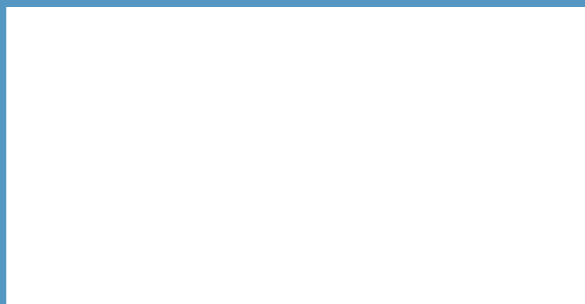


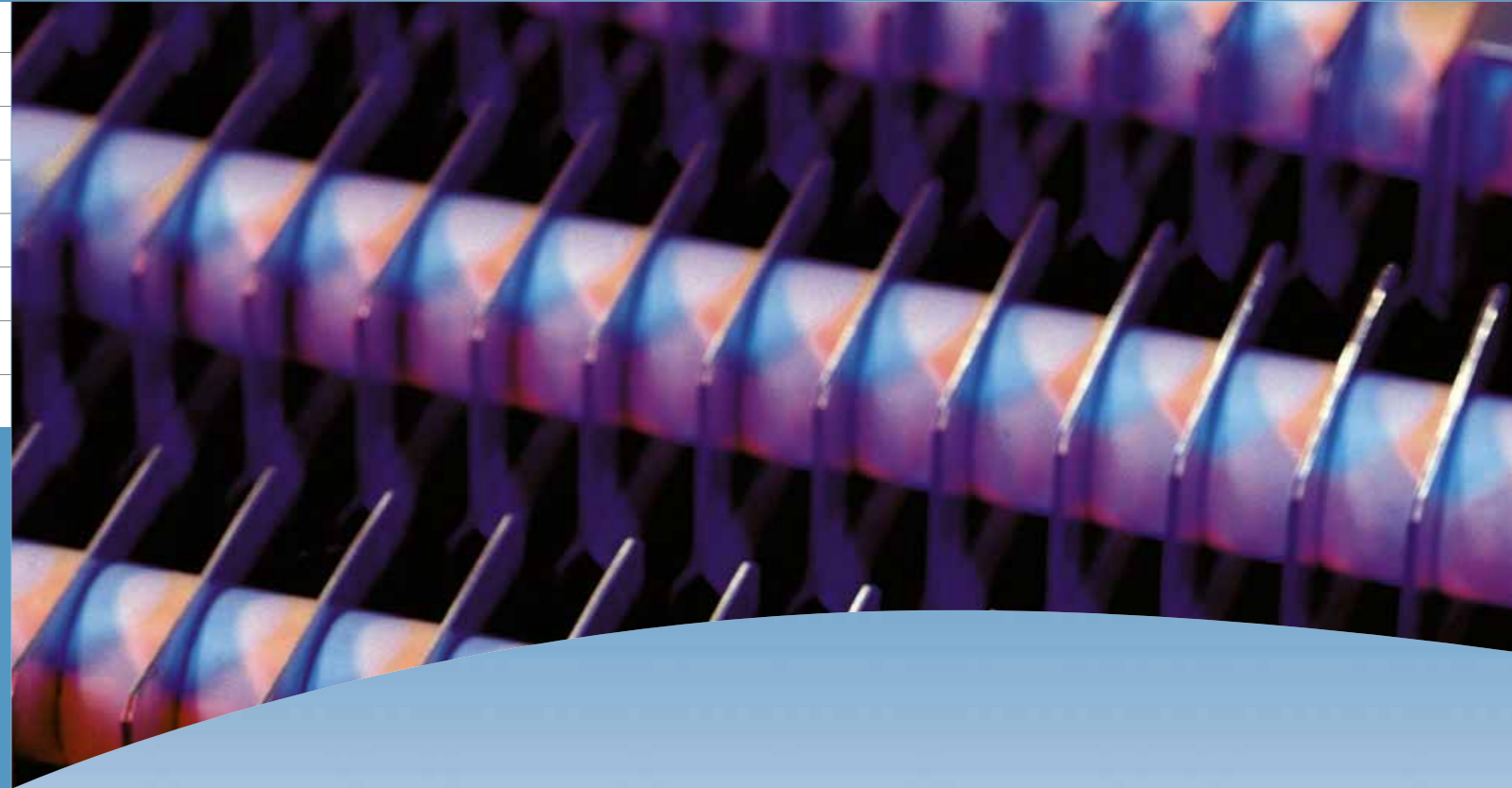
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# Resistors



