

HIGH-VOLTAGE COMPONENTS:

Tailored for reliable power delivery

Why every application calls for unique high-voltage components and how TE Connectivity offers the ideal industry-leading solutions



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AS A TECHNOLOGY LEADER, TE CONNECTIVITY DESIGNS AND MANUFACTURES THE ELECTRONIC AND ELECTRICAL CONNECTORS, COMPONENTS AND SYSTEMS INSIDE PRODUCTS THAT ARE CHANGING THE WORLD, MAKING THEM SMARTER, SAFER, GREENER AND BETTER CONNECTED. IN THE WORLD OF RAIL, TE CONNECTIVITY DELIVERS THE BROADEST PORTFOLIO AND SYSTEMS EXPERTISE REQUIRED TO CONNECT POWER AND DATA SAFELY AND RELIABLY, FROM THE HIGH-VOLTAGE SUPPLY AND ON THROUGHOUT THE ENTIRE TRAIN.

Elizabeth da Silva, TE Connectivity's High Voltage Development Engineering Manager, explores why the components that carry the 25 kV power supply from the catenary lines to the traction transformer must be unique for every rail application. She goes on to describe how TE Connectivity is able to manufacture insulating bushings that meet the rail industry's most exacting environmental conditions.

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CONNECTING TRAINS TO POWER SUPPLIES

TE Connectivity supplies the specialist high-voltage roofline products that provide the vital electrical connection between the overhead catenary wires and the traction transformers that supply the power on board rolling stock. The systems include the switchgear that controls the flow of power, surge arrestors to limit damaging over-voltages and high voltage cable assemblies that provide a safe and reliable connection between the roofline system and the train traction transformer. Electric trains would be unable to operate without these high-voltage components, so they are essential to efficient and environmentally friendly transport.

In playing this vital role, roofline systems are subject to conditions experienced by few high-voltage components in other industries. Environmental operation conditions include high speed air flow, rapid changes in air pressure and temperature, driven rain etc, which can disrupt the reliable operation of electrical systems on the roof of a train, these environmental factors are combined with the mechanical shock and vibration of train travel.

THE IMPLICATIONS OF FAILURE

Any failure of train roofline equipment can potentially have service disruptions and have reactive consequences. Loss of power to a train on an isolated track in a remote and inhospitable area could leave passengers stranded and potentially at risk. Alternatively, a peak rush hour service that loses power at a key location can hold back an entire schedule, with a knock-on impact on services throughout the day and across an entire network.

The impact on rail operations and fare-paying passengers can be significant, as can reaction from political stakeholders and the media. On long distance services, rescue by a shunting locomotive may take longer than two hours. Failure of a busy commuter service might cause other services to back up along the line, causing delays to thousands of passengers. A tram service on the other hand wouldn't necessarily suffer the same level of disruption.

HIGH-VOLTAGE ROOFLINE SYSTEMS

Electrical power is supplied to trains via an overhead catenary line at high-voltage. On board the train, a roofline system provides the control and connections that ensure the safe transfer of this high-voltage power to the traction transformer inside the train.

Typically, roofline systems include the pantograph that links the train to the catenary line, as well as a surge arrestor, circuit breaker, and an insulated bushing that protects and insulates the high-voltage line as it passes through the carriage roof and the down-lead that feeds into the traction transformer. The transformer then steps the voltage down to power the traction motors and other on-board loads such as heating, lighting and train control system.

TE Connectivity supplies specialist high-voltage insulators that support the pantograph, busbar or other equipment, circuit breakers, inter-car jumper cables and high voltage cable assemblies that include the bushings and insulated power cables that pass the conductor through the train roof and train interior to the traction transformer that is typically located under the train car.

WHY EVERY APPLICATION IS UNIQUE

Rail systems operate in a wide range of climate and environmental conditions. Customers in Saudi Arabia and Belarus might order the same platform - but their operating environment will be very different. Some trains might experience scorching heat at midday whereas others will routinely operate in sub zero conditions.

Although train builders create basic platforms that are designed to operate in a wide range of conditions, they amend the detailed design for every application and require components designed for the rigours of their specific operating environment.

