CONNECT AND PROTECT

Modernizing Rolling Stock

Upgrading, adding new electronics &
Maximizing limited space in on-board railway applications.

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SCHROFF

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1. Introduction

Macro trends such as urbanization, IIoT and Smart Connected Railways and Cities have spurred the rail industry to make key changes and upgrades in recent years and plan for the future move to 4G-LTE or 5G for communications. Increased political support for energy savings and more environmentally friendly modes of transport such as high-speed rail has increased government spending on infrastructure projects that ultimately reduce carbon footprint.

The demand for improved infrastructure is also driven by the continued urbanization of rapidly developing regions in Asia and South America. Urban rail is set to grow at an average of 5% per year through 2025 according to SCI Verkehr[1]. Increasing ridership while generating revenue has also driven operators to look for other opportunities to increase efficiency and profitability which can be difficult with aging infrastructure in place. Ultimately, greater connected solutions are enabling key efficiencies but also present new unique design challenges. The Industrial Internet of Things has gained importance in railways around the world. Smart trains benefit from new interconnected systems that are improving safety, security, scheduling, and rider experience while optimizing efficiency and improving the overall lifecycle cost of the infrastructure. Interconnectivity has enabled railway operators to move from reactive maintenance to proactive, predictive and preventative maintenance schemes allowing operators to avoid unplanned downtime and optimize utilization of manpower resources and efficient stocking of spare parts.

The rail industry is well established and, as a result, there is legacy infrastructure in place along with a need to upgrade existing rolling stock with new technology to enable predictive maintenance, safety initiatives, and next generation 4G-LTE and 5G communications to enhance customer experience and enable better signaling capabilities. Modernizing aging equipment for rolling stock presents unique challenges such as installing more electronics in onboard locations where space is at a premium. Installing a greater number of electronic systems on board is a balancing act to maximize space while creating passenger and operator friendly interiors. Adding new electronic systems also introduces added complexity electromagnetically. EMC protection is becoming more and more important to ensuring the safe operation of these systems.

This E-Book will discuss applications where rolling stock and signaling manufacturers were able to deliver railway certified, robust, safe designs while overcoming the challenges presented by upgrading legacy equipment or adding new IIoT connected devices. The benefits of modular electronics protection platforms and how they enable compact electronics solutions for on board use will also be highlighted.

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2. Accessibility without obstruction – Overcoming spatial limitations

Application: Train control unit located in driver's cab

For one major rolling stock provider, an electronics upgrade for a train control unit was required located in the cabin of the train. The electronics in the on-board rack needed to be fully accessible. Width was a concern for the design engineers as a standard width cabinet or rack would protrude into the aisle way obstructing a safe pathway for the driver.

Accessing electronics from the driver's cab was also a crucial part of the design. The design team leveraged the nVent SCHROFF Varistar cabinet platform which offered a space-saving solution for the on-board electronics. nVent SCHROFF Varistar is a versatile and flexible electronics cabinet solution and due to this, is often leveraged in railway applications. The final design minimized the footprint of the electronics cabinet while allowing easy access to the panels inside. This particular nVent SCHROFF Varistar included a swing frame. In a swing frame configuration, the door itself holds electronics and swings open to allow access to the back panel, which typically contains wiring to inputs/outputs and is necessary for maintenance. Without the swing frame, operators would need to remove the electronics located in the front of the rack to access the electronics at the back which would be time consuming and puts the electronics at greater risk of damage during re-installation. Mounting the electronics perpendicular to the back wall would not be possible as it would obstruct the aisle way. With the flexible, modular design of the Varistar cabinet, configuring a swing frame was a simple modification, and is one of many customizable assembly options. Additionally, leveraging a modular cabinet platform gives design engineers the ability to meet specific needs with standard part components, which is more cost effective than total customization.

Key Specifications

- IEC 61 587-1 and EN 50155 for smooth performance against shock and vibration
- EN 61000-5-7 and IEC 61587-3 for advanced EMC shielding, up to 10 GHz
- IEC 60529 for ingress protection, up to IP 55
- EN 45545-2 for 'low smoke zero halogen' compliant EMC + IP55 gaskets
- CENELEC EN 50125-3 certification for trackside use (1-3 m from the track)
- AREMA 11.5.1 class C (designed to meet U.S. railway standards for trackside use in bungalows)

Image 1: nVent SCHROFF Varistar, including a swing frame

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3. Using limited on-board space while saving transport costs

Application: Vehicle On Board Computer (VOBC) for signaling

Another example of an innovative space-saving, rack design offered by nVent SCHROFF is the bolted frame rack. The design team's goals were to simplify and reduce cost of an on board cabinet by introducing a design that could be shipped flat packed anywhere in the world and assembled efficiently and easily on site. The VOBC electronics housed in the bolted frame rack could be used for a number of critical signaling applications including monitoring train position and speed status.