Stationary Resistors  
**Neutral Grounding**  
**Filter**  
**Load Bank**  
**Starting/Braking/Discharge**  
**Line Test**

On Board Resistors  
**Braking**  
**Continuous Duty Control**  
**Impulsive Duty Control**



# Resistors



Applications
Rail On Board
DC Substation
Energy
Industry

Microelettrica Scientifica Resistor Division is one of the world leading companies in the design and production of power Resistors for Rail, Substation, Energy and Industrial application. The MS Resistor division is capable to tailor engineer and fully validate a dedicated solution for Rail Vehicles, but at the same time offers a wide variety of standardised types of resistor for stationary use (Energy and Industrial use). Its quality is in compliance with standards ISO 9001: 2008 and ISO 14000.

The MS Resistor Division is located in Lacchiarella, approximately 20 km South of Milan along the route to Genova. The factory site comprises 5000 square-meters of which 3400 indoor. The Microelettrica Scientifica Resistors experience and tradition begins in the 1970's as the company develops its first Resistors for crane control based on RL plate elements. It then evolves in the 1980's with the development of the JF ribbon elements technology, with which the Company rapidly expands

on the Rail Vehicles market, becoming one of the world leading suppliers of braking Resistors and other traction control Resistors. As of 2005 Microelettrica Scientifica is member of the Knorr Bremse Group, the German world leader in rail and commercial vehicles braking systems. Knorr Bremse Group portfolio for Rail Vehicles also includes doors and entrance systems and HVAC systems for vehicles, as well as platform screen doors and gates for railway stations.



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Products	
Stationary Resistors	Neutral Grounding
	Filter
	Load Banks
	Starting Braking Discharge
	Line Test
On Board Resistors	Braking
	Continuous duty control
	Impulsive duty control

# Neutral Grounding



Short circuits between phase and ground can result in irreversible damage to networks and equipments; it is therefore of the utmost importance to be able to control and reduce their effects: Grounding Resistors limit the fault current that arises due to phase-neutral short circuits. Grounding through resistor offers several advantages with respect to alternative methods (such as insulated grounding, direct grounding or grounding through a reactance). The main advantages are: easier detection of fault location, limitation of fault current, no transient over voltages.

Relevant parameters in the design of a Neutral Grounding Resistors may vary greatly: Microelettrica has developed a line of standard products (for the most common requirements) along with tailored projects, each developed and customised according to the required characteristics. Our products range from Low Voltage systems (<1kV) to High Voltage (132kV insulation class), as well as from very low fault current values (tens of Amps) to very high (>10kA).

The essential pieces of information needed to design a Grounding Resistors are:

- Nominal Voltage
- Fault Current
- Fault Duration (10s is customary)



Other relevant parameters are:

- Protection degree of enclosure; from IP00 - i.e. no enclosure - to IP55, standard solution IP23
- Enclosure finish; our standard is mild galvanised, but different stainless steel (such as AISI304 or AISI316) are also available. Painting in the desired RAL colour is also an option
- Continuous current rating; it may affect significantly the performance of the resistor, especially when high IP degrees are required
- Environment and Elevation; we design resistors for the harshest industrial or natural settings
- Auxiliary components; during our many years of operation we have selected a number of trusted suppliers for a wide choice of ancillary components, such as Current Transformers, Switches, Disconnectors, etc.

