

## DIN-RAIL IN THE ELECTRICAL CONTROL CABINET AND JUNCTION BOX

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### **ABSTRACT**

This paper describes the history and use of the electrical device assembly rail, better known in the electrical industry as DIN-Rail. Originally conceived in Germany, it has become ubiquitous in virtually every electrical engineering project across the globe and may prove to be useful in the new generation of instrumentation, control, and low voltage power distribution designs in nuclear I&C designs in the United States of America. The name DIN-Rail was based on the **DIN (Deutsche Industrie Norm)** (translation: German Industrial Standard) which defined the dimensions and tolerances of the rail in order to allow manufacturers to design mounting and assembly methods for products destined for assembly onto the rail.

All dimensions on DIN-Rail are metric with a common length of 2 meters, which suits many control cabinet heights when installed vertically.

Over time, DIN-Rail has evolved from an asymmetric design (popular until the late 80's) into a family of symmetrical designs in differing widths, and heights. The most commonly used DIN-Rail in the electrical industry today is also called Top-Hat or U-Rail due to its silhouette. In the modern control cabinet it allows a host of electrical, electromechanical and electronic devices from many different manufacturers to be installed in a flexible manner, and unlike panel-mounted devices negates the need

for drilling and tapping as the capability of the control panel or junction box is enhanced over time.

### **1.0 INTRODUCTION**

Originally developed in the late 1920's, DIN-Rail has its origins in a project between the Phoenix Electrical Supply Company (today known as Phoenix Contact) and the RWE (**Rhine Westphalian Electrical Power Utility**) who were both headquartered in Essen, Germany at the time.

Due to the increase of electrical connections using nuts and bolts spaced apart on a panel board, the RWE required a method to place more electrical connections closer together. A flexible and higher density of electrical circuits was called for.

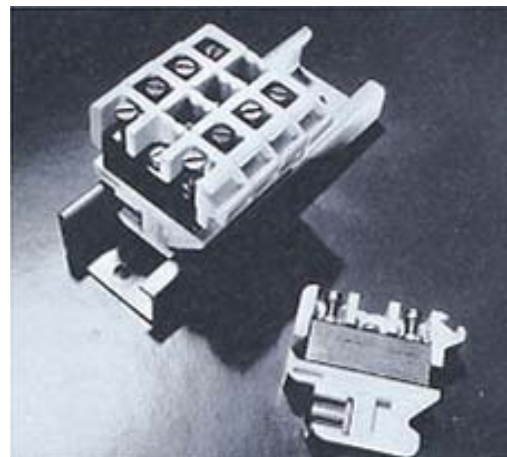


Figure 1: The Original Modular Terminal Block and Mounting Rail (ca. 1934)

The concept called for a modular termination block using ceramic porcelain as the insulation material, and a patented termination method developed by Mr. Josef Eisert, an electrical engineer and business partner with Mr. Knuemann at Phoenix Contact. Porcelain was considered the best insulator at the time, and due to its mechanical properties, a spring-loaded snap foot was installed to allow for both easy installation and removal from the mounting rail. Each terminal was designed to be open on one side and in order to ensure that products were never mounted face to face, an asymmetric rail design was developed. To allow a spectrum of products to be developed for the mounting rail, the design criteria of terminal blocks was defined to avoid any potential of electrical short circuiting between two neighboring connectors. Each group of terminal blocks, or end of the rail assembly was then closed off with a porcelain cover in the same profile as the terminal mounted on the rail.

Since ceramic is brittle and porous, it was glazed and fired in an oven prior to assembly with the patented ReacDyn (Reactionary Dynamic Screw Lock) termination assembly. To increase the air and creepage distances between the terminal block connection assembly and the steel rail which was grounded, the addition of grooves was incorporated. This combination of rail and termination block became the de-facto standard for many power plant projects.

The rail was also known as G-Rail due to its asymmetric shape, and was produced by various manufacturers under the designation NS 32 due to its 32 millimeter width. Norm Schiene (translated Standard Rail).