The resulting rack design is unique because it is bolted together instead of being welded. The bolted design provides a compact solution that can be shipped via flat pack saving on shipping and storage costs globally. The rack can then be assembled on site, making the installation easier and faster on the train in confined spaces. The ability to assemble the rack aboard the train is easier and safer than moving a fully loaded rack through confined spaces and around corners for installation. The bolted frame has been designed and tested to AREMA and CENELEC shock and vibration specifications and provides a robust solution for housing sensitive electronics. Similar to the above On-Board Rack, the bolted frame rack is based on a modular platform, allowing engineers to easily configure a solution that can help minimize rack's overall footprint.

Key Specifications

- AREMA 11.5.1 for equipment class 1
- CENELEC EN 61373 (Category 1 Class A-B)
- EN 15085 (CL2)
- EN 45545 (Product Class A1 according to EN 13501-1)
- Shock: 5*g* in all axes (when part of train structure)
- Shock: 5*g* in one axes / 3*g* in all other axes (when not fully integrated into train structure)

Image 2: nVent SCHROFF Vehicle On-Board Rack

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4. Housing new CBTC technology in existing infrastructure systems

Application: Upgrade of signaling electronics

As electronics are becoming more and more compact, the need for smaller, modular rack solutions have arisen - often in footprints smaller than 9 U in height. Innovative On-Board Racks (OBR) from nVent SCHROFF bring space-saving efficiency to on-board electronics and can also reduce transportation costs as demonstrated in recently with a bolted frame rack design. A more compact rack enables mounting in locations previously not available such as on the floor, beneath a seat or in the ceiling of a train. Design engineers not only face designing to a fixed, limited amount of space, but also must consider the ease of installation. Recently a signaling provider was working to upgrade several lines of a major Asian city's metro network with the latest CBTC signaling technology. The 9 U footprint available for the rack was less than that of a standard 19" electronics cabinet footprint. Ease of installation on board the train was also a concern for the signaling provider. nVent SCHROFF offers a standard, compact rack design that was ideal for this retrofit application and helped the signaling design engineers meet the two challenges of limited space and ease of installation.

This modular, standard rack is a welded, stainless steel design providing durability, shock and vibration resistance, and corrosion resistance. It is welded to meet AWS and EN 15085 (CL2) standards. The modular platform gave the rolling stock manufacturer the flexibility to leverage a standard product that could easily be configured to fit the installation location's dimensions. The smaller footprint of the rack is also easier to manage during the electronics integration and installation on the train.

Leveraging a modular design, On-Board Racks can easily be stacked on top of each other or mounted side by side via a standard ganging kit. The On-Board Rack itself is rigid but is open on all sides to allow the electronics to easily be installed and maintained. The open concept of the design enables efficient cooling and simple cable management as well.

Key Specifications

- Welded to EN 15085 (CL2) and AWS standards
- Suitable for ongoing vibrations, shock, high temperatures, and high humidity
- Height 3, 6, and 9 U, width 36 and 84 HP, depth 341.8 mm
- Suitable for 1, 2, or 3 U SNCF subracks (NF F61-005, CF 60-002)
- Rear side is equipped for standard connectors; crossbar can be custom-coded for the SNCF coding pins

Image 3: nVent SCHROFF On-Board Racks are flexible in all dimensions

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5. Certified shock and vibration resistant protection for on-board electronics

Application: On-board computer for driver alerts and train control management system

Another signaling provider needed subracks to house the vehicle electronics within the above mentioned bolted frame. The electronics would be running essential driver alerts such as train position, speed, and automatic braking. nVent SCHROFF offers rugged EuropacPRO subracks that can be installed in standard Varistar cabinet solutions, rack-mount or bolted rack frames. Rugged subracks are designed to withstand extreme shock and vibrations as well as provide required EMC shielding. nVent SCHROFF has extensive experience working with end user rail standards such as EuropacPRO subracks, built specifically to French and Germany railway standards for SNCF and DB railways. Similar to the On-Board Racks and electronics cabinets, EuropacPRO subracks are based on a modular platform, enabling design engineers to easily configure the chassis to meet application requirements like various loading capacities, multiple mounting options, and the overall footprint of the chassis.

Key Specifications

- EN 50155 for smooth performance against shock and vibration
- IEC 60297-3-100 to IEC 60297-3-105
- IEEE 1101.1, 1101.10 and 1101.11
- Tested to BN 411002, NF F 67-012, NF F 60-002, and IEC 61587-2
- 3 or 6 U high, 84 HP wide, 235/295 mm deep, board 160 mm
- Vibration: 5 – 150 Hz, Shock: 5g all axes
- Temperature: 4°C – 85°C (–40°F – 185°F)
- EMC shielded or unshielded
- EMC tested to IEC 61587-3, VG 95373 T.15
- MIL 810G, MIL 901-D

Image 4: nVent SCHROFF EuropacPRO rugged subrack

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6. Faster availability of state-of-the-art railway technology using online tools and product configurators

Application: On-board computer

Specifying a subrack or electronics cabinet can be complex and requires engineers to select the right product for an application The modular nature of the nVent SCHROFF rack and subrack platforms allow versatile combinations, enabling design engineers to implement a range of versions in varying height, width and depth, simply, cost-effectively and with no design outlay. Factors such as electronics load, EMC shielding, and certifications must be considered.

nVent SCHROFF offers online configuration tools to assist with product selection. All configurators have a 3D drag and drop interface that enables users to easily configure a cabinet, subrack and front panels. The configurators have a built-in logic to ensure all components in the design are compatible while automatically generating a bill of materials. Modifications like cutouts, paint, and even card guide placement in the subracks can be defined. Finally, design engineers can also export CAD drawings to be imported into their systems or shared within their organizations.