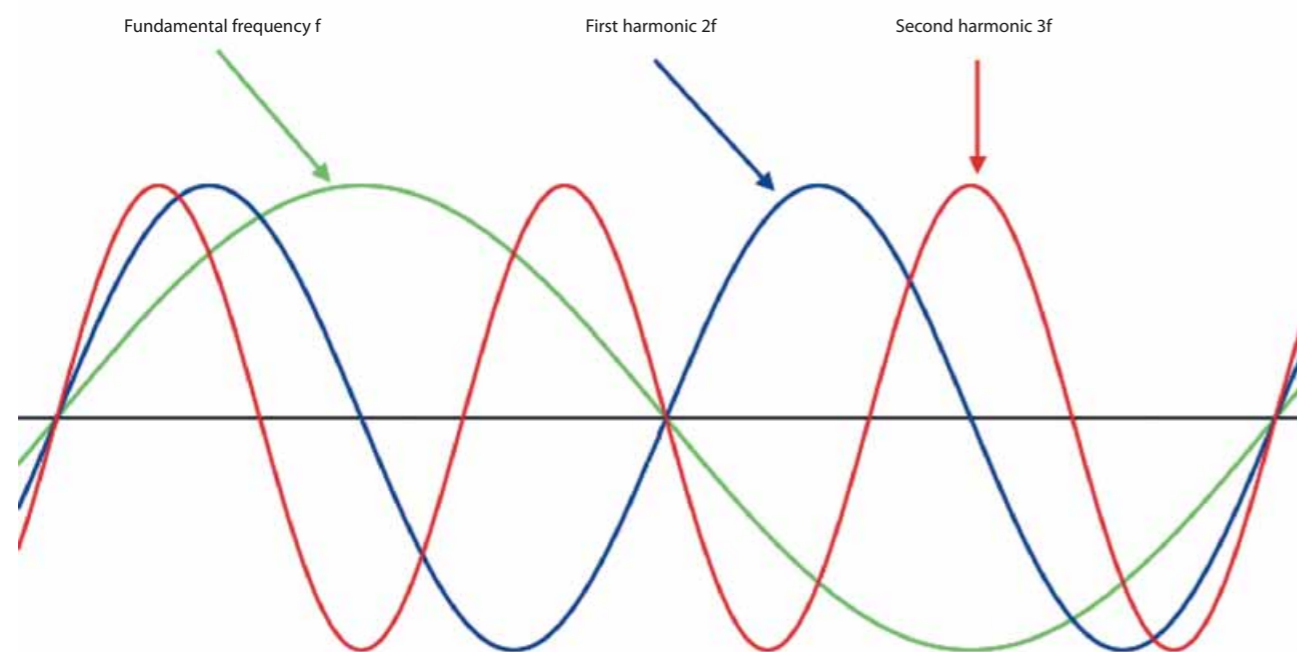
## Applications

Energy

Industry



# Harmonic Filter



Quality of power is becoming ever more important for both suppliers and end users, as the number of devices that may feed harmonics in power systems is increased, resulting in higher line losses, interferences and resonances.

Harmonic Filters - made up by capacitors, inductors and resistors - help clearing harmonics which inevitably tend to occur. The LC circuit filters all spurious frequencies and only lets fundamental frequency through, while the Harmonic Filter Resistors (Harmonic Filters Resistors, also referred to as Damping Resistors) dissipate harmonic currents into heat.

Typical fields of applications for Harmonic Filters Resistors are HVDC networks and electrical induction furnaces.

Our team of experienced engineers designs the best solution for the different characteristics required and the most diverse environment. Microelettrica can custom design Harmonic Filters Resistors from a few kW power up to tens of MW, as well as B.I.L. up to 600kV. Our Harmonic Filter Resistors employ non-magnetic low temperature-coefficient elements, to minimise Ohmic value drift and therefore preventing excessive power increase. They also show low parasitic inductance values, which is a key feature for the effective design of damping elements.