CHALLENGES FOR HIGH-VOLTAGE COMPONENTS IN RAIL

The 25 kV roofline connectors are often considered late in the design process. And they are typically sized to handle the required current, it's easy to overlook the fact that, like the mechanical systems, the electrical systems also need to be designed for their operating environment.

A major source of failure in high-voltage roofline systems is through flashover, or the short circuit that is caused when the current jumps through the layer of insulating air between the electrical conductor and the roof of the train.

Flashover happens when an electric field (measured in kV per millimetre) is too strong for an insulator to withstand. Every insulator has a withstand limit that can be reduced by extremes of environmental conditions, particularly high and sustained levels of humidity and pollution, that may reduce also low temperatures at high altitudes also create vulnerabilities to reduced performance.

The build-up of pollutants on the surface on insulators will reduce their performance over time under wet conditions-, increasing their potential for failure, this can be compensated by increasing their physical clearance or electrical creepage length in a smart way.

And while high voltage products borrow elements of their design from the utility industry, components on trains are also subject to shock and vibration loads that are not experienced in static power distribution installations and design of equipment for rolling stock applications must take this into consideration.

TAILORED SOLUTIONS

Only by understanding in detail its customers' operating environments can TE Connectivity supply high voltage components that will work reliably. That's why we do not offer high-voltage products for the rail industry on an off-the-shelf basis. Instead, we work with customers on a case-by-case business and ask for detailed information about the planned operation of the train and environment, the end user operator.

This forms the basis of products designed to meet the demands of the unique application, ensuring a reliable HV power supply even the worst case scenario of high humidity, pollution and altitude that the train may experience.

MARKET-LEADING PRODUCTS

The rapid proliferation of electric railway systems has led to a corresponding growth in failures on roofline systems, leading to a loss of power on rail services. Rail operating companies now demand high-voltage systems that are more reliable than ever before.

TE Connectivity's high-voltage insulators and bushings are created using insulated materials developed and manufactured in-house. The firm's long history of developing and manufacturing insulating polymers dates back to the 1950s when it developed the first cross-linked Polyethylene under the Raychem trade name.

Today, TE Connectivity manufactures the longest bushings and insulators on the market. At 500 mm long, they give the advantage of better insulating performance, which means that a high-voltage system based on these components is able to perform in the most demanding conditions possible.

Manufactured from a TE Connectivity formulation based on ethanyl vinyl acetate (EVA), the insulators have proven ability to perform reliable in the most adverse conditions experienced on board high-speed trains, and the latest polymer is on track to meet new European standards for fire safety performance that will come into force in 2016.

TE Connectivity's objective is to be more than just a supplier of components. By working closely in collaboration with its customers' engineering teams, TE Connectivity will evaluate the technical aspects of the application



ABOUT THE AUTHORS

Elizabeth Da Silva Domingues is TE Connectivity's High Voltage Development Engineering manager and is responsible for high voltage roofline systems. She holds a doctorate in electrical and electronic engineering from the University of Manchester and is a Senior Member of the Institute of Electrical and Electronics Engineers. Originally from Caracas, Venezuela, has led multiple research projects in medium and high voltage systems within academia, government and industry and has also worked as a consultant for utilities, oil companies and manufacturing industries. She had published more than 50 technical papers on HV insulation in journals and conferences.

HISTORY OF TE CONNECTIVITY

TE Connectivity is a technology leader that designs and manufactures the electronic connectors, components and systems inside the products that are changing the world - making them smarter, safer, greener and more connected.

It is a leading supplier of high-voltage components to the rail industry that deliver proven longevity and performance in diverse and harsh environments. TE Connectivity's unique knowledge of materials science positions it at the forefront in developing the insulation materials that perform the essential task of insulating line power from the train structure.

Its legacy dates back to the 1950s when Raychem, which has since joined the TE Connectivity group, first used the technique of radiation chemistry to develop products. Since then, the firm has undergone a number of changes of name and structure. These include the name of Tyco Electronics, which the firm bore until March 2011 when it took the name TE Connectivity to reflect its role as a component and communications manufacturer.



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