Fire Hazard Specifications such as EN45545-2
- Excellent balance of properties for the Rail industry – Compliant with EM 104 Sheath Materials
- Developed and tested for rolling stock applications
- Excellent mechanical properties
- High resistance to Weathering, Heat & Cold Flexing

te.com/rail

TE Connectivity Ltd. is a $14 billion global technology and manufacturing leader creating a safer, sustainable, productive, and connected future. For more than 75 years, our connectivity and sensor solutions, proven in the harshest environments, have enabled advancements in transportation, industrial applications, medical technology, energy, data communications, and the home. With 80,000 employees, including more than 8,000 engineers, working alongside customers in approximately 140 countries, TE ensures that EVERY CONNECTION COUNTS. Learn more at www.te.com and on LinkedIn, Facebook, WeChat and Twitter.

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