The essential pieces of information needed to design an Harmonic Filters Resistors are:

- Nominal Voltage
- Current or Power
- Ohmic Value (with tolerance in %)

Other relevant parameters are:

- B.I.L.
- Required Insulation Level; HV terminal to hearth, LV terminal to earth, between terminals
- Clearance and Creepage
- Enclosure finish; our standard is mild galvanised, but different stainless steel (such as AISI304 or AISI316) are also available. Painting in the desired RAL colour is also an option
- Environment; we design resistors for the harshest industrial or natural settings
- Maximum Inductance
- Bushing Layout; top or side mounted
- Mounting; three-phase stacked, side by side, others

## Applications

Energy

Industry



# Load Banks



Load Banks allow to effectively check the efficiency of emergency sets (generators, Uninterruptible Power Supplies...) and can be employed as dummy loads to prevent wet stacking on diesel engines. They represent a reliable and economic way to prolong the lifetime of extremely expensive and important equipments.

Microelettrica custom designs Load Banks to satisfy all requirements, both in terms of power to be dissipated (from tens of kW to tens of MW), of insulation level (from hundreds of Volts up to 36kV insulation class) and of integration of the most diverse power steps, thanks to the wide variety of grid types designed and produced by Microelettrica itself.

Thanks to its many years of experience in both industrial and railway field, Microelettrica has also developed reliable ventilation curves, and can therefore offer forced-ventilated Load Banks, whose main advantage is that of allowing higher power-per-element and thus smaller size. Microelettrica Load Banks are suitable for indoor and/or outdoor use; they are placed in enclosures with up to IP23 protection degree. Ventilation can be without distinction horizontal or vertical.



# Resistors



Microelettrica Load Banks can be controlled either locally or remotely (on request), through switches and contactors (also produced by Microelettrica).

The essential pieces of information needed to design a Load Banks are:

- Nominal Voltage
- Power
- Number and type of steps, if any
- Type of ventilation (natural or forced)

Other relevant parameters are:

- Maximum Ohmic value drift; in case it is necessary to contain the thermal drift of the resistance value, alloys with extremely low temperature coefficients can be employed
- Protection degree of enclosure; up to IP23, standard IP20 (vertical ventilation) or IP21 (horizontal ventilation, only for forced air cooled Load Banks)
- Enclosure finish; our standard is mild galvanised, but different stainless steel (such as AISI304 or AISI316) are also available. Painting in the desired RAL colour is also an option
- Environment and Elevation; we design resistors for the harshest industrial or natural settings
- Auxiliary components; contactors for step switching, also manufactured by Microelettrica



## Applications

Energy

Industry

# Starting Braking Discharge



Starting and Braking Resistors are widely employed for controlling motors during start and/or stop.

**Starting Resistors** may be used for wound rotor induction motor and DC wound motor (this last type of motor is less and less common): adding a series resistor to each rotor phase reduces the current and improves the starting torque. Starting Resistors may also be employed for squirrel cage induction motors, where series resistors added to the stator, limit initial current to three times its nominal value. Starting Resistors for squirrel cage motors are also known as Ballast Resistor.

The essential pieces of information needed to design a Starting Resistor are:

- Horsepower
- Rotor/Stator Voltage
- Rotor/Stator Current
- RPM
- Application; different applications require different solutions

Crane control is a quite common application for **Braking Resistors**: during descent the load, especially if heavy, may cause the motor to generate power as if it were lifting. Resistors are thus used to avoid unwanted and uncontrolled acceleration.



# Resistors



Braking Resistors for large motors are customised to best comply with any requirement: we have developed special Braking Resistors for important research institutes (among them Max Planck Institute) and for energies in excess of 3400MJ.

