nVent | SCHROFF

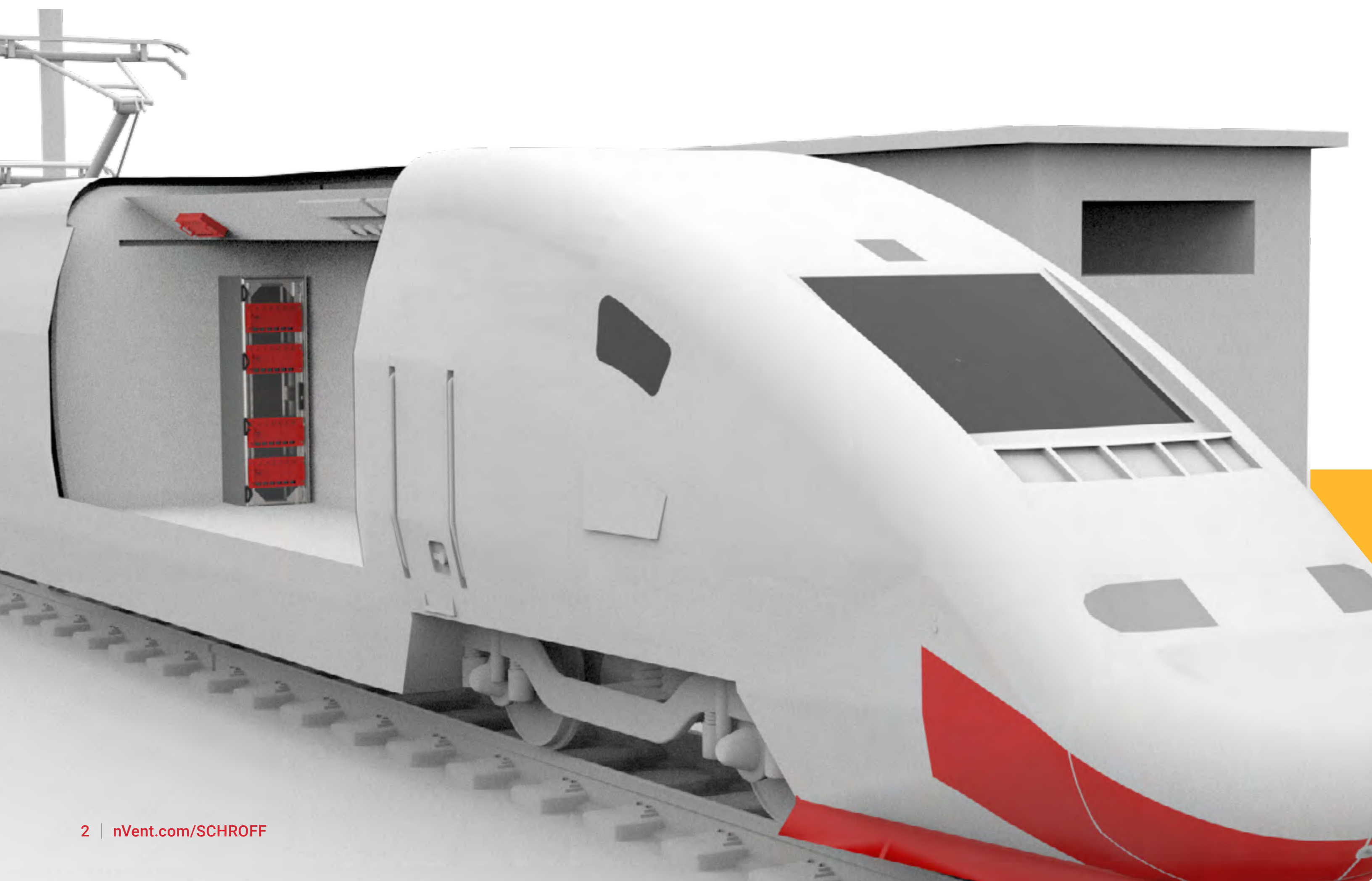
We connect and protect

Advanced Electromagnetic Shielding for 5G Technologies

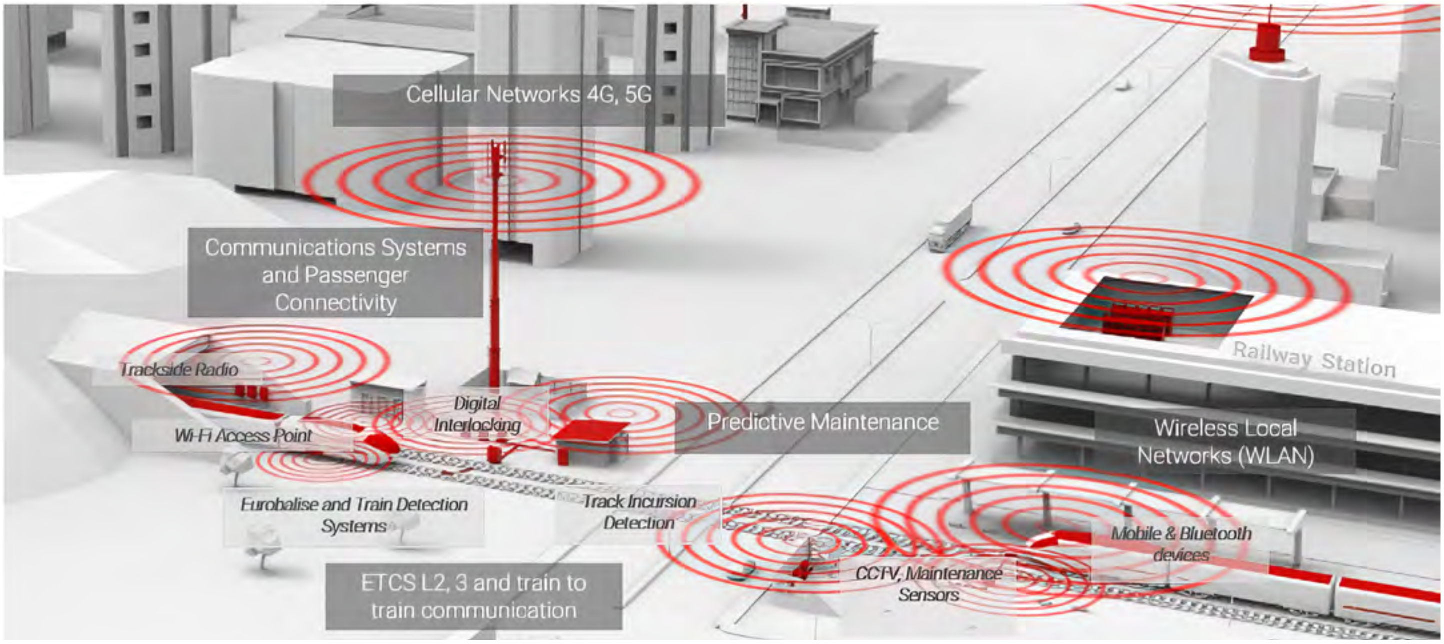
How **NEW CYBERSECURE DESIGNS** of shielded enclosures can increase EMI protection for today's railways and ensure readiness for tomorrow

Tightening fiscal budgets means that railways must become more resilient to operate effectively and successfully in the future, delivering greater capacity and reducing downtime triggered by maintenance.

Digitalization is key to achieving the flexibility and efficiency that railways require, but it also presents a challenge to rail owners, operators and infrastructure managers in terms of how they manage the electromagnetic emissions and immunity of their digital systems. In this white paper, we examine how technology advancements such as electromagnetic compatible (EMC) subracks from nVent SCHROFF can help increase the resilience of today's railways.



The growing challenge posed by EMI



Electromagnetic interference (EMI) is an ongoing threat to railway signaling systems. Rail vehicles contain complex electronic systems that are sensitive to EMI, and the rise of digital rail, wireless communication, IoT devices and embedded microelectronics in rolling stock has only added to the challenge. Such technologies require robust EMI protection to ensure they function properly.