Key Specifications

- Smart, intuitive, web-based tool that saves time during product selection
- Easy to use graphical interface with drag & drop functionality
- 3D real-time visualization and automated compatibility check ensuring all parts work with one another
- Receive a quote within 48 hours
- Output includes CAD data, 2 and 3D drawings, and BOM

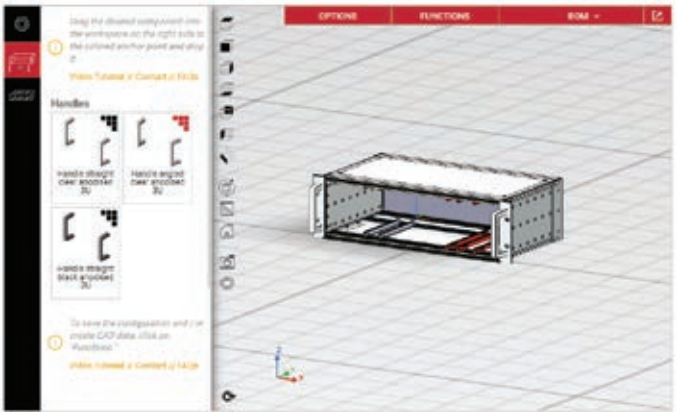

Image 5: nVent SCHROFF subrack configurator

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7. Withstanding harsh environmental conditions – even underneath the train

Application: Track quality measurement

With technology and sensor advances, predictive maintenance electronic systems may now need to be mounted in places they had not before - such as outside of the train, exposing the electronics to environmental elements like wind and weather or shock and vibrations. Small form factor or embedded systems, which are integrated in a rugged enclosure, are ideal for predictive maintenance applications outside of the train. nVent SCHROFF provides enclosure and system solutions for embedded systems both inside and outside of the train, ultimately enabling rolling stock manufacturers maximize usable on-board space.

One such example is that of a track quality measurement that must be taken from under the train. High speed data transfer was required as was a robust chassis that could offer high IP protection up to IP 65 from the elements which as a resulted in a fan less cooled solution. Additionally the enclosure needed to be completely EMC sealed for the 3 U standard CompactPCI cards in the 5 HP chassis. The rugged enclosure provided a small footprint and met technical requirements.

Withstanding the elements and forces experienced mounted underneath a passenger train was easily accomplished with the robust design. nVent SCHROFF not only was able to provide the design engineering expertise required to design the rugged enclosure but also the backplanes for the system. The system operates without downtime and reliably provides the track quality data at high speeds.

Key Specifications

- Integrated wide-range PSU (9 - 36V, 35W)
- 3-slot CompactPCI backplane, high data transfer rates
- 4 MIL-C-38999 connectors
- –40°C to +70°C (–40°F to +158°F) operating temperature
- IP 65 protection class, mounted beneath train
- Completely EMC sealed
- EN 50155 for smooth performance against shock and vibration
- Dimensions:
  Width: 200 mm x Height: 350 mm x Depth: 145 mm

Image 6: nVent SCHROFF rugged conduction cooled system

8. Conclusion

Market trends such as predictive maintenance, IIoT, and the move to 4G LTE / 5G based communications require design engineers to creatively solve the inherent challenges of adding new electronic systems on board rolling stock with limited space. Whether a new or a retrofitted solution, the need for rugged, compact rack and enclosures will continue to grow as rolling stock manufacturers are pushed to upgrade or add new systems. Modular cabinet and rack products will continue to enable rolling stock and signaling providers to leverage standard platforms globally to economically meet these challenges. Additionally, the availability of online configuration tools continue to help engineers configure modular products efficiently. Solid design partnerships between rolling stock providers, signaling manufactures, and electronics providers will ultimately enable the solutions needed to support more interconnected and sophisticated systems moving forward in the rail industry.

About the author

Katie Hausman holds a Bachelor of Science degree in Chemical Engineering from Iowa State University and an MBA from the University of St. Thomas. Prior to nVent, she spent several years with Emerson in various global product management roles. She currently is the Global Product Marketing Manager focused on the Rail Vertical Market for nVent SCHROFF products including cabinets, electromechanical components, and systems. Katie Hausman resides in the Minneapolis, MN area and is based at nVent's facility in Anoka, MN.

Sources

1) Briginshaw, David. "Global Rail Traffic Forecast for Continued Growth." International Railway Journal, Simmons Boardman Publishing, 9 Mar. 2017, www.railjournal.com/passenger/metros/global-rail-traffic-forecast-for-continued-growth/.

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