Disexcitation of large capacitors and inductors must be carried out with care to avoid impulsive currents that could damage them permanently. **Discharge Resistors** limit the peak current and protect the capacitive/inductive device.

The essential pieces of information needed to design a Discharge Resistors are:

- Nominal Voltage
- Discharge Current
- Discharge Duration

Discharge Resistors are often connected with research institutes and they require a very high level of customisation, sometimes also leading to the development of new technologies for resistive elements. Microelettrica has cooperated with Universities all over the world and with the most prestigious research centers (among them, CERN in Geneve).

## Applications

Industry



# Line Test

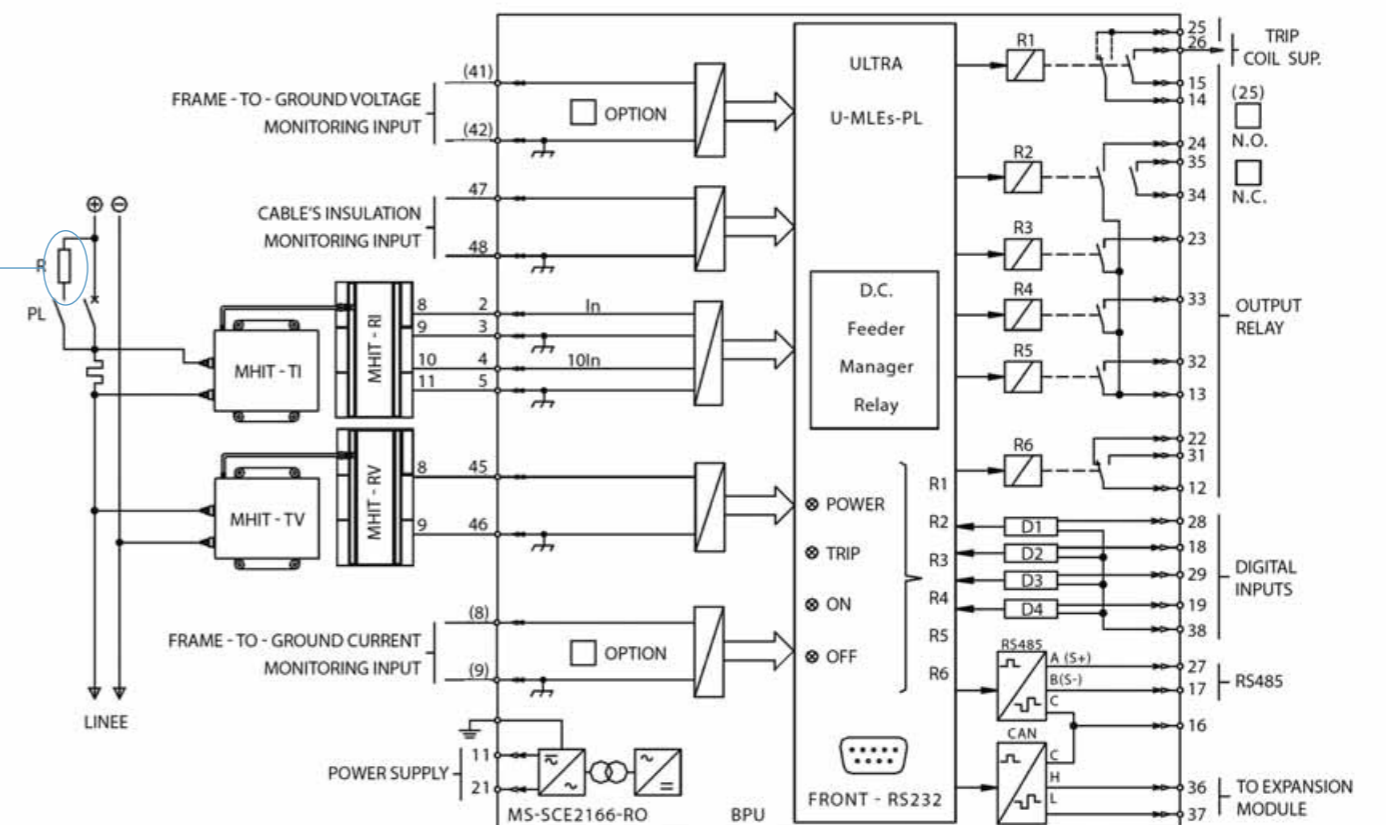
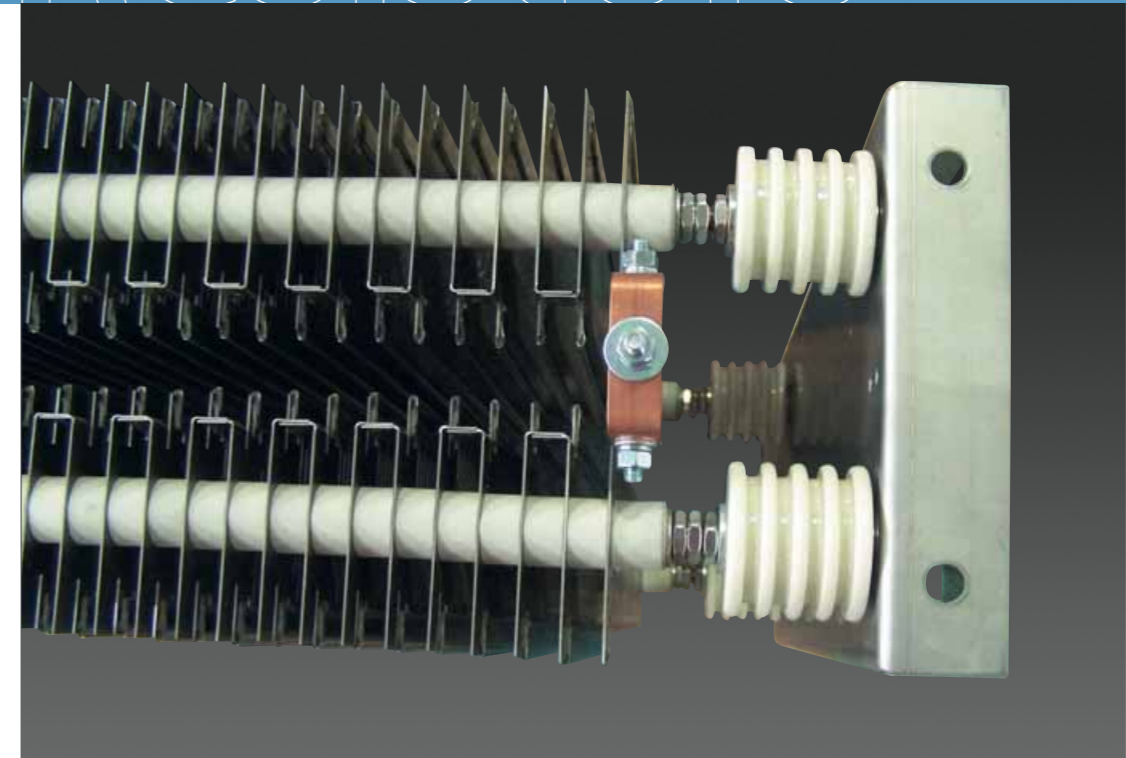
## Applications