The responsibility for managing such risks often lies with suppliers that provide components for trains or infrastructure. Such suppliers must have both a holistic understanding of EMI and the risks inherent in rail deployments. 5G telecommunications, for example, might require frequencies up to 40 GHz in the medium term, and up to 100 GHz in the long run, which could inadvertently interfere with railway signaling systems. There's also the increasing complexity of train control systems to consider, along with the potential impact of nascent innovations such as edge computing and predictive maintenance technology.

Standards for radio or electrical interference, too, are set to evolve in line with threats. At present, the European standard for rolling stock is EN 50155, which references EN 50121-3-2. Ultimately, EN 50121-3-2 further refers to the EN 61000-5-7 standard, encompassing performance, testing, measurement techniques and levels of protection against electromagnetic disturbances up to 40 GHz. Understanding these standards, how to comply with them, and how they will evolve in the future is also a must for components suppliers.

EN 50155

Covers electronic equipment used in railway rolling stock. Equivalent to the international IEC 60571, it covers aspects such as temperature, humidity, shock and vibration

EN 50121-3-2

Specific standard covering electromagnetic compatibility for rolling stock components

EN 61000-5-7

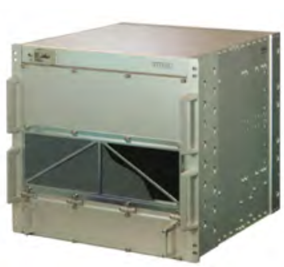
A testing standard setting out performance requirements for degrees of protection by empty enclosures against electromagnetic disturbances

Ready to Support Urban Connectivity, Advanced Networks and AI

Cities of the future will require massive amounts of data acquisition and transfer. Super networks will support advanced communications and AI enabled applications. The EMI challenges that rail suppliers will face in years to come can already be seen in other industries, where – for example – higher data processing rates and frequencies are driving the tighter application of EMC regulations and standards.

The decentralization of high-power electronics is a driving force behind convergence in the rail industry, enabling the digitalization of operations and infrastructure management. This is evident in the increasing presence of safety-critical signaling and train control equipment in wayside shelters and onboard vehicles, supporting systems like CBTC and ETCS. Similarly, in infrastructure, adopting IoT technology and edge computing for condition monitoring necessitates electronic components at the lineside. As a result, there will be a greater need for investment in physical and cyber protection to safeguard these emerging innovations.

In aerospace and defense, interference prevention tasks being undertaken in areas such as naval radar or mobile defense equipment could also be transferred to rail. nVent SCHROFF already offers a ruggedized AC/DC single output power supply unit and a DC/DC converter board that minimizes interference for optimum cybersecurity. nVent SCHROFF VPX systems are typically used on naval ships, integrated into MIL cabinets as part of the radar system or in mobile defense and surveillance systems. These systems use two levels of shielding around the cards and a honeycomb air intake filter that minimizes interference, making it more difficult to intercept signals.



"nVent SCHROFF VPX systems are typically used on naval ships, integrated into MIL cabinets, as part of the radar system or in mobile defence and surveillance systems. These VPX systems utilize two levels of shielding around the cards internally and a honeycomb air intake filter that minimises interference, making it more difficult to intercept signals"

Emerging technology in fields such as quantum computing and data acquisition for autonomous cars could soon be used to support predictive maintenance applications in rail. However, these systems require racks and enclosures that have a strong mechanical focus on EMC protection within the chassis, offering extensive shielding to prevent interference with test data and clock modules.

"Mechanical shielding of PSU and card cage are required in test and measurement applications so that clock modules and test data are not negatively influenced. nVent SCHROFF's PXI systems incorporate this type of EMI design."