Figure 2: The original Modular Terminal Block was designed together with the 32 mm wide G-Rail.



Figure 3: The perforated version of the 32mm DIN-Rail

## **2.0 GERMANY'S NUCLEAR FLEET**

In the early 1950's, Siemens partnered with Westinghouse to build the 9 nuclear plants in Germany. Phoenix Contact supplied much of the connection technology and all these products were installed on DIN-Rail. Both Ceramic and thermo-setting plastics were used as insulation material, and mounted on 32mm Rail. The design rules were those of the German Nuclear Safety Standards Commission, better known as the KTA.

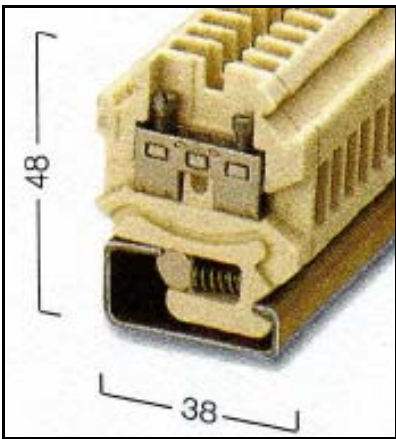


Figure 4: The Ceramic 1E Terminal Block (all dimensions in mm)

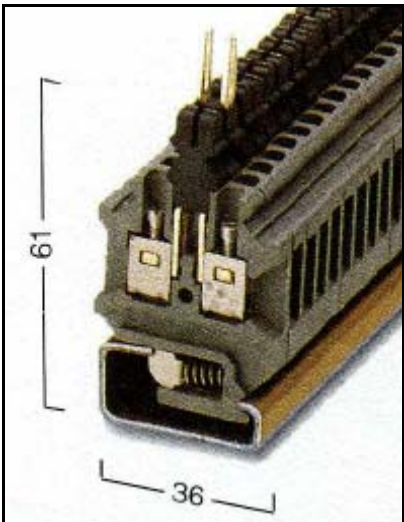


Figure 5: The Thermosetting Plastic 1E Terminal Block (all dimensions in mm)

It was in the 1980's that additional terminal blocks were added to the instrumentation and control circuits using the now popular NS 35 Rail, a symmetrical DIN-Rail that measured 35mm across. The terminal blocks utilized thermosetting plastic and the Termi-Point® and Fast-On® connections to use as little space as possible in the control cabinet and junction boxes in the containment building. The terminal blocks are designed for a maximum operating voltage of 48V. The Termi-Point® connector version has a 2Ampere current rating and the Fast-On® connector is rated to a maximum of 16Ampere.

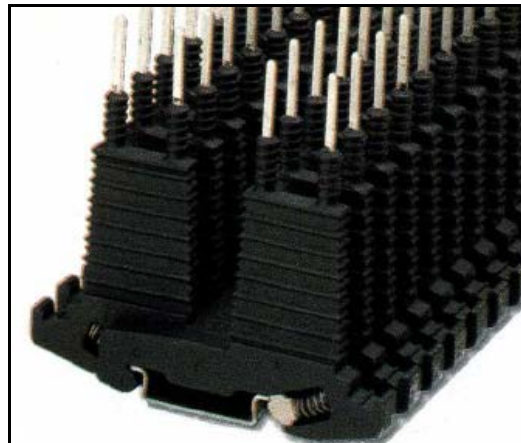


Figure 6: The TermiPoint® Containment Terminal Blocks.

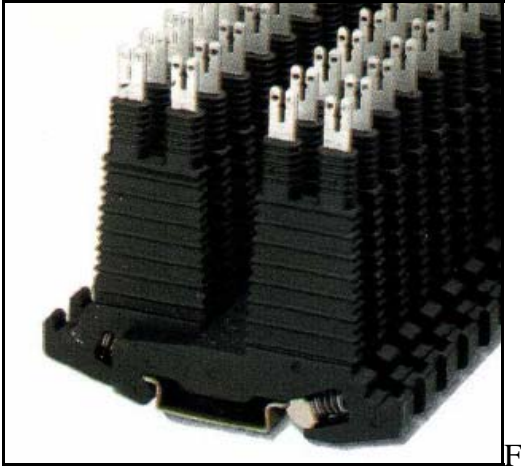


Figure 7: The 6,3/2.8 Fast-On® Containment Terminal Blocks. Both connectors were designed for installation in the containment building in revisions to nuclear power plants in Germany.