DC Substation

High Speed DC circuit breakers are valuable components which must be protected against wear and tear and excessive current flow. Before closing High Speed Circuit Breaker on a power line, it is therefore advisable to test whether a short circuit is occurring by means of line test resistors. The resistor is electrically connected through a contactor - if no fault current is detected - then it is safe to activate the circuit breaker; otherwise, there is a fault somewhere on the line. It is as well possible that activating the resistor for a few times in a row (On - Off cycles with the desired number of consecutive on steps) may help in getting rid of the physical cause of the short circuit.

The essential pieces of information needed to design a Line Test Resistor are:

- Nominal Voltage
- Test Current
- Duty cycle



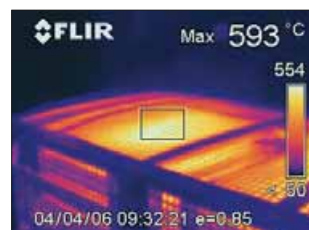
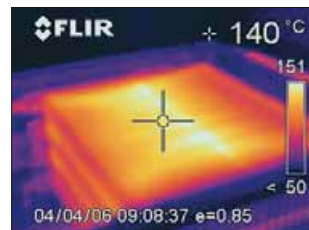
# Braking

Braking Resistors are used to transform kinetic energy of the vehicle into heat by/means/of electric braking.

Braking Resistors are usually installed:

- On the roof of a vehicle, where hot exhaust air is released upwards
- Under frame, where the hot air released is exhausted sideways when the vehicle is in motion or using a blower
- Inside the vehicle, where the resistors are usually forced air cooled, where fresh air is taken from the bottom of the vehicle and hot air is expelled from the top

Resistor elements are assembled in banks by means of strong rods and ceramic spacers. The banks are contained in strong shoulders or support frame of AISI 304 stainless steel.



Stainless steel is also used for bolts, nuts and washers. The resistors are designed to avoid disturbing noises caused by pulsating current.

Resistors are designed by our engineers with a sophisticated 3D model in order to find the best solution for customers and to withstand shocks and vibrations that normally occur in operation. Design and all production, strictly follow ISO 9001-2008 quality standards and the most severe international specifications.

All our resistors are type tested at our test room where real service conditions can be reproduced via mock-up and motion air flow simulation. All Microelettrica Scientifica sites are equipped with dedicated testing facilities to guarantee product compliance with spec requirements.

A Railway Resistor is a 100% custom made product, where a few constructive and technological principles are applied in a project-specific mechanical frame layout.

## Applications

Rail On Board



# Continuos Duty Control Resistors

- Damping
- Filter

## Applications

Rail On Board

Auxiliary resistors are designed and optimized in order to adapt to the available space on the vehicle.

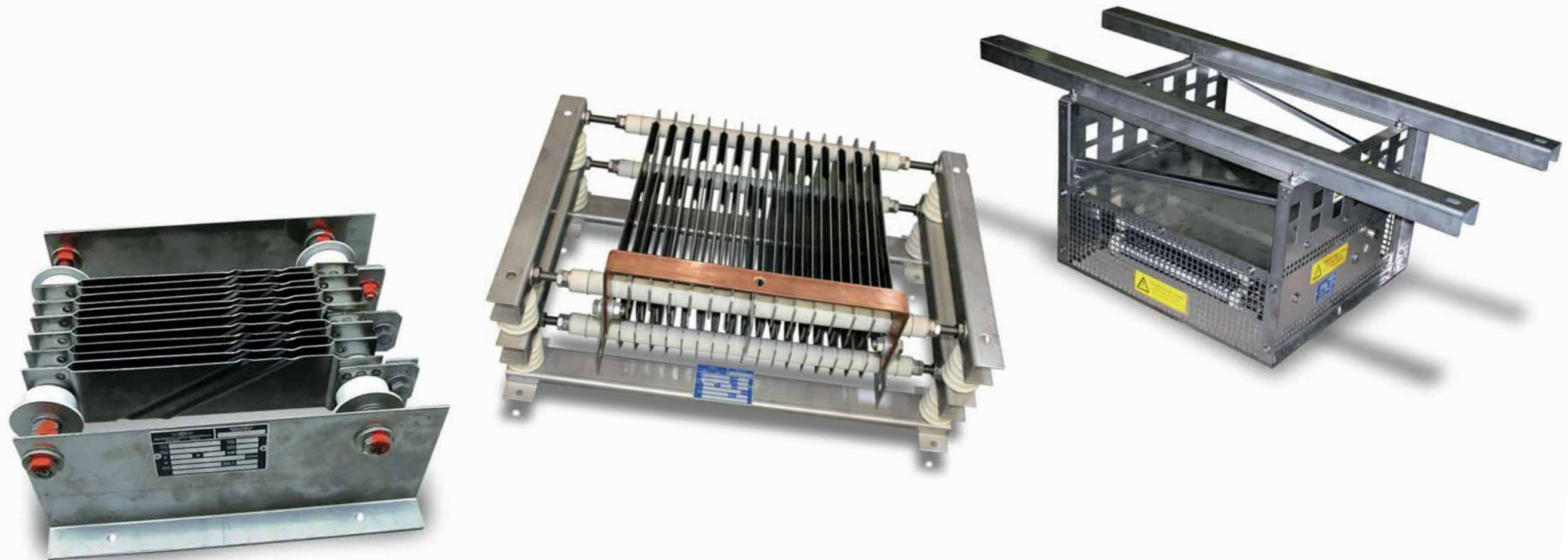
Damping Resistors are used to limit current and voltage peaks in a power circuit.