Emerging MTCA and ATCA applications have been deployed to control beam arrays in particle accelerators and security systems with multiple high-resolution cameras. Data acquisition in particle accelerator research is particularly challenging given the huge quantities to be captured and processed in a short timeframe. Here, edge servers for local processing and data transmission can help — nVent SCHROFF's ATCA 450/100 Series, for example, has been EMC tested up to 40 GHz.

"nVent SCHROFF's ATCA system EMC performance has been tested up to 40 GHz for telecommunications applications and the design focuses on minimising overall interference sensitivity and emission, including an additional mesh layer beneath the cards for added protection."

How to minimize the risks of EMI

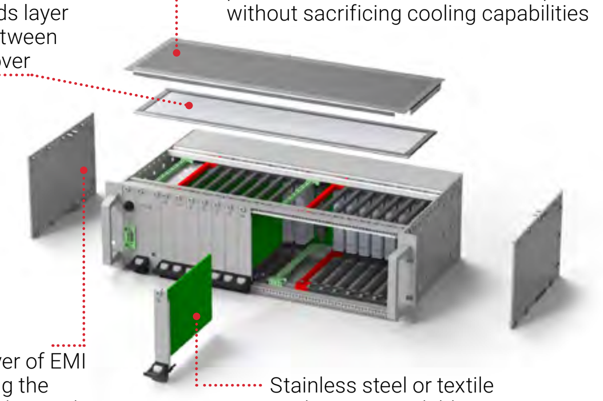
A component's design is arguably the most critical factor in realizing successful EMI protection — particularly in applications where EMC concerns grow as the frequency increases.

Test data from an independent, third-party lab recently revealed that a new EMC subrack design from nVent SCHROFF improves EMI shielding by up to 160% at 40 gHz. How does it achieve such performance?

When developing the EMC subrack, nVent SCHROFF considered how the number and size of perforations or air vents in cabinets, racks or enclosures impacted EMC behavior. Smaller openings or perforations are required to maintain shielding effectiveness at higher frequencies, and these must be balanced with manufacturability considerations.

Building on an existing design already suitable for rail applications, nVent SCHROFF added features to ensure EMI resilience for future applications. An optimized top and bottom cover design maximizes EMI protection while retaining similar airflow capabilities to the previous design. This updated top cover is complemented by dual mesh and side panel covers, providing additional safeguarding for side panel perforations.

As a result of these improvements,
UP TO 160% ENHANCEMENT
in EMI protection has been achieved.