The terminal blocks are staggered to increase isolation voltage between neighboring circuits. The creepage distance of more than 65mm represents more than 2½”.

The design was tested in Germany in a five stage test including; Thermal Aging, Gamma Irradiation (5Mrad and 20Mrad), HELB, and Climate and Corrosion Testing.

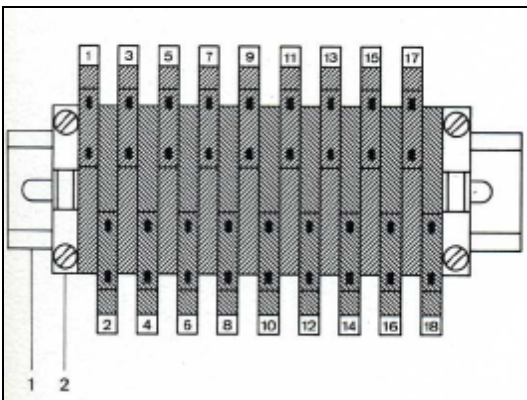


Figure 8: The stagger is symmetrical, since the connection tabs are fully enclosed.

### 3.0 DIN-RAIL IN THE USA

DIN-Rail has become ubiquitous in the American industrial control and automation market over the past few decades. The many products that can be installed on DIN-Rail are sometimes referred to as IEC Terminal Blocks, however even their US-equivalents, the NEMA Blocks, are also designed for the symmetrical 35mm DIN-Rail. Aside from a dizzying array of terminal block versions, other products such as molded case circuit breakers (MCB's), power supplies, instrumentation and control electronics, various electromechanical and solid-state relay types are also designed for the 35mm DIN-Rail.

### 4.0 DESIGN CONSIDERATIONS

Depending on the combined mass of the products loaded on a length of DIN-Rail, the choice exists for perforated and non-perforated versions of both the 7.5mm and 15mm high NS35 Rail.

The IEC EN 60715 Standard provides measurement tolerances of the rail and also details the loading of the DIN-Rail based on standard Industrial applications.

To satisfy the Seismic and other nuclear-relevant requirements of new installations it is suggested that an ad-hoc committee be formed to evaluate the requirements and recommended practices for the spacing of fixing points along the length of the rail.

In many regular non-nuclear applications, many would place the fixing screws at the end of the rails if just regular 12AWG terminal blocks were to be fitted on the rail. With the potential for products with higher mass, smaller intervals and sturdier fixing of the DIN-Rail to a control cabinet back-plate is suggested.

The torsional or twisting behavior of the rail with a combination of heavier products mounted on the DIN-Rail must be evaluated. With the use of the symmetrical rail, and a myriad of mounting mechanisms used by product manufacturers to allow their product to mount onto the DIN-Rail, it is imperative that a set of installation rules using the end stops or end clamps be developed.

### **5.0 EPRI SQRSTS**

The ad-hoc committee could benefit from the expertise of the members of the EPRI Seismic Qualification Reporting and Testing Standardization (SQRSTS) group.

The Generic – Seismic Technical Evaluation of Replacement Items evaluation (G-STERI evaluations) authored under G-STERI E-07001 title “DIN Rail Mounted Electrical and I&C Devices” evaluated the installation of Terminal Blocks, Fuse Blocks and Molded Case Circuit Breakers on DIN-Rail. The current EPRI Document is currently not available free-of-charge to the general public, since only Utilities represent the membership of the EPRI (Electric Power Research Institute, [www.epri.com](http://www.epri.com)).