Filter Resistors are used to remove harmonic voltage distortion caused by the ever-increasing use of power electronics and other solid state devices.

Harmonics can be reduced to acceptable levels by passive filter circuits, where the currents are dissipated as heat.

Small resistors size and high ohmic value are available.

Resistors are designed by our engineers with a 3D model in order to find the best solution for customers and to withstand shocks and vibrations that normally occur in operation without being damaged. Design and all production strictly follow ISO 9001-2008 quality standards and the most severe international specifications.



# Impulsive Duty Control Resistors

- Crowbar
- Charging
- Discharging

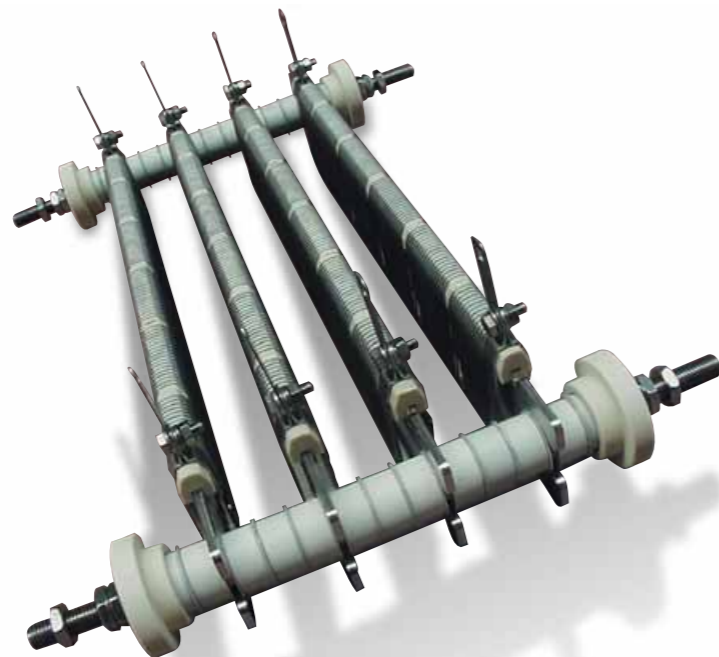
## Applications

Rail On Board

Control Resistors are designed and optimized in order to adapt to the available space on the vehicle.

Charging and Discharging Resistors are used to limit inrush currents to the capacitors during charging and also to discharge them safely when required.

Crowbar Resistors are used in traction power supply circuits in order to deal with the effects of transient or longer lasting over-voltage conditions



# Resistors



Resistors are designed by our engineers with a 3D model in order to find the best solution for customers and to withstand shocks and vibrations that normally occur in operation without being damaged. Design and all production strictly follow ISO 9001-2008 quality standards and the most severe international specifications.