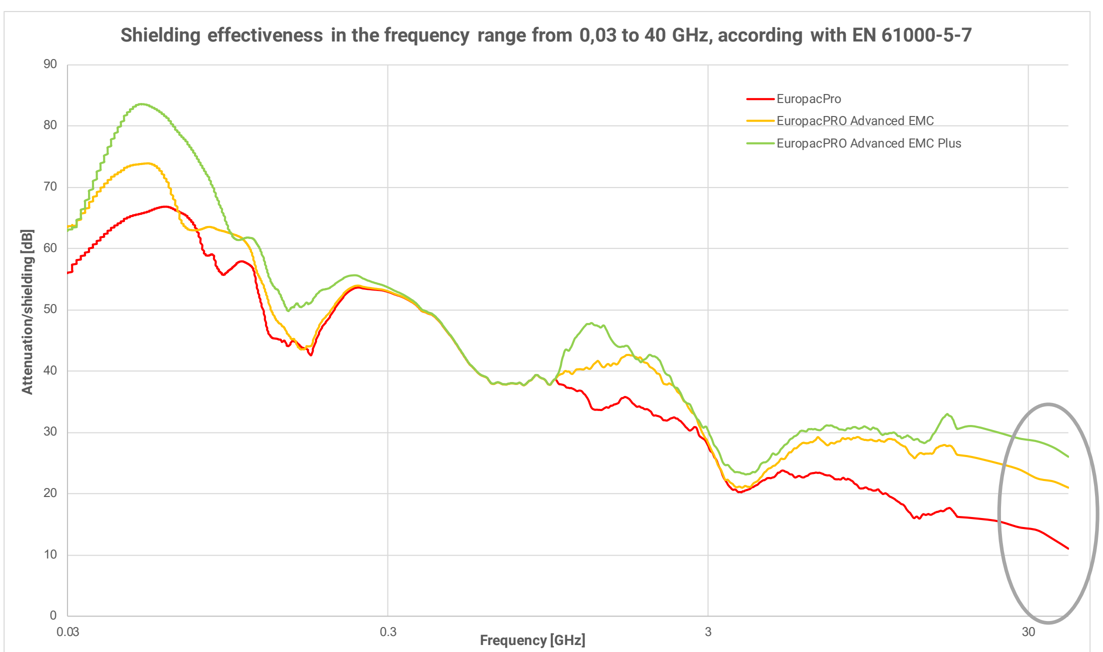
TEST REPORT

According to third party lab testing, at high frequencies the benefit of the newly designed components is significant.

EuropacPRO
Legacy design without new EMC features

EuropacPRO Advanced EMC
Newly designed side panels and covers

EuropacPRO Advanced EMC Plus
Newly designed dual mesh, side panels, and covers



The role of gaskets and seals

Gaskets and sealing are another key element of EMC protection because they prevent electromagnetic emissions from entering or leaving the enclosure. They also ensure compliance with regulatory standards and improve reliability and durability in harsh conditions.

Seal transitions in any form represent EMC-critical points since these joints will never achieve the same sealing effect as a closed surface and could reduce shielding attenuation. Today, the most well-known type of EMC seal is a contact spring, typically produced from stainless steel or copper-beryllium, which is well suited to the challenging environmental conditions of railways.

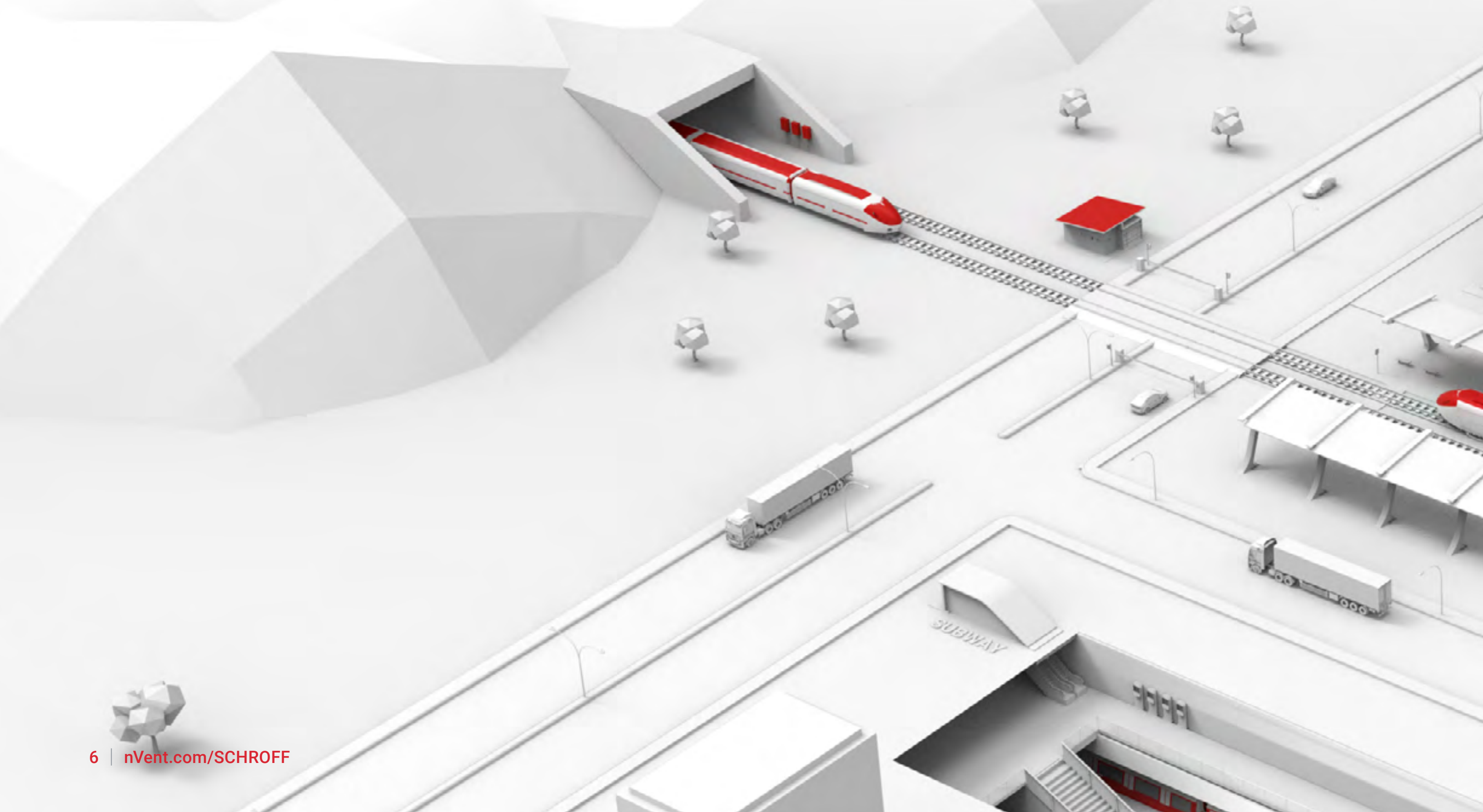
Alternatively, elastomer or textile seals can be coated with conductive textiles and can act as an environmental shield against dust and moisture. Depending on the design engineer's preference or application requirements, such as temperature range, textile or stainless-steel gaskets are a suitable choice from an EMC perspective.