The document TR 105849, EPRI Product ID 1016694, is listed for sale at \$ 25,000 on the EPRI web-site.

### **References On DIN-Rail:**

The current standard that defines DIN is the **IEC EN 60715:2001**

**Titled;** Dimensions of low-voltage switchgear and controlgear Standardized mounting on rails for mechanical support of electrical devices

in switchgear and controlgear installations  
(IEC 60715:1981 + A1:1995);  
German version EN 60715:2001

Previous Standards relating to DIN Rail were the DN EN (**D**eutsche **I**ndustrie **N**orm, **E**uropäische **N**orm, translated German Industrial Standard, European Standard) versions

DIN EN 50022: 1978-05

DIN EN 50023: 1978-05

DIN EN 50024: 1980-04

DIN EN 50035: 1980-04

DIN EN 50045: 1982-04

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# DIN-Rail and related DIN-Rail mounted devices

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## Agenda

- - History of DIN-Rail
- - Applications in the nuclear power plants
- - DIN-Rail types
- - Shock and Vibration results
- - General installation topics
- - Questions and Answers

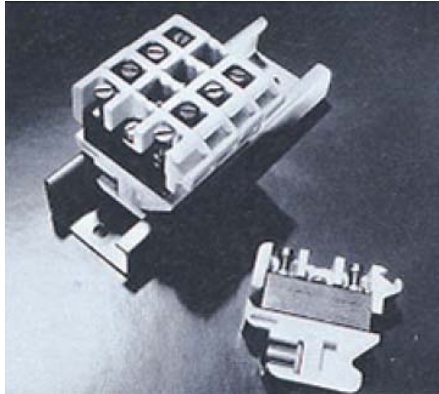
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## History of DIN-Rail



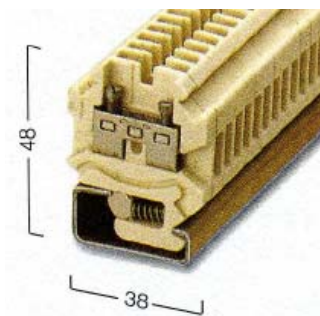
- Created and patented in 1928 together with a ceramic terminal block that allowed for space-saving wiring in a control cabinet



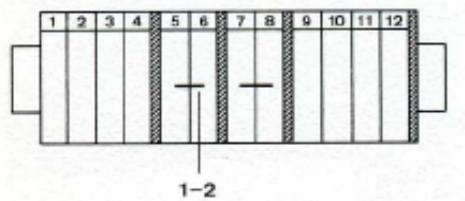
## 1E Ceramic Blocks



- 12AWG, 34A and 500V Rating



Dimensions in millimeters



Bridging and End Clamps

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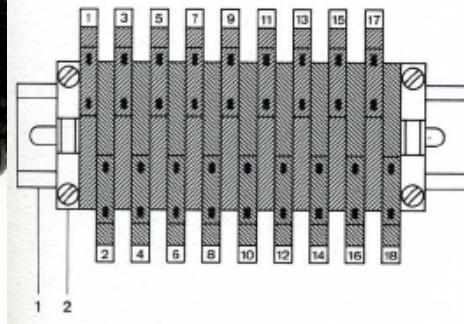
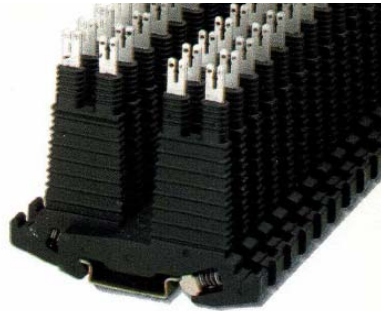


## Containment Block-CK



1980

- 16 Ampere rating at 48VDC
- Creepage distance 54mm (over 2 ½ Inches)



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## Applications in nuclear power plants

- Used in all types of power utility in Europe since the 1930's
- A standard in the European nuclear plant since the 1950's
- Being implemented in life extensions and safety upgrades of Nuclear Power Plants in the USA

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## DIN-Rail types

- Steel, Copper, Aluminium, Zinc-plated and Trivalent Chromated (Cr3) versions
- NS 32 and NS 35 versions

NS 32 Perforated



NS 35 Perforated



NS 35/15 Unperforated



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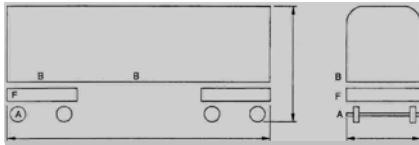
## Shock and Vibration results

- In the Railroad industry, 350G Shock, and 5 G Vibration is a requirement for all electrical systems.
- In the near future, together with the industry we could collate all existing data and collaborate on continuing tests related to Shock and Vibration for Nuclear Applications

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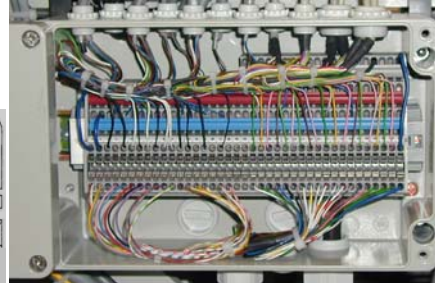


# DIN-Rail Equipment Random Vibration Test



IEC 61373 (DIN 50155)

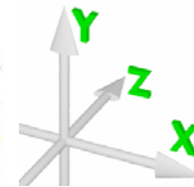
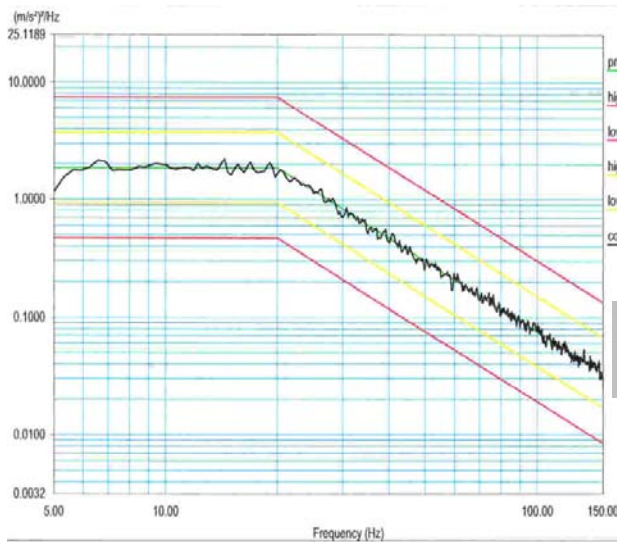
**Requirement: Category 1 B:**  
Components, that are used inside body mounted cabinets of the railway vehicle



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# DIN-Rail Equipment Random Vibration Test



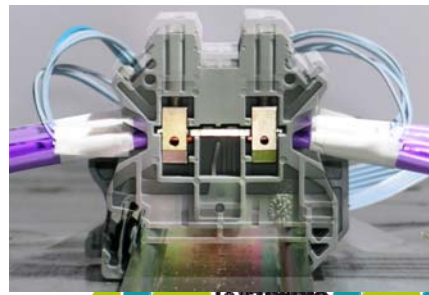
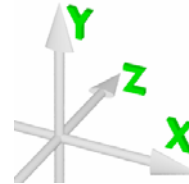
5 h per Axis with spectral density of acceleration : 7,9 (m/s²)²



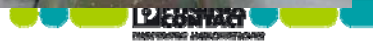
# DIN-Rail Equipment Mechanical Shock Test