Overall, attention needs to be paid to the structural design of onboard enclosures, subracks and cabinets to ensure EMC protection, including the type of covers and side panels. Along with gaskets and sealing, these elements can help optimize airflow while limiting the passage of electromagnetic emissions and combine to form a highly compliant product.

The importance of regular testing

To ensure quality and regulatory compliance, suppliers must test their components multiple times per year. In particular, they need to monitor material composition and surface quality – both of which impact EMC protection.

nVent SCHROFF maintains a rigorous and consistent testing regime for its solutions. Its EMC subrack design has been fine-tuned with the application of low-resistivity materials and mechanical design best practices developed over 60 years.



Building EMI resilience for a successful future

The emergence of a more demanding electromagnetic environment combined with tightening EMI regulations means that rolling stock owners, operators and infrastructure managers will need support from specialist suppliers with a high level of insight and technical expertise.

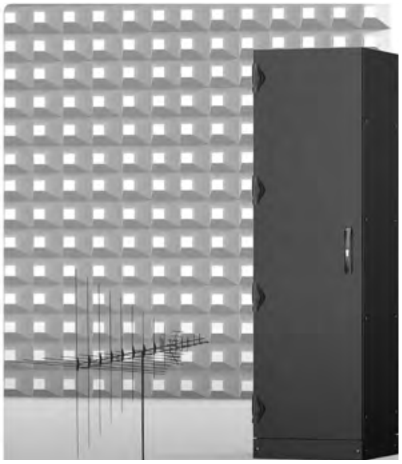
Bespoke R&D facilities, advanced production processes and rigorous testing equipment all contribute to successful component development. nVent SCHROFF offers a wide range of on-board, trackside and indoor enclosure products, including the EMC subrack, that incorporate advanced protection features such as shielding and seals, ensuring that electronic equipment functions properly and that the risk of EMI-related malfunctions or failures is minimized.