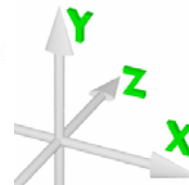
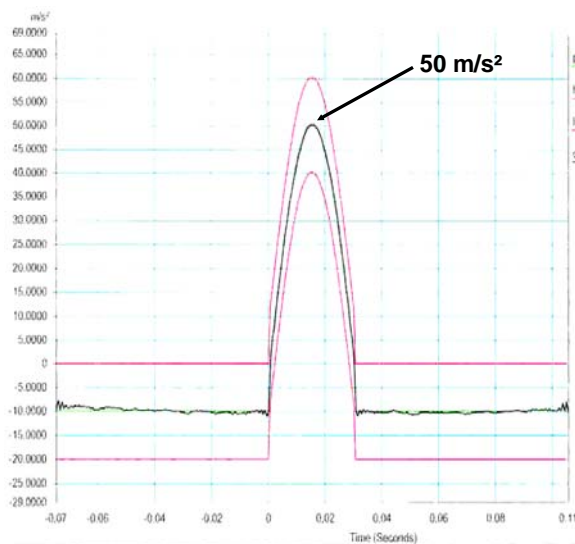
IEC 61373 (IEC 60068-2-27)  
**Requirement: Category 1 B:**  
**Components, that are used inside body mounted cabinets of the railway vehicle**



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# DIN-Rail Equipment Mechanical Shock Test





**3 Peaks lasting 30 ms in each direction, positive and negative**

**No Interruption of electrical contact exceeding 1  $\mu$ s**



## RoHS & OSHA Directives

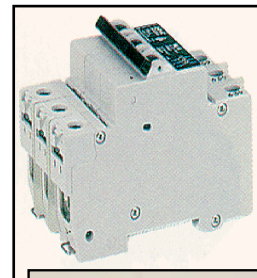
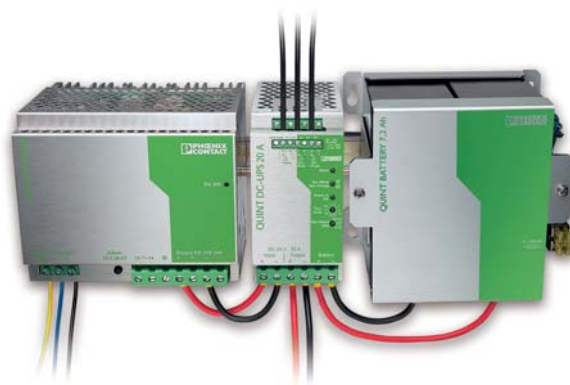
- **RoHS** Directive (2002/95/EC) < 0.1% ppm
- **OSHA** Directive 1910.1026 of February 2006  
Reduce personal exposure to Cr6 particulate.  
2.5 micrograms/cubic meter of air in 8 hour period.

|   |  |
|---|--|
| Yellow Chromate (Cr6)<br>Hexavalent Chromium                                      | White Chromate (Cr6)<br>Trivalent Chromium   |
|  |  |
|   | January 2006 onwards.....  |

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## Products on DIN-Rail

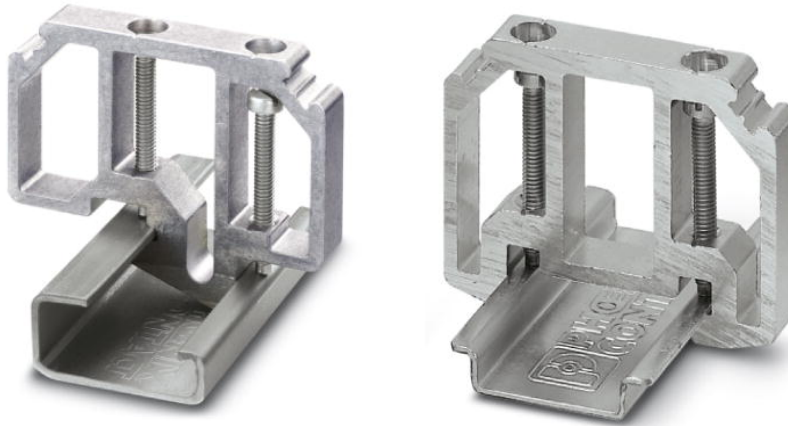


Electronic Interfaces, Relays, Contactors and Power Supplies

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## End Clamps



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## Q & A

- Questions & Answers
- Comments
- Next Activities

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