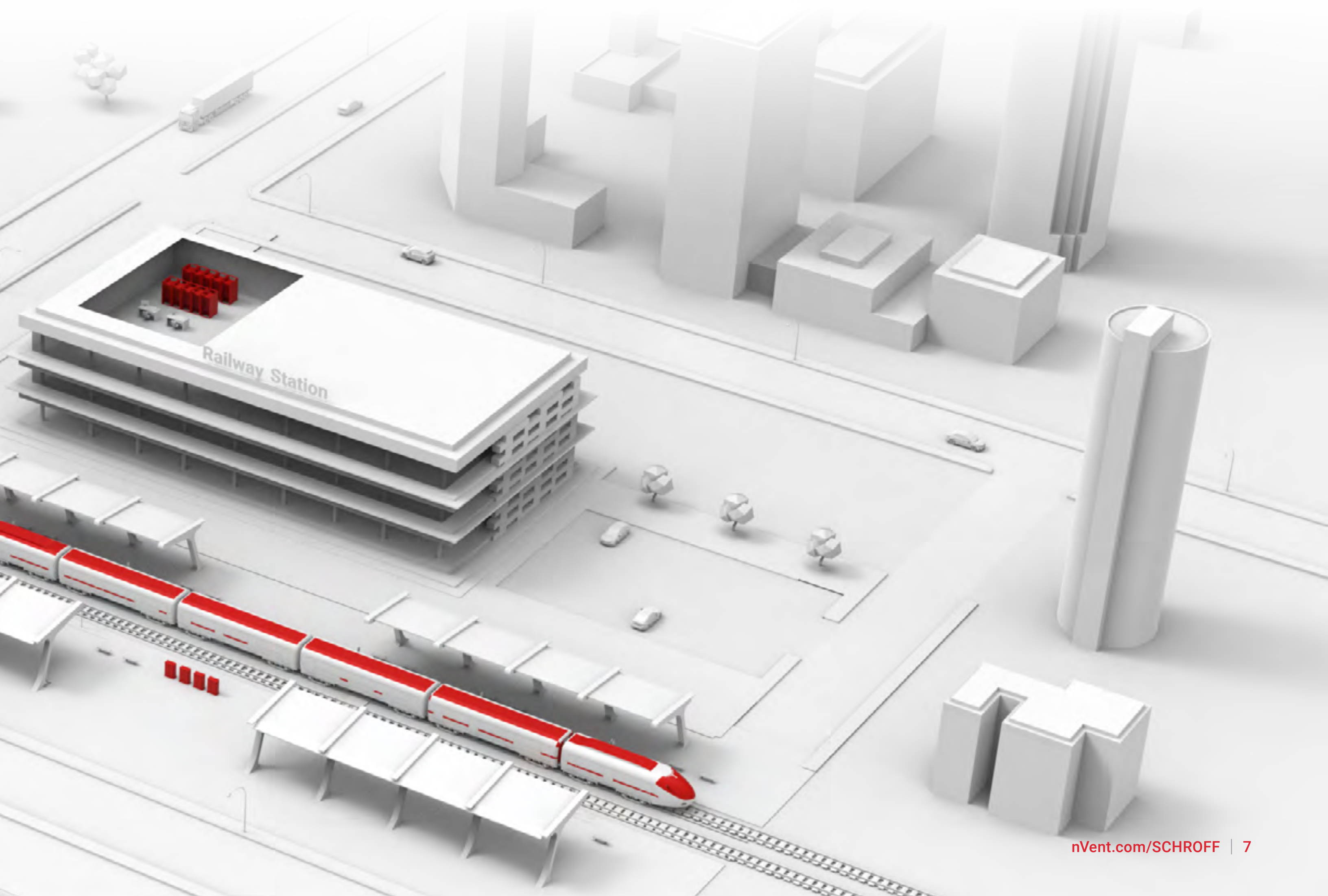
Such solutions will enable the resilient, digitalized railway of the future to progress from vision to reality.

Electromagnetic Interference (EMI/EMC),

tested to 18 GHz, per

EN 61000-5-7 and IEC 61587-3





nVent.com

Our powerful portfolio of brands:

CADDY ERICO HOFFMAN ILSCO RAYCHEM SCHROFF

SCHROFF-WPCS-N00835-AdvancedEMC-EN